Appendix A
Overhaul of the System

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ACRONYMS AND ABBREVIATIONS

BGS	behavioral guidance structure
BiOp	biological opinion
BPA	Bonneville Power Administration
cfs	cubic feet per second
Corps	U.S. Army Corps of Engineers
DART	Data Access in Real Time
ESA	Endangered Species Act
ESBS	extended-length submerged bar screen
ESTS	extended submerged traveling screen
ESU	Evolutionarily Significant Unit
FCRPS	Federal Columbia River Power System
FGE	fish guidance efficiency
FPE	fish passage efficiency
HGMP	hatchery and genetic management plan
HUC	hydrologic unit code
kcfs	thousand cubic feet per second
MAF	million acre-feet
MOP	minimum operating pool
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
PH1	Powerhouse One
PH2	Powerhouse Two
PIT-tag	passive integrated transponder (tag)
RM&E	research, monitoring, and evaluation
RPA	Reasonable and Prudent Alternative
RSW	Removable Spillway Weir
SLED	Sea Lion Exclusion Device
SRD	Storage Reservation Diagram
STS	submerged traveling screen
TDG	total dissolved gas
TSW	temporary spillway weir
URC	upper rule curve
USFWS	U.S. Fish and Wildlife Service
VARQ	variable flow schedule - VAR (variable) Q (flow)
VBS	vertical barrier screen

A.1. INTRODUCTION

In reference to actions taken for fish protection at the Federal Columbia River Power System (FCRPS) projects, Judge Marsh declared in 1994 "the situation literally cries out for a major overhaul" (Marsh 1994). Since then, the Action Agencies made significant changes, including a number of improvements and additions to fish passage facilities, operational changes in flow, spill and the juvenile transportation program, and aggressive predator management.

Primarily through the U.S. Army Corps of Engineers' (Corps') Columbia River Fish Mitigation Project, structural improvements at the dams have been added to improve fish passage resulting in significant survival improvements. Over $1 billion has been invested from the mid-1990s through 2006 in baseline research, development and testing of prototype improvements, and construction of new facilities and upgrades. The improvements in the physical facilities, along with improvements in the flow and spill programs, have delivered substantial improvements in both juvenile survival numbers and adult returns.

Figure A-1 illustrates the changes in Snake River juvenile spring and summer Chinook salmon and steelhead in-river survivals during this period. Increases in juvenile survival will likely improve adult returns over the long term. Recent adult returns are shown below in Figure A-2.

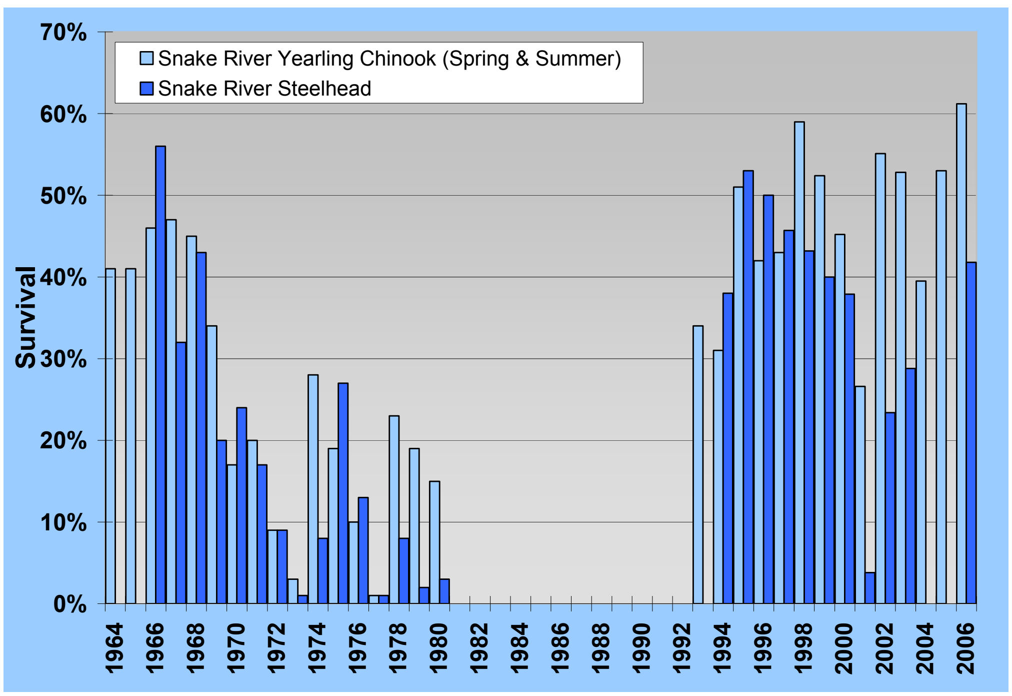

Figure A-1. Estimates of In-River Survival of Snake River Chinook Salmon and Steelhead from 1964 to 2006[1]

[1] Data were not collected in some years for both species. Returns from 1964 to 1980 were obtained using a different methodology from the PIT-tag-based returns in 1993 to 2006. Trends within the two groups of data are accurate, but caution should be exercised when making direct comparisons between groups.

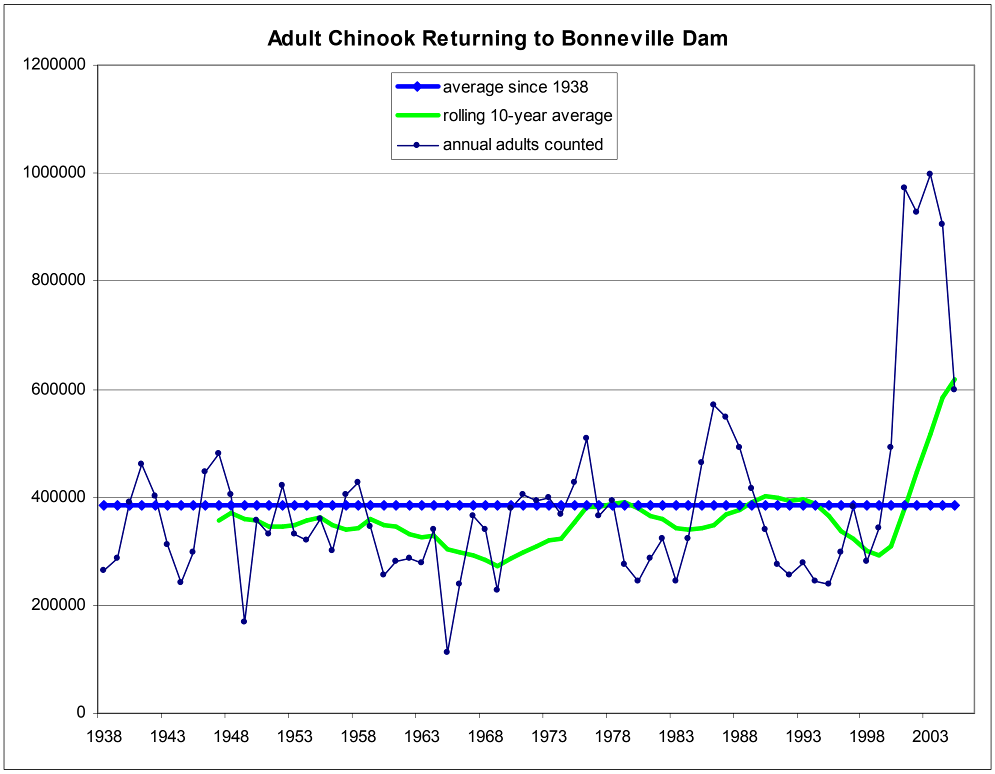

Figure A-2. Numbers of Adult Chinook Salmon Returning to Bonneville Dam, 1938 to 2005

A.2. STRUCTURAL CHANGES FOR FISH PASSAGE AT MAINSTEM DAMS

Significant structural changes for juvenile and adult passage at the Lower Snake and Lower Columbia river mainstem projects that have improved passage conditions are discussed in this section. Juvenile migrants pass the projects several ways: 1) through turbines, 2) through juvenile bypass facilities, 3) through spillways, and 4) through surface bypass facilities. Adults migrate back to their spawning grounds and traverse the dams using fish ladders, also called fishways. Improvements in all passage routes for both juvenile and adult migrating fish are explained in more detail below.

The following outlines the major modifications to dams and fish facilities for improving juvenile and adult salmon passage during this period:

- Addition of surface collectors or surface bypass systems, exemplified by the highly effective bypass collectors (Corner Collector) and flumes at Bonneville Dam, and the removable spillway weirs (RSWs) at Lower Granite and Ice Harbor dams;
- Improvements to the existing juvenile fish guidance screens, bypass facilities and outfalls, transport collection and handling facilities, and state-of-the-art monitoring systems;
- Installation of spillway flow deflectors on most spillbays at all projects, except The Dalles Dam[2], to reduce the harmful affects of total dissolved gas (TDG) and increase spill passage of juvenile fish;

[2] Flow deflectors have not been installed at The Dalles due to the shallow stilling basin.

- Improved adult fish ladders, auxiliary water supplies as well as more effective passive integrated transponder (PIT)-tag monitoring systems for both adults and juveniles, including the state-of-the-art facilities at Little Goose and Bonneville dams;
- Developing and testing behavioral guidance structures (BGS) to influence the horizontal travel of juvenile fish toward bypass facilities at the dams;
- Tailrace egress improvements such as the new "spill wall," in year two of testing at The Dalles Dam; and
- Powerhouse turbine unit operational priorities to enhance juvenile egress and adult passage.

As a case in point, the following discussion specifically addresses modifications made at Bonneville Dam to illustrate the significant improvement in juvenile survival associated with these changes. Figure A-3 describes the survival of juvenile salmonids by route of passage in years 1995 to 1999, prior to installation of the Corner Collector and other major improvements.

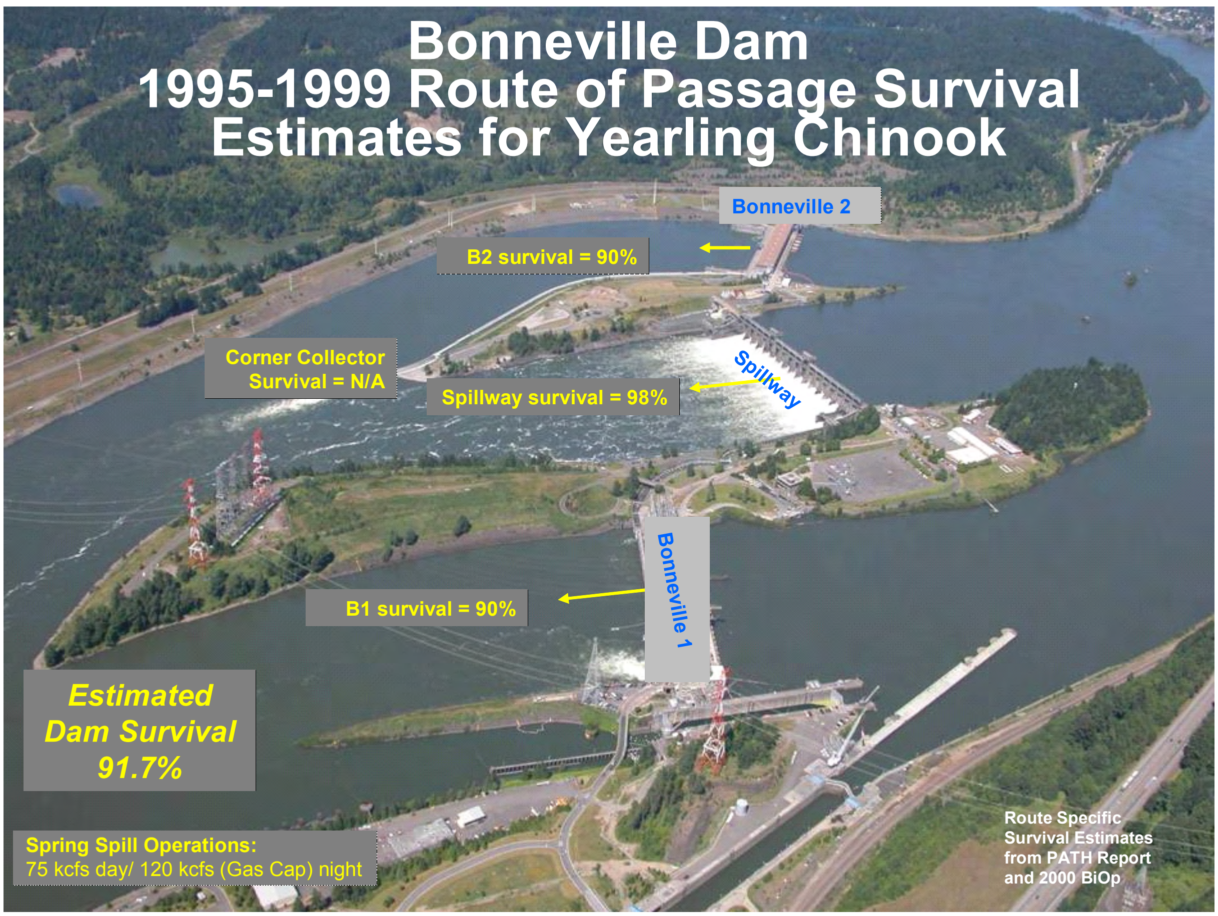

Figure A-3. Estimated Dam Survival Rate at Bonneville Dam for Yearling Chinook Salmon from 1995 to 1999
(Survival numbers depicted do not include improvements from the Corner Collector, which was not installed until 2004.)

The combined modifications identified in Figure A-4 have improved survival of listed Evolutionarily Significant Units (ESUs), as well as non-listed salmonid populations, passing Bonneville Dam. The primary actions that have contributed to these improvements include:

- Priority operation of Bonneville Powerhouse 2 (PH2). Increased juvenile survival as well as reduced adult fallback at the project.
- Improvements to the Bonneville PH2 juvenile bypass system and outfall. The entire juvenile bypass system was rebuilt including modifications to the orifices, complete rebuild of the collection channel and dewatering facility, a 2-mile conveyance system, a new monitoring facility to ensure fish passage safely, and a new outfall structure to release the fish below the dam in a high velocity area to minimize predation.
- Addition of the Bonneville PH2 Corner Collector. Includes a surface collection system in the forebay, one-half mile conveyance system, and an outfall. This structure was intended to provide a means for the fish to decrease forebay residence time, minimize stress through passage, and provide an outfall in a location to minimize predation.
- Minimum Gap Runner installation at the Bonneville Powerhouse 1 (PH1). Replacement of the turbine runners to minimize gaps on the blades of main turbine units and redesign of the blades to decrease pressure across the blades (10 units completed). This reduced fish injury by 40 percent (from 2.5 percent to 1.4 percent of the fish being injured) and improved survival of turbine passed fish.
- Removed fish screens and juvenile bypass system from Bonneville PH1.

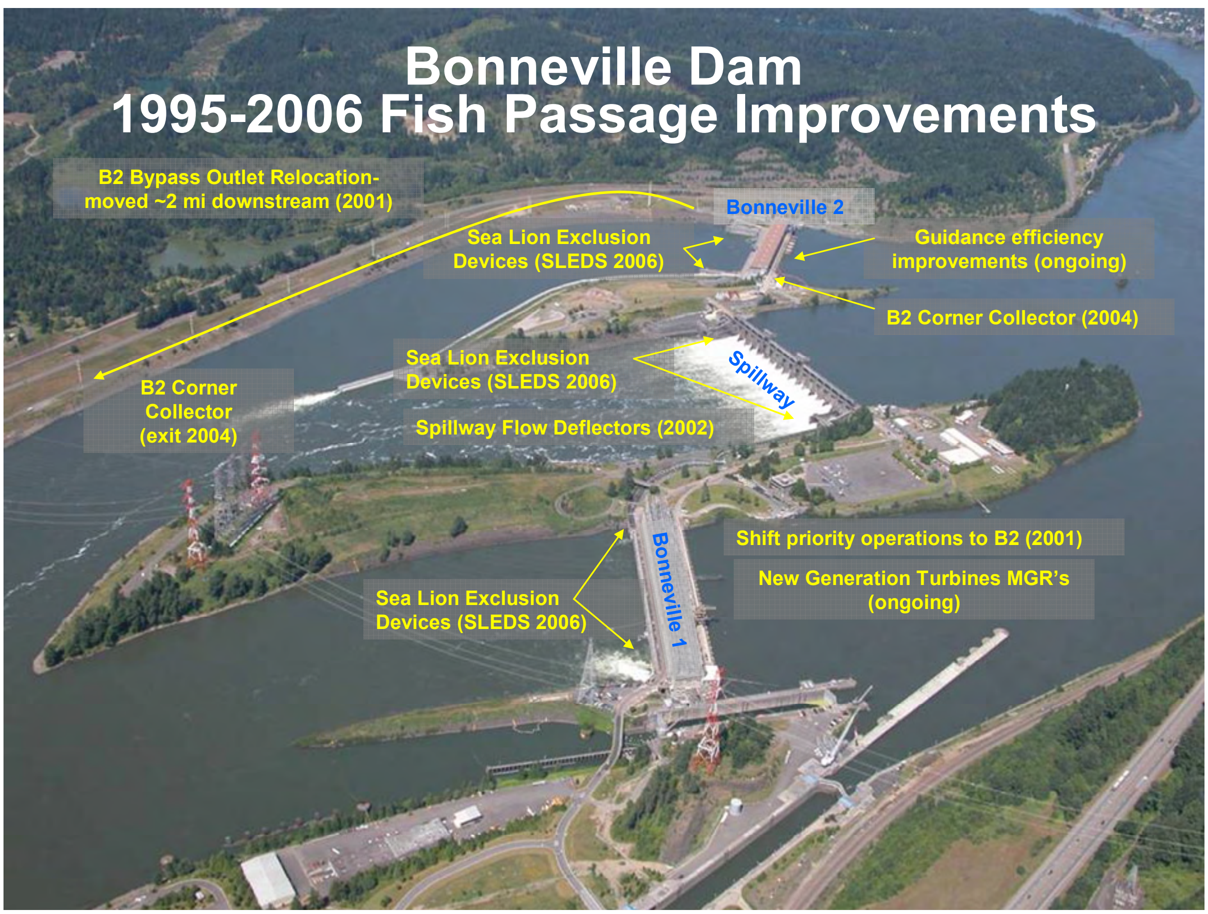

Figure A-4. Improvements at Bonneville Dam from 1995 to 2006

- Spillway structural and operational changes. With the addition of five flow deflectors, all spillbays have deflectors, with new spill patterns to move fish out of the basin. As illustrated by comparing Figures A-4 and A-6, this action may have decreased spillway survival. Evaluation of potential operational or structural modifications is underway to improve spillway survival.
- Addition of sea lion excluder devices (SLEDs) at all entrances to the adult fishways. This action was taken to stop passage of sea lions into the adult fishways to reduce predation on salmonids and potential adult delay at the project.

Figure A-5 describes the changes in estimated dam survival from 91.7 to 95.9 percent for yearling Chinook salmon as a result of modifications made at Bonneville Dam.

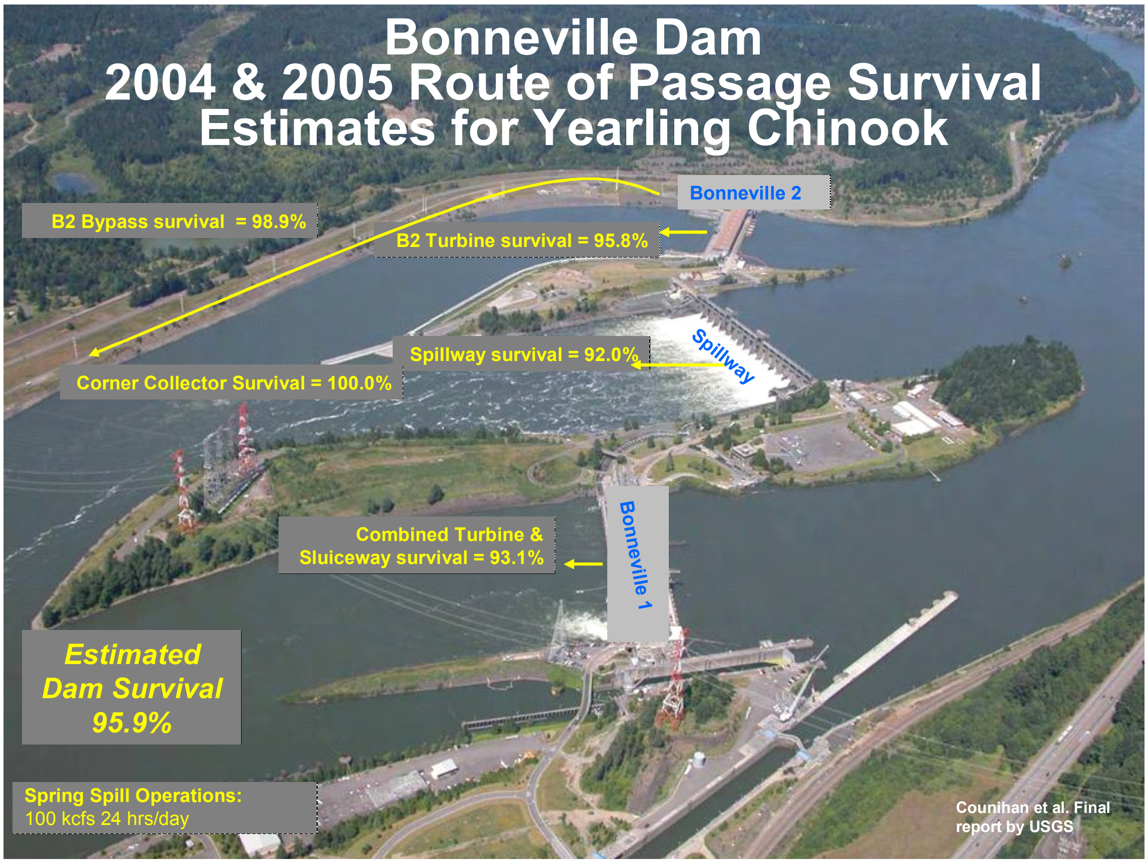

Figure A-5. Route-Specific Dam Survival Estimates for Yearling Chinook Salmon for 2004 and 2005

A.2.1 SURFACE COLLECTORS OR SURFACE BYPASS SYSTEMS

Observation of fish behavior led to the concept of providing surface routes to attract or "skim" the fish from the forebay of the dam through a "surface bypass" structure to improve passage efficiency and reduce forebay passage delays. With conventional passage systems, juvenile fish must dive or "sound" as deep as 50 feet to enter turbine intakes or conventional spillway openings. The Corps has designed and installed different surface collector systems at several dams.

One such surface bypass structure is the Corner Collector installed at Bonneville Dam in 2004 (Figure A-6). Other successful surface bypass systems, called RSWs, have been installed at Lower Granite and Ice Harbor dams in the lower Snake River.

Figure A-6. Fish Bypass Corner Collector at Bonneville Dam

A.2.1.1 Bonneville Dam Corner Collector

The Corner Collector at the Bonneville Dam second powerhouse (PH2) on the north shore of the river has proven to be very effective in attracting and safely moving juvenile fish past the project. It consists of an overflow weir adjacent to the powerhouse with a one-half mile open flume providing downstream reentry well below the PH2 tailrace. Thirteen percent of the juvenile fish approaching the dam pass through the Corner Collector, exiting into higher velocity water, which reduces predation by other fish downstream of the dam. A large antenna detects PIT-tagged fish as they pass, transferring data to computers that record the origin of the fish and other data needed for scientific analysis. Corner Collector survival is virtually 100 percent.

A.2.2 REMOVABLE SPILLWAY WEIRS (RSWs)

RSWs are another successful surface bypass system currently installed at Lower Granite and Ice Harbor dams to provide a surface passage route for juvenile fish (Figure A-7). RSW installation is underway for Lower Monumental Dam and under design for Little Goose Dam.

The massive, seven-story-high steel structures are bolted to the upstream faces of dams. Fish entering the device get a smoother, gentler ride over the spillway. Testing has shown that these “fish slides” decrease juvenile fish delay in the forebay and increase survival of juveniles as compared to other routes of passage.

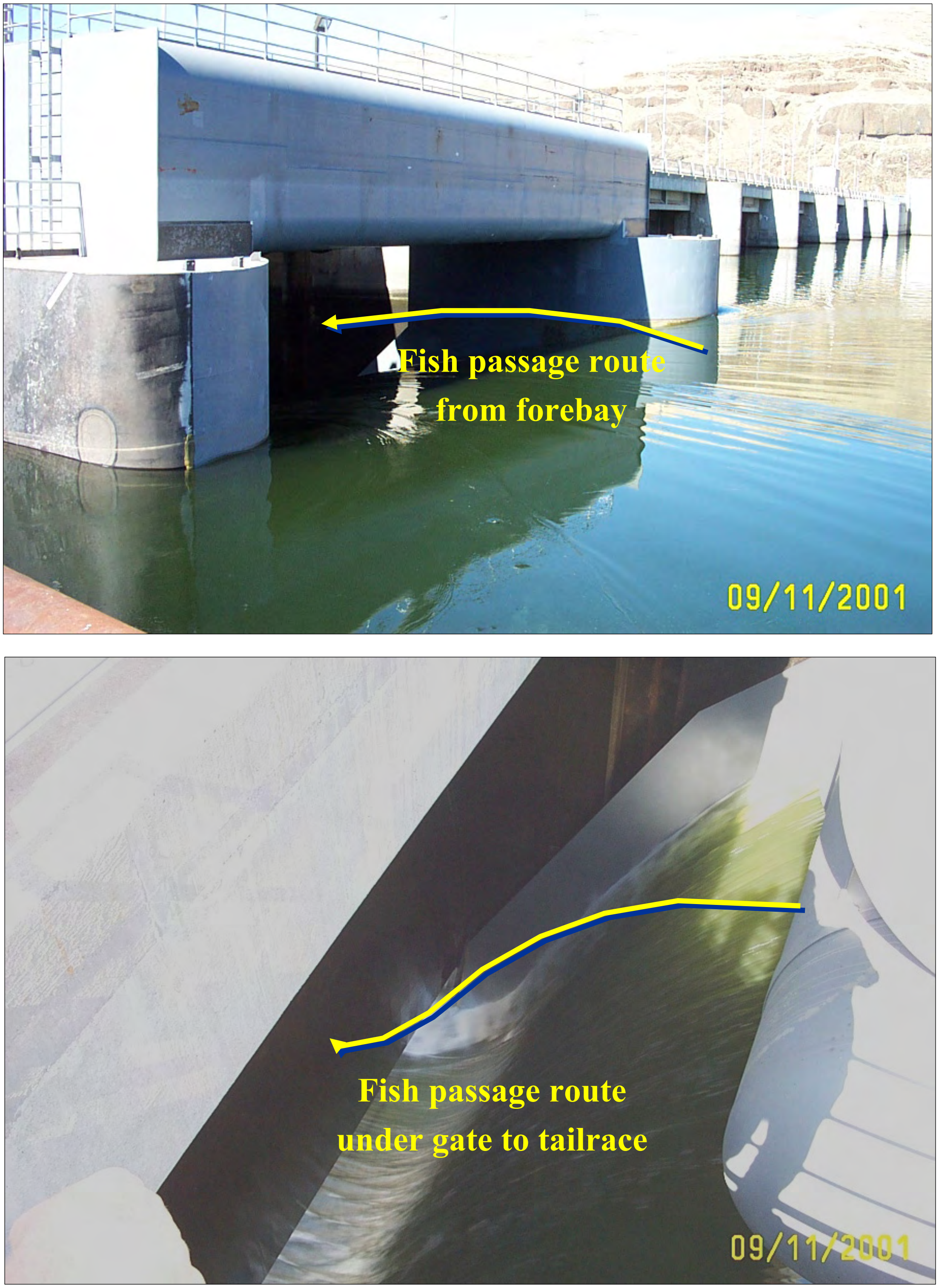

Figure A-7. Removable Spillway Weir in Operation at Lower Granite Dam during Testing in 2001

The Corps is currently testing smaller temporary spillway weirs (TSW), which are more economical to build and possibly equally effective. The first test is ongoing at McNary Dam for the 2007 fish passage season. If successful, the TSW design could become templates for surface bypass structures on other dams. These work on the same principle as their larger counterparts, attracting fish on the surface and avoiding the dive required to pass through a conventional spillway. Initial thinking is that these devices could be installed in multiple spillbays at McNary and John Day dams, and potentially at The Dalles Dam.

Testing of surface passage devices (RSWs) at Lower Granite and Ice Harbor dams on the Snake River have demonstrated that forebay delay is decreased, dam survival is better than or equal to past operations, and good juvenile egress through the tailrace is provided. For example, in tests at Ice Harbor in 2003, forebay residence times decreased from 1.8 hours to 1.1 hours for yearling Chinook salmon, despite a lower spill volume, and tailrace egress times were under 5 minutes. In addition, dam survival (concrete to tailrace) at Lower Granite and Ice Harbor dams in 2006 was estimated at 97 percent and 100 percent respectively.

A.2.3 PROJECT-SPECIFIC CHANGES

The following identifies structural improvements and upgrades made at particular projects through 2006, including baseline research, development and testing of prototype improvements, and construction of new facilities.

A.2.3.1 Bonneville Dam First Power House (PH1)

Bonneville Dam's PH1 was the first Federal hydroelectric dam to be built on the Columbia River. It is the last dam that migrating juvenile fish pass on their downstream journey to the ocean. This project began operating in 1938 with an adult fish ladder and an adult fish attraction system, and fish locks that were later closed because they were ineffective.

In the 1960s and 1970s, juvenile fish bypass channels were enhanced by drilling orifices from the turbine intake bulkhead slots into the ice/trash sluiceway. This allowed juvenile fish to enter the slots, swim into the sluiceway, and pass around the powerhouse. In the early 1980s, a complete screened juvenile bypass facility was installed that included standard length screens (STSs), a juvenile monitoring facility, and a pressurized pipe system leading to an underwater outfall. Several modifications were made to the system in the late 1980s through the 1990s to improve fish guidance efficiency, reduce stress, and improve survival. In recent years, the screen bypass system has been removed from operation during the juvenile fish passage season. In addition, flow deflectors were added to reduce total dissolved gas, and sophisticated monitoring devices have been installed to monitor passage for both juveniles and adult salmon.

Fish passage improvements at Bonneville Dam are listed in Table A-1. These improvements complement earlier facilities, substantially improving in-river passage for both juvenile and adult salmon.

A.2.3.2 Bonneville Dam 2nd Powerhouse (PH2)

The second powerhouse (PH2) at Bonneville Dam was the last constructed at a FCRPS mainstem dam; therefore, engineers had the benefit of lessons learned from the monitoring and evaluation of fish passage facilities at the other dams. The construction included an adult ladder and an adult powerhouse collection system, which proved to be effective and few modifications have been needed subsequently.[3] The construction also included juvenile bypass facilities; however, follow-on studies identified several issues

[3] Many improvements discussed became operational in 2007.

with the juvenile facilities including lower than desired guidance efficiency and survival. Improvements to juvenile bypass facilities have increased their efficiency putting more fish in the juvenile bypass facility and decreasing the number of fish passing through turbines (Table A-2). In 2001, a new non-

Table A-1. Fish Passage Improvements at Bonneville Dam PH1 since 1995

Year	Improvement	Purpose
	Juvenile Passage Improvements	
1995 to 2006	1. Spillway deflectors added to five bays. 2. Power distribution system modified for fish operations. 3. Installation of minimum gap turbine runners - five units completed by 2006 (two additional units in 2007 and remaining three by 2009). 4. Removal of STS screens during juvenile fish passage season.	1. Reduces TDG production during spill and increases flexibility for spill operations 2. Allows for B2 priority for powerhouse operations to improve juvenile survival (and reduce adult fallback) 3. Reduces injury and mortality for fish passing through turbines 4. Reduce injury, stress, and mortality for fish passing through the bypass system
	Adult Passage Improvements	
1995 to 2006	1. Gates were taken out of entrances 1, 2, 64, and 65 to provide 8 feet of opening. 2. Floating gate/orifice operating system modified with new motors and control system. 3. Adult PIT-tag detectors were installed. 4. Sea Lion Exclusion Devices (SLED) were installed.	1. Enhances collection system effectiveness and reliability. 2. Enhances collection system effectiveness and reliability 3. Provides for monitoring PIT-tags on adults. 4. Reduces marine mammals' presence in the ladders.

Table A-2. Fish Passage Improvements at Bonneville Dam PH2 since 1995

Year	Improvement	Purpose
	Juvenile Passage Improvements	
1995 to 2006	1. Juvenile bypass system upgraded, including outfall relocation and new collection channel and dewatering facility. 2. Surface bypass Corner Collector with one-half mile conveyance channel. 3. Improvements for fish guidance into juvenile bypass system (3 out of 8 units completed by 2006, 2 additional units completed in 2007). 4. Full flow PIT-tag detection on bypass outfall flume. 5. PIT-tag antenna installed in the Corner Collector channel.	1. Relocated bypass avoids predation at original outfall location. New collection channel and dewatering facility, reduces injury and stress. These features provided survival improvements. 2. Further increases the percentage of fish that avoid turbine passage and provides outfall in location to improve survival. 3. Improves percentage of fish guided away from turbines. 4. Reduces need to subject juveniles to very low flow levels for PIT-tag detection, which reduces stress levels. 5. Capable of detecting tagged fish moving at high speeds down flume.
	Adult Passage Improvements	
1995 to 2006	1. Installed adult PIT-tag detectors. 2. Installed Sea Lion Exclusion Devices (SLEDs).	1. Provides collection point for PIT-tag data on adults. 2. Reduces marine mammals presence in the ladders.

pressurized flume was installed from the powerhouse to a reach of the river with swifter flow several miles below the project. New PIT-tag monitoring equipment, separation/sampling facilities, and an outfall structure were constructed at the site.

A.2.3.3 The Dalles Dam

The Dalles Dam was completed in 1957, and included adult passage facilities on each side of the project that were based on designs from Bonneville Dam. In the 1990s, a series of improvements were made to the adult passage system. Juvenile fish passage facilities were not included in the initial construction of The Dalles Dam. In 1971, the ice/trash sluiceway was opened to skim juveniles from the forebay, and has proved to be effective at passing juvenile fish. Improvements to passage facilities are shown in Table A-3.

Table A-3. Fish Passage Improvements at The Dalles Dam since 1995

Year	Improvement	Purpose
	Juvenile Passage Improvements	
1995 to 2006	1. Constructed spillway wall. 2. Sluiceway improvements completed, including opening additional gates.	1. Allows increased flows and fish at the north end of spillway, which improves collection efficiency and juvenile egress from the spillway. 2. Provides increased sluiceway efficiency and reduced turbine entrainment.
	Adult Passage Improvements	
1995 to 2006	1. Modifications to allow for adult entrance channel dewatering.	1. Allows for inspection and maintenance to ensure reliability of adult ladder system.

A.2.3.4 John Day Dam

John Day Dam was completed in 1968 and included a full adult passage system on each side of the project. A juvenile fish bypass system was retrofitted to the project in the 1980s and has subsequently been upgraded with a new monitoring facility. Recent improvements at John Day are shown in Table A-4.

Table A-4. Fish Passage Improvements at John Day Dam since 1995

Year	Improvement	Purpose
	Juvenile Passage Improvements	
1995 to 2006	1. Juvenile fish monitoring facility built. 2. Spill deflectors installed on 18 of 20 bays. 3. Refurbished two north shore fish pumps. 4. Full flow PIT-tag detection completed.	1. Allows evaluation of juvenile condition and counting/sampling of PIT-tagged fish. 2. Reduces TDG production during spill, and increases flexibility for spill operations. 3. Improves reliability. 4. Improves detection and reduces stress on juvenile fish.
	Adult Passage Improvements	
Year	**Improvement**	**Purpose**
1995 to 2006	1. Rehabilitated auxiliary water pumps. 2. South ladder exit control section reconfigured.	1. Provides reliable auxiliary water supply for attraction/passage of fish. 2. Reduces fish jumping and delays in the south ladder.

A.2.3.5 McNary Dam

McNary Dam, the second dam to be built on the lower Columbia River, was completed in 1954 with adult fish ladders on both shores of the project. This project was retrofitted with a juvenile bypass facility in

1978, with a full complement of submerged traveling screens (STSs) and Vertical Barrier Screens (VBSs) added in 1981.

In 1996 to 1997, extended submerged traveling screens (ESBSs) and VBSs were added to the bypass system. The system now guides over 80 percent of spring and 60 percent of summer migrants from the turbine intake into the bypass.

The McNary fish passage system is considered to be state-of-the-art. As research, monitoring, and evaluation efforts provide feedback, additional enhancements will be made to the McNary passage system to further benefit migrating fish. More recent improvements at McNary Dam are shown in Table A-5.

Table A-5. Fish Passage Improvements at McNary Dam since 1995

Year	Improvement	Purpose
	Juvenile Passage Improvements	
1995 to 2006	1. ESBSs installed. 2. Spill deflectors placed in remaining four bays. Others installed earlier. 3. Bypass system upgrades including full flow system. 4. Spillway gates rehabilitated and hoists added.	1. Guides more migrants away from the turbines into the bypass system. 2. Reduces TDG production during spill, and increases flexibility for spill operations. 3. Improves fish survival and health as they transit the bypass system. 4. Allowed optimal spillway operation for fish passage.
	Adult Passage Improvements	
1995 to 2006	1. Adult PIT-tag detection systems in both fish ladders. 2. Replaced powerhouse collection system stop logs with new stop logs.	1. Improves PIT-tags monitoring of adult passage through mainstem dams. 2. Increases reliability of adult fish passage system.

A.2.3.6 Ice Harbor Dam

Ice Harbor Dam was completed in 1961. Its original design included two adult fish ladders and a powerhouse adult fish attraction and collection system, all of which have been improved (Table A-6). The dam was constructed without dedicated juvenile salmon passage facilities because at that time it was assumed that juvenile survival would be adequate through the turbines and spill.

Table A-6. Fish Passage Improvements at Ice Harbor Dam since 1995

Year	Improvement	Purpose
	Juvenile Passage Improvements	
1995 to 2006	1. STSs and VBSs put into each turbine intake, 12-inch orifices drilled from gatewell to bypass channel in old sluiceway, evaluation/marking facilities constructed at bottom of bypass flume. 2. Spill deflectors installed on all spillbays. 3. PIT-tag detection on main bypass flume 4. RSW installed in 2005.	1. Increases the percentage of fish bypassed from the turbines. 2. Reduces TDG production during spill, and increases flexibility for spill operations. 3. Allows PIT-tag monitoring with lower potential for stress. 4. Allows more efficient spillway passage, reduces delay in the forebay.
	Adult Passage Improvements	
1995 to 2006	1. North shore auxiliary water supply system modified, new fish pumps installed. 2. Adult PIT-tag detection systems.	1. Makes auxiliary water system effective and reliable. 2. Improves PIT-tag monitoring of adults through mainstem dams.

By the mid-1960s, studies of improvements with access to the ice/trash sluiceway were provided and in 1996, a powerhouse bypass system consisting of STSs, a dedicated channel in the old sluiceway, a flume to carry juveniles to the tailrace, and sampling facilities were installed. High TDG levels from spill proved to be especially problematic at Ice Harbor, so spillway deflectors were installed on all ten spillbays in 1999.

A.2.3.7 Lower Monumental Dam

Lower Monumental Dam was completed in 1969 with adult fish ladders on both shores of the project. It also had a rudimentary powerhouse collection system with orifice entrances along the face of the powerhouse and a pipe that ran along the face of the dam. Recent improvements are substantial; including an RSW, spill deflectors, screen overhaul, and improved transportation facilities (Table A-7).

Table A-7. Fish Passage Improvements at Lower Monumental Dam since 1995

Year	Improvement	Purpose
	Juvenile Passage Improvements	
1995 to 2006	1. STS overhauled. 2. Spill deflectors installed on bays one and eight. 3. Improved barge loading and improved dewatering facilities. 4. Parapet wall added 5. PIT-tag detector added in main transport flume	1. Ensures STS efficacy and reliability. 2. Reduces TDG production during spill and increases flexibility for spill operations. 3. Improves juvenile transportation system. 4. Reduces TDG levels and allows full use of end bays at the spillway 5. Allows for better counting and analysis of migration patterns and survival.
	Adult Passage Improvements	
1995 to 2006	1. All three auxiliary water supply pumps rehabilitated.	1. Ensures fish ladder auxiliary water system efficacy and reliability.

Additionally, an RSW has been constructed and is scheduled for installation in fall of 2007.

A.2.3.8 Little Goose Dam

Little Goose Dam went into service in 1970 with a single south shore ladder for adult fish passage, a powerhouse collection channel, and two north spillway entrances with a channel leading to the powerhouse collection channel. A turbine pump provided auxiliary water from the tailrace for the powerhouse collection system. In 1991, picketed leads to reduce adult fish fallout from the ladder entrances were placed at the north end of the powerhouse collection channel and were enhanced in 1994.

Little Goose was constructed with the same elemental juvenile fish bypass design as Lower Monumental and John Day dams. It featured 6-inch orifices to each gatewell leading to an embedded pipe that carried fish around the powerhouse and discharged them into the tailrace. The bypass-transport facilities that had been built in 1980 were replaced in 1990. The new facilities featured a modified collection channel, a new dewatering structure, a corrugated flume, a new "wet" separator, a new evaluation facility, holding ponds, and a loading/outfall structure. In the mid-1990s the STSs were replaced with newly designed VBSs and ESBSs. The PIT-tag diversion and detection system has also been rebuilt and is now state of the art. Turbine intake emergency gates were also raised to increase fish guidance efficiency (FGE). More recent improvements at Little Goose are shown in Table A-8.

Table A-8. Fish Passage Improvements at Little Goose Dam since 1995

Year	Improvement	Purpose
	Juvenile Passage Improvements	
1995 to 2006	1. Installed new ESBSs and VBSs improved. 2. Upgraded PIT-tag sort by code, routing, and bypass outfall. 3. Trash shear boom installed.	1. Increases FGE and reduces turbine entrainment on juveniles. 2. Reduces fish delay, stress, and predation. 3. Reduces amount of debris entering gatewells, thereby reducing fish injury and mortality.
	Adult Passage Improvements	
1995 to 2006	1. Picketed leads in collection system channel. 2. Improved auxiliary water supply.	1. Decreases adult fish falling out of the channel into the tailrace. 2. Improves fish ladder system reliability.

A.2.3.9 Lower Granite Dam

Lower Granite Dam was constructed in 1975 with an adult fish collection and passage system consisting of a single south shore adult fish ladder, a powerhouse collection channel with main entrances at the end of the powerhouse, and two north shore entrances with a transportation channel under the spillway leading to the powerhouse collection channel.

The adult passage system proved to be effective and was not modified until the early 1990s when the fishway controls were upgraded. In 1993, permanent picketed leads were installed to reduce fallout of adults from the ladder entrances. The adult fish trap was rebuilt in 1998 and adult PIT-tag detectors were added.

Lower Granite Dam was the first mainstem project to have a full juvenile STS bypass-transport system included in its original design. The bypass included VBSs, 8-inch orifices that led to dewatering structures, and a pressurized pipe at the south end of the powerhouse. The pipe led down the tailrace into a fish/water separator, holding ponds, an evaluation/monitoring facility, a transport loading dock, and an outfall.

In the early 1980s, the juvenile bypass and transportation systems were overhauled. New generation STSs were installed, the gatewell orifices were increased to 10 inches, the dry separator was replaced by a wet separator, and new raceways were installed. In the early 1990s, emergency gates were removed from their gate slots in a successful effort to improve FGE. In 1996, the screened bypass system was replaced with new VBSs and ESBSs. To provide a surface passage route for juvenile fish, an RSW was installed in 2001, which yields roughly 98 percent passing survival for juvenile fish. More recent improvements at Lower Granite are shown in Table A-9.

Table A-9. Fish Passage Improvements at Lower Granite Dam since 1995

Year	Improvement	Purpose
	Juvenile Passage Improvements	
1995 to 2006	1. New ESBSs and VBSs installed. 2. PIT-tag sort by code improvements. 3. Spill deflectors. 4. RSW installed and tested.	1. Fish stress and injury reduced in bypass system. 2. Decrease stress through reduced handling of juvenile fish. 3. Reduces TDG production during spill and increases flexibility for spill operations. 4. Allows more efficient spillway passage and decreased forebay delay.
	Adult Passage Improvements	
1995 to 2006	1. PIT-tag detectors added. 2. Fish trap modified and expanded. 3. Modified diffuser and transition pools. 4. Improved auxiliary water supply.	1. Allows for monitoring of returning adult fish. 2. Provides better adult fish handling conditions. 3. Improves adult passage by eliminating fishway fallout. 4. Increases reliability of ladder operation.

A.3. OPERATIONAL CHANGES IN FISH PASSAGE

A.3.1 REGULATING FLOW TO ASSIST JUVENILE FISH MIGRATION

Managing water in the Columbia River system for its many purposes is particularly challenging given the relatively small portion of the annual runoff volume that can actually be stored in reservoirs. The runoff produces an annual average of about 200 million acre-feet (MAF) of water, but only about 20 percent of it can be impounded in storage reservoirs. The Columbia River system, with its large annual volume to usable storage ratio, evacuates storage reservoirs on a yearly basis to accommodate water supply conditions in the Columbia River Basin. This means that operators cannot store water in one year and transform a subsequent dry year water supply into an average flow year. Hydropower system operators deal with the variability in annual rain and snowpack run-off volumes relying on professional judgment to best meet project purposes.

Providing flows for fish is an important component of water management in the Columbia River Basin. Fish operations draw on up to 5 MAF of stored water annually—about one-sixth of the 32-MAF of storage in U.S. reservoirs in the FCRPS and storage in Canadian reservoirs. Because much of the available storage is in Treaty projects in Canada, its use downstream is governed by the Columbia River Treaty. Use of Treaty storage for fishery purposes is contingent on development of mutually beneficial agreements between the United States and Canada. Use of space in Canadian reservoirs not included in the Treaty, referred to as non-Treaty storage, requires negotiating additional agreements.

In recent Treaty agreements, Canada has allowed storage of flow augmentation water (1 MAF) for U.S. fishery benefits in exchange for flow shaping for meeting fishery objectives in Canada. The 1 MAF is released within the May through July period to assist juvenile migration in the United States. If this flow augmentation water is released across one month, it equates to an additional flow of 16,000 thousand cubic feet per second (kcfs) for that month, equal to about 6 percent of spring flow objective, or about 8 percent of the summer flow objective of 200 kcfs at McNary Dam.

With the issuance of the 1995 Biological Opinion (BiOp), the Reasonable and Prudent Alternative (RPA) "substantially alters the operation of the reservoirs in the FCRPS compared to the 1993 and 1994 BiOps" (1995 BiOp, p. 96). The Action Agencies were to henceforth operate the FCRPS during fall and winter months at high confidence levels that refill would be accomplished by April 20. Flow was to be released in the spring while ensuring sufficient storage of water to be available by June 30 to provide for summer flow augmentation.

An objective of fish operations today is to provide flows in a more natural pattern or hydrograph, to the extent that the design of the system to meet multiple purpose responsibilities will allow. Figure A-8 illustrates how flows are shaped to more closely approximate a natural, unregulated river to assist fish migration. This figure compares the "regulated" flow in October 2005 to September 2006 (the 2006 water year) to what would have been a natural flow absent the hdyro system in that same water year. In this year, precipitation was measured at about 100 percent of the 71-year average.

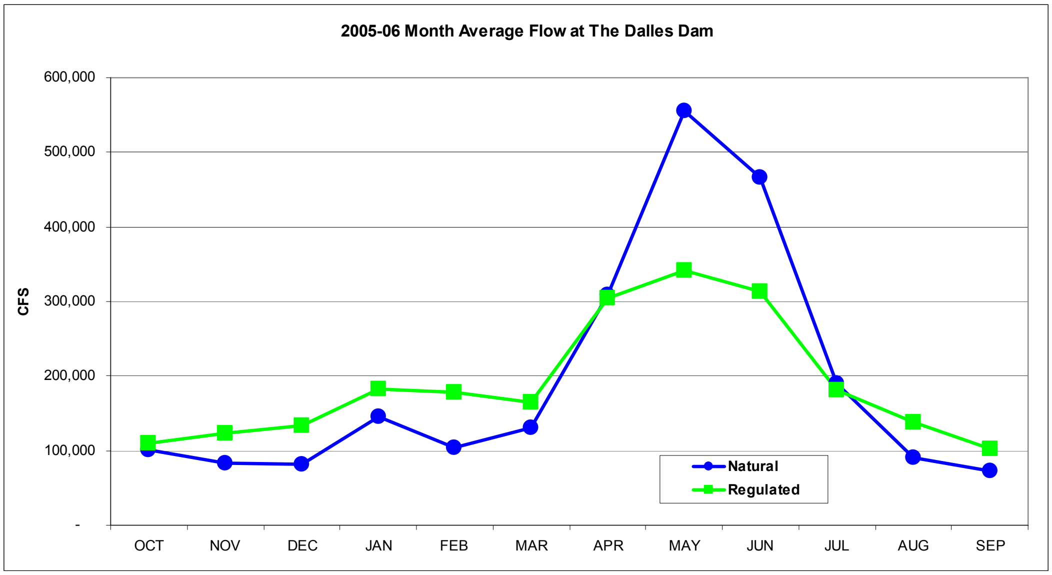

Figure A-8. Natural and Regulated Monthly Average Flow at The Dalles Dam for the 2006 Water Year

Another way of looking at the available flow due to changes in reservoir operations to benefit fish is noting millions of acre-feet of water passing The Dalles Dam. Figure A-9 shows the additional flow at The Dalles during the juvenile migration period (April through August) as a result of reservoir operations for fish (60-year average) under the 2004 BiOp. Operations for fish flows shape 8.3 MAF on average—4.6 to 13.2 MAF, depending on annual precipitation.

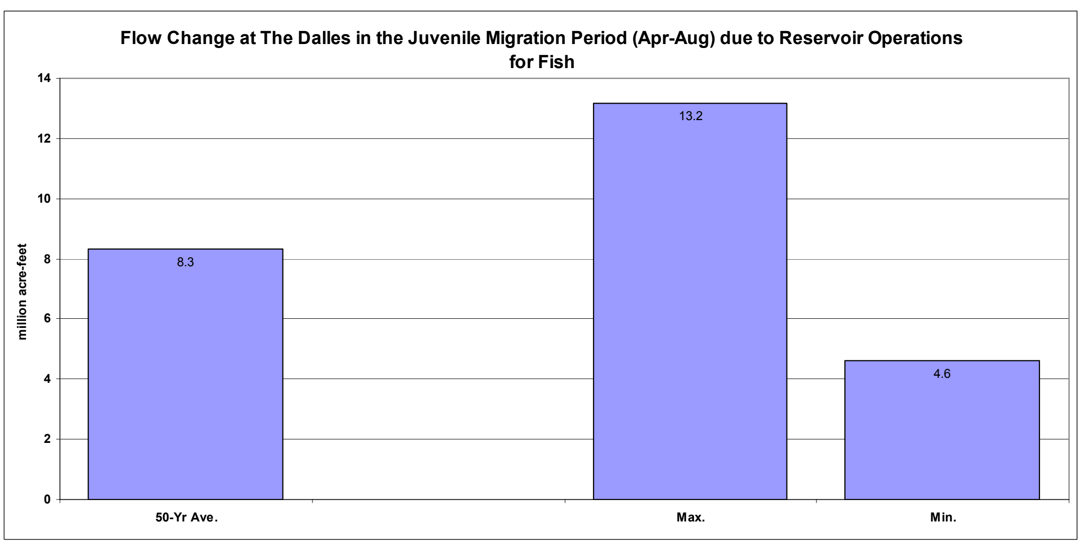

Figure A-9. Flow Change at The Dalles Dam during the Juvenile Migration Period (April through August) Due to Reservoir Operations for Fish (60-year average)

As mentioned above, the volume of water in the river each year is as variable as the weather. Figure A-10 depicts a 60-year average regulated flow at The Dalles Dam, with and without fish operations. Given the limited storage available in the hydro system and other constraints to provide for multiple uses, these operations represent a substantial improvement in providing flows for fish within the design capabilities of the system.

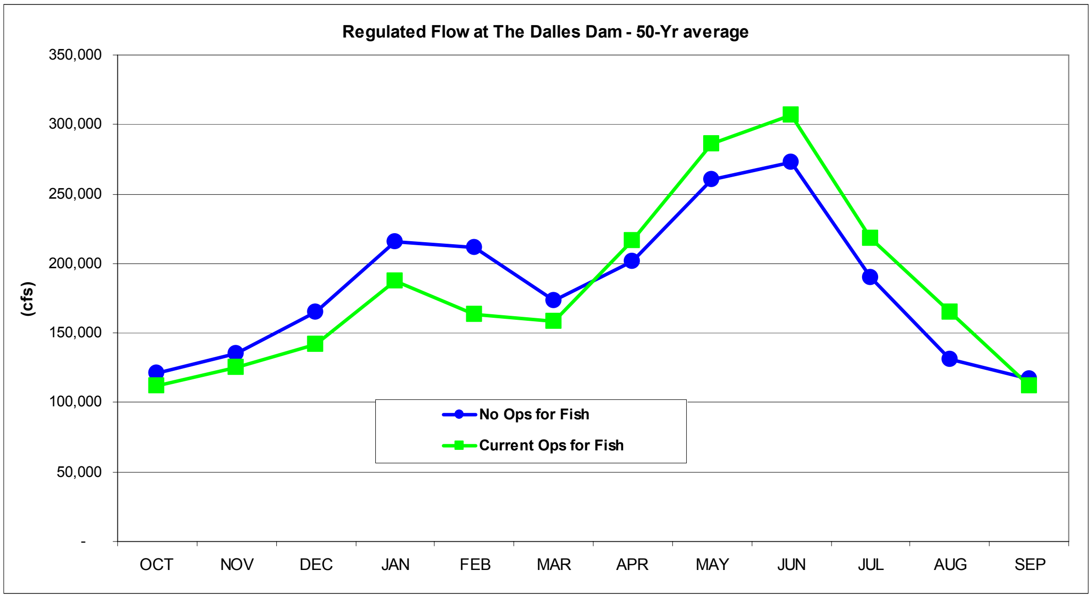

Figure A-10. Sixty-Year Average Regulated Flow at The Dalles Dam, With and Without Fish Operations

Flood control procedures have been closely evaluated and modified to the extent possible. At storage reservoirs behind Libby and Hungry Horse dams, operators adopted new flood control procedures with the objective of having more water available for spring flow augmentation, while maintaining flood control objectives. This new flood control criteria is called VARQ (variable outflow). It entails a new set of Storage Reservation Diagrams (SRD) and upper rule curves (URC) for both Libby and Hungry Horse dams which allows for higher water levels in the reservoirs from January through April when the runoff is forecasted to be about average or less. As the reservoir pools may be higher in spring than previously, releases must be increased during the refill period (April, May, and June). By this means, operators can provide the same level of flood protection while ensuring that more water is available for adult Kootenai River white sturgeon and juvenile salmon and steelhead migration in spring and summer.

The summer flow management objective is to draft reservoirs within specific limits in an attempt to meet flow targets and to manage water temperatures to benefit migrating juvenile salmon. Cooler water is also thought to assist adult migration.

The eight Federal dams on the mainstem lower Columbia and Snake rivers are “run of the river” dams, that is, low head dams that have little or no storage capacity and essentially pass inflows[4]. Nevertheless, those reservoirs impede flow and affect the progress of juvenile salmon through the system in several ways: slowing travel, increasing exposure to warmer water temperature, and increasing exposure to predators among them. In 1992, the Corps began operating the lower Snake reservoirs within 1 foot of minimum operating pool (MOP) (the level required to provide safe navigation, operate fish facilities

[4] John Day Dam has approximately 500 thousand acre-feet of flood control storage.

within design criteria, and operate turbines). The 1995 BiOp also called for John Day pool to be operated within one and one-half foot of minimum irrigation pool from April 20 through the summer. These drawdowns reduce the width or the cross-section of the reservoir, thereby increasing water velocity.

Finally, the water managers strive to provide flow conditions for mainstem habitat suitable for spawning chum and fall Chinook salmon. They maintain sufficient flow below Bonneville Dam to keep redds submerged until juvenile fish hatch in the spring.

A.3.2 SPILL OPERATIONS TO ASSIST JUVENILE FISH PASSAGE

Spill operations are a method of guiding juvenile salmon and steelhead through spillways rather than through turbines. The objective of the spill program is to achieve maximum passage survival, along with other passage routes, at each dam. Survival is measured by detecting the PIT-tagged fish as they pass from the forebay above the dam to the tailwater below the dam.

Prior to the 1995 BiOp, the operators' objective was to attain a fish passage efficiency[5] (FPE) of 70 percent for spring migrants and 50 percent for summer migrants. To accomplish this, spill was provided at three dams. The other dams met this goal without spill. In the longer term, the plan was to complete structural bypass systems at the four lower Snake River and four lower Columbia River dams to boost in-river survival.

In the 1995 BiOp, the objective was raised to achieve 80 percent FPE at all eight projects by spilling water through the spring months at each project. Timing and volume of spill at each project was designed to achieve biological benefits with a cap to avoid harmful levels of TDG. Limited spill was to be provided in summer months, primarily at Ice Harbor on the lower Snake River and the three lower Columbia River dams.

With the 2000 BiOp, the focus was shifted to dam survival estimates instead of FPE due to advancements in radio and acoustic tracking technologies. This has allowed for better assessment of passage improvements at the mainstem dams. For instance, bypass facilities of various types have been added to dams with survival of juvenile fish increasing to 90 to 95 percent at each dam. As discussed earlier, surface passage modifications such as RSWs and the Bonneville Dam Corner Collector can achieve higher survival rates (97 percent or higher with RSWs, and 100 percent with the Corner Collector).

The various routes of juvenile passage notwithstanding, most juvenile fish in the river find their way through juvenile bypass facilities, spillways, and surface bypass facilities. Table A-10 illustrates the increased use of spill in duration and volume since the 1995 BiOp based on biological results. Notable are the significant increases in spring and summer spill in that year and again in 2000, along with the addition of biological criteria balancing gas saturation, tailrace conditions, and adult passage. The 2000 BiOp based annual spill programs on "the best available monitoring and evaluation data concerning project passage, spill, and system survival research" (2000 BiOp, pp. 9-88). This principle was extended to the 2004 BiOp, further increasing the reliance on biological performance to set spill levels at each project.

In 2004, emphasis turned to 24-hour surface spill through RSWs and the Corner Collector at Bonneville Dam. The Court Order in 2005 required summer spill at Lower Granite, Little Goose, and Lower Monumental dams on the Snake River, and at McNary Dam on the Columbia River, which was continued in 2006 and 2007. Monitoring in 2005 and 2006 showed nearly all of the Snake River fall Chinook

[5] Fish passage efficiency (FPE) is a measure of percent of juvenile fish that are diverted away from turbine passage, either via spill or through the juvenile bypass facilities.

Table A-10. Historical, Spring, and Summer Spill Levels

		1988 Spill MOA	1994 BiOp	1995 BiOp	1998 BiOp	2000 BiOp	2004 BiOp	2005 Court Order	2006 Court Order
Historical Spill Levels									
	Starting ~1978 spill is provided informally based on fish presence at each dam.	Spill is intended as an interim measure until bypass systems are installed to provide 70% spring and 50% summer FPE (non-turbine passage).	Still striving for 70% spring and 50% summer FPE and completion of bypass systems at all dams.	Spill percentages primarily based on achieving 80% FPE (non-turbine passage), uncertainty about benefits of transportation is noted.	Emphasis on increasing gas caps.	Prioritized spill passage, also seeking balance between high gas cap spill, good tailrace conditions, and good adult passage.	Emphasis on 24-hour surface spill, good tailrace conditions, and good adult passage.	Addition of summer spill at transport projects.	Continuing summer spill at transport projects.
Spring Spill Levels									
Dates	No Formal Dates	Between 10 and 90% passage dates (4/15 to 5/31 at IHR and LMN and 5/1 to 6/6 at TDA)	4/15 to 5/31 at IHR and 5/1 to 6/6 at TDA	4/10 to 6/20 in Snake River, 4/20 to 6/30 in Columbia River	4/3 to 6/20 in Snake River, 4/10 to 6/30 in Columbia River	4/3 to 6/20 in Snake River, 4/10 to 6/30 in Columbia River	4/3 to 6/20 in Snake River, 4/10 to 6/30 in Columbia River	n/a (2004 BiOp operations implemented during the spring)	4/3 to 6/20 in Snake River, 4/10 to 6/30 in Columbia River
Hours	Generally at night, no specific times	12 hours at LMN and IHR, 24 hours at TDA	12 hours at IHR, 8 hours at TDA	24 hours at IHR, TDA and BON, 12 hours at all others	24 hours at IHR, TDA and BON, 12 hours at all others	24 hours at LMN, IHR, TDA and BON, 12 hours at all others	24 hours at LMN, IHR, TDA and BON, 12 hours at all others	n/a	12 hours at JDA, 24 hours at all others
Lower Granite		No spill	No spill	0 day and 80% night (40 kcfs gas cap)	0 day and 80% night (45 kcfs gas cap)	0 day and gas cap night (60 kcfs gas cap)	20 kcfs day and 20 kcfs night	n/a	20 kcfs day and night
Little Goose		No spill	No spill	0 day and 80% night (35 kcfs gas cap)	0 day and 80% night (60 kcfs gas cap)	0 day and gas cap night (45 kcfs gas cap)	0 day and gas cap night	n/a	30% of flow day and night

Table A-10. Historical, Spring, and Summer Spill Levels (continued)

		1988 Spill MOA	1994 BiOp	1995 BiOp	1998 BiOp	2000 BiOp	2004 BiOp	2005 Court Order	2006 Court Order
Spring Spill Levels (continued)									
Lower Monumental		0 day and 70% night	No spill	0 day and 81% night (40 kcfs gas cap)	0 day and 81% night (40 kcfs gas cap)	Gas cap day and gas cap night (40 kcfs gas cap)	Gas cap day and night	n/a	Gas cap day and night
Dates	No Formal Dates	Between 10 and 90% passage dates (6/1 to 7/22 at IHR and LMN and 6/7 to 8/22 at JDA and TDA)	6/1 to 8/23 at IHR and 6/7 to 8/23 at TDA and JDA	6/21 to 8/31 in Snake River, 7/1 to 8/31 in Columbia River	6/21 to 8/31 in Snake River, 7/1 to 8/31 in Columbia River	6/21 to 8/31 in Snake River, 7/1 to 8/31 in Columbia River	6/21 to 8/31 at IHR, 7/1 to 8/31 at JDA, TDA, and BON	2004 BiOp spill plus 7/1 to 8/31 at LGR, LGS, LMN, MCN	6/21 to 8/31 at Snake River Dams, 7/1 to 8/31 at Columbia River Dams
Hours	Generally at night, no specific times	12 hours at LMN and IHR, 24 hours at TDA	12 hours at IHR, 8 hours at TDA	24 hours at IHR, TDA and BON, 12 hours at all others	24 hours at IHR, TDA and BON, 12 hours at all others	24 hours at LMN, IHR, TDA and BON, 12 hours at all others	24 hours at LMN, IHR, TDA and BON, 12 hours at all others	n/a	12 hours at JDA, 24 hours at all others
Ice Harbor		0 day and 25% night	0 day and 60% night up to 25 kcfs max	27% day and 27% night (25 kcfs gas cap)	45 kcfs day and gas cap night (75 kcfs gas cap)	45 kcfs day and gas cap night (100 kcfs gas cap)	20 kcfs day and night	n/a	45 kcfs day/Gas Cap Night 4/3 to 4/19, BiOp vs 30% ~4/20 to 6/20
McNary		No spill	No spill	0 day and 50% night (120 kcfs gas cap)	0 day and gas cap night (150 kcfs gas	0 day and gas cap night (120 to 150 kcfs gas cap)	0 day and gas cap night	n/a	0 day and Gas Cap night 4/10 to 4/19, 40% 4/20 to 6/20
John Day		No spill	No spill	0 day and 33% night (20 to 50 kcfs gas cap)	0 day and 60% night (180 kcfs gas cap)	0 day and 60% night (85 to 160 kcfs gas cap) (began testing 24 to hr spill)	No spill day and 60% night	n/a	0 day, 60% night

Table A-10. Historical, Spring, and Summer Spill Levels (continued)

		1988 Spill MOA	1994 BiOp	1995 BiOp	1998 BiOp	2000 BiOp	2004 BiOp	2005 Court Order	2006 Court Order
Summer Spill Levels									
The Dalles		0 day and 10% night	0 day and 10% night	64% day and 64% night (230 kcfs gas cap)	64% day and 64% night (230 kcfs gas cap)	40% day and 40% night (230 kcfs gas cap) (40% spill improved tailrace conditions)	40% day and 40% night	n/a	40% of flow day and night
Bonneville		No spill	Spill if necessary to provide 70% FPE (non-turbine passage.	Not specified due to adult passage concerns, implemented 75 kcfs day and gas cap night (120 kcfs gas cap).	Not specified due to adult passage concerns, implemented 75 kcfs day and gas cap night (120 kcfs gas cap).	75 kcfs day and gas gap night (90 to 150 kcfs gas cap)	75 kcfs day and gas cap night	n/a	100 kcfs day and night
Dates	No Formal Dates	Between 10 and 90% passage dates (6/1 to 7/22 at IHR and LMN and 6/7 to 8/22 at JDA and TDA)	6/1 to 8/23 at IHR and 6/7 to 8/23 at TDA and JDA	6/21 to 8/31 in Snake River, 7/1 to 8/31 in Columbia River	6/21 to 8/31 in Snake River, 7/1 to 8/31 in Columbia River	6/21 to 8/31 in Snake River, 7/1 to 8/31 in Columbia River	6/21 to 8/31 at IHR, 7/1 to 8/31 at JDA, TDA and BON	2004 BiOp spill plus 7/1 to 8/31 at LGR, LGS, LMN, MCN	6/21 to 8/31 at Snake River Dams, 7/1 to 8/31 at Columbia River Dams
Hours	Generally at night, no specific times	12 hours at LMN and IHR, 10 hours at JDA, 24 hours at TDA	12 hours at IHR, 10 hours at JDA, 8 hours at TDA	24 hours at IHR, TDA and BON, 12 hours at all others	24 hours at IHR, TDA and BON, 12 hours at all others	24 hours at LMN, IHR, TDA and BON, 12 hours at all others	24 hours at LMN, IHR, TDA at BON, 12 hours at all others	24 hours at all projects	24 hours at all projects

Table A-10. Historical, Spring, and Summer Spill Levels (continued)

	1988 Spill MOA	1994 BiOp	1995 BiOp	1998 BiOp	2000 BiOp	2004 BiOp	2005 Court Order	2006 Court Order
Summer Spill Levels (continued)								
Lower Granite	No spill	No spill	No spill	No spill	No spill	No spill	Operate one turbine, spill the rest	18 kcfs day and 18 kcfs night
Little Goose	No spill	No spill	No spill	No spill	No spill	No spill	Operate one turbine, spill the rest	30% day and 30% night
Lower Monumental	0 day and 70% night	No spill	No spill	No spill	No spill	No spill	Operate one turbine, spill the rest	17 kcfs day and 17 kcfs night
Ice Harbor	0 day and 25% night	0 day and 30% night up to 25 kcfs max	70% day and 70% night (25 kcfs gas cap)	45kcfs day and gas cap night (75 kcfs gas cap)	45kcfs day and gas cap night (100 kcfs gas cap)	45kcfs day and gas cap night (115 to 120 kcfs gas cap)	Operate one turbine, spill the rest	45 kcfs day and gas cap night
McNary	No spill	No spill	No spill	No spill	No spill	No spill	50 kcfs through powerhouse, spill the rest	Alternating 40% day and 40% night vs 60% day and 60% night
John Day	0 day and 20% night	0 day and 20% night	0 day and 86% night (20 to 50 kcfs gas cap)	0 day and 60% night (180 kcfs gas cap)	0 day and 60% night (85 to 160 kcfs gas cap) (began testing 24-hour spill)	30% day and 30% night	30% day and 30% night	30% day and 30% night
The Dalles	0 day and 5% night	0 day and 5% night	64% day and 64% night (230 kcfs gas cap)	64% day and 64% night (230 kcfs gas cap)	40% day and 40% night (230 kcfs gas cap) (40% spill improved tailrace conditions)	40% day and 40% night	40% day and 40% night	40% day and 40% night

Table A-10. Historical, Spring, and Summer Spill Levels (continued)

		1988 Spill MOA	1994 BiOp	1995 BiOp	1998 BiOp	2000 BiOp	2004 BiOp	2005 Court Order	2006 Court Order
Summer Spill Levels (continued)									
Dates	No Formal Dates	Between 10 and 90% passage dates (6/1 to 7/22 at IHR and LMN and 6/7 to 8/22 at JDA and TDA)	6/1 to 8/23 at IHR and 6/7 to 8/23 at TDA and JDA	6/21 to 8/31 in Snake River, 7/1 to 8/31 in Columbia River	6/21 to 8/31 in Snake River, 7/1 to 8/31 in Columbia River	6/21 to 8/31 in Snake River, 7/1 to 8/31 in Columbia River	6/21 to 8/31 at IHR, 7/1 to 8/31 at JDA, TDA and BON	2004 BiOp spill plus 7/1 to 8/31 at LGR, LGS, LMN, MCN	6/21 to 8/31 at Snake River Dams, 7/1 to 8/31 at Columbia River Dams
Hours	Generally at night, no specific times	12 hours at LMN and IHR, 10 hours at JDA, 24 hours at TDA	12 hours at IHR, 10 hours at JDA, 8 hours at TDA	24 hours at IHR, TDA and BON, 12 hours at all others	24 hours at IHR, TDA and BON, 12 hours at all others	24 hours at LMN, IHR, TDA and BON, 12 hours at all others	24 hours at LMN, IHR, TDA at BON, 12 hours at all others	24 hours at all projects	24 hours at all projects
Bonneville		No spill	Spill if necessary to provide 50% FPE (non-turbine passage).	Not specified due to adult passage concerns, implemented 75 kcfs day and gas cap night (120 kcfs gas cap).	Not specified due to adult passage concerns, implemented 75 kcfs day and gas cap night (120 kcfs gas cap).	75 kcfs day and gas cap night (90 to 150 kcfs gas cap)	75 kcfs day and gas cap night (115 to 120 kcfs gas cap)	75 kcfs day and gas cap night (115 to 120 kcfs gas cap)	75 kcfs day and 120 kcfs night

BON= Bonneville Dam, IHR= Ice Harbor Dam, JDA = John Day Dam, LGR = Lower Granite Dam, LGS = Little Goose Dam, LMN = Lower Monumental Dam, MCN = McNary Dam, MOA = memorandum of agreement salmon (both hatchery and wild) passed Little Goose and Lower Monumental dams by late July or early August.

A.3.3 TRANSPORTATION OF JUVENILE FISH

Research on the most effective ways to transport juvenile fish began in 1968. Today, millions of juvenile fish are collected and transported each year from facilities located at Lower Granite, Little Goose, Lower Monumental, and McNary dams. Utilizing transportation is a component of the “spread the risk” strategy, given the uncertainties surrounding both in-river migration and transportation.

Operations since 1995 dictate transport during summer flow and other low-flow periods, when juveniles face the highest risk if left in the river to migrate. Ninety-eight percent of transported fish survive to be released in the river below Bonneville Dam. While researchers have collected substantial data on the risks of leaving juvenile fish in the river to migrate, they have not been able to quantify any latent or delayed mortality that might occur among transported fish.

The returns of adult fish are an indicator of the success of transportation. During the drought of 2000-2001, virtually all spring and summer migrants in the Snake River were transported. When those fish returned as adults to Ice Harbor Dam as adults in 2003 and 2004, their numbers were among the highest of record (University of Washington Data Access in Real Time [DART] Program). Transportation, along with other mitigating measures, helped ensure that a large number of healthy juvenile fish entered the Pacific Ocean to benefit from favorable ocean conditions. Since 1995, two additional large transport barges went into service, bringing the total to eight.

A.4. CONTROL OF PREDATORS

Many kinds of human activity in the river environment have had the unintended consequence of increasing predation on juvenile salmon by birds, fish, and marine mammals. In some cases, this predation can be severe. For example, Caspian terns residing on islands of dredged material in the estuary consume large numbers of listed juvenile fish. A program to redistribute the terns away from the estuary and closer to the ocean has proved effective, reducing the losses of young salmon from an estimated 15 million in 1999 to 3.6 million in 1995. The Federal agencies are now preparing to address growing populations of double-crested cormorants nesting in the estuary and Caspian terns and double crested cormorants in the mid-Columbia. The cormorants consumed an estimated 6.4 million juvenile salmon in 2005.

Over the last few years, sea lions have appeared at Bonneville Dam, which is 140 miles upstream of the Pacific Ocean. Adult salmon congregating below the dam are easy prey for the sea lions. The National Marine Fisheries Service (NMFS, also called National Oceanic and Atmospheric Administration [NOAA]) and the Corps, with the Oregon and Washington fish and wildlife departments, have employed a variety of harassment techniques to drive the sea lions away. Large, removable steel gates have been installed to keep the animals out of the fish ladders. These excluder gates have been effective in keeping most of the sea lions out of the adult fishways and do not appear to slow the passage of salmon.

One of the largest and most successful predator control programs addresses the northern pikeminnow, which consumes juvenile salmon. A sport-reward angling program, which began in the early 1990s, pays fishers for each pikeminnow they catch. Each year the program is upgraded to produce better results. In 2006, the fishers hooked nearly 200,000 pikeminnow and were paid $4 to $8 per fish at reception stations. Since its inception, the program has removed 2.7 million pikeminnow, saving about 3 million juvenile salmon annually.

A.5. HATCHERIES

With the exception of lower Columbia River chum salmon, Mid-Columbia River steelhead, and Upper Willamette River steelhead, 50 percent or more of the anadromous salmonids in the basin today originate in hatcheries. In the Snake River Basin, 60 to 85 percent of returning steelhead and salmon begin their lives in hatcheries (Federal Caucus 2005). BPA funds, in whole or in part, 75 anadromous fish propagation programs out of a total of 189 programs in the Columbia River Basin. The remaining facilities are supported by other State and Federal funding.

BPA-funded programs, which concentrate on specific fish species and populations, are located at 25 major hatcheries. BPA funding totals $60 million a year for hatchery operation and maintenance.

Construction of most of these hatcheries pre-dates the first Endangered Species Act (ESA) listing of Columbia River salmon in 1991. They originally existed to provide more fish for harvest and to mitigate for effects of the dams. Since listing, however, BPA has increasingly re-oriented programs toward recovery of weak natural stocks. NOAA Fisheries and the Action Agencies are reviewing hatchery operations to determine whether they are detrimental to natural stocks. One concern is that the hatcheries may be producing genetically inferior fish that compete with natural stocks for habitat and increase harvest pressures on weak wild runs.

Measure 169 of the Reasonable and Prudent Action of the 2000 FCRPS BiOp called for the Action Agencies to: “fund the development of NMFS-approved HGMPs for implementation, including plans for monitoring and revising them as necessary as new information becomes available.” The hatchery and genetic management plans (HGMP), developed by NMFS to facilitate the application of hatchery reforms to specific artificial production programs, provides a standardized approach and a consistent body of relevant information about hatchery programs. According to the 2000 BiOp, the HGMP would comprehensively address facility and operational details relevant to reform measures and the menu of potential hatchery reform actions identified in Section 9.6.4.2 of the 2000 BiOp. BPA began funding the development of over 200 HGMPs in 2000, continued funding this action under the 2004 Updated Proposed Action, and recently completed the project in 2006. The HGMPs have been submitted to NMFS for approval.

Since the early 1990s, the Action Agencies have adopted safety-net programs that reduce the risk of extinction of very weak stocks. The good news is that few new safety-net programs have been necessary since 2000 and some seem ready to be phased out based on improving fish status.

The Snake River Sockeye Salmon Captive Broodstock Program is an example of a safety-net program. Between 1999 and 2005, 348 adult fish from the program returned to Redfish Lake, 20 times the number that returned from 1990 to 1998 (Corps et al. 2006, p. 14). The return of this species to self-sustaining numbers remains highly uncertain. In 2004, BPA proposed new facilities at the Oxbow Hatchery (located approximately 1 mile east of Cascade Locks, Oregon) operated by the Oregon Department of Fish and Wildlife. This facility is designed to produce 150,000 additional Snake River sockeye salmon smolts, which would bolster the captive population and over time help restore a healthy natural run.

Work continues on establishing the optimal mix of hatchery and natural stocks. Action Agencies have funded and completed HGMPs for all basin hatcheries to address the number of hatchery fish and balance the ratio of wild-to-hatchery stocks over time. The HGMPs have been submitted to NMFS for review and approval.

A.6. HABITAT IMPROVEMENTS

Under both the ESA and the Northwest Power Act of 1980, the contributions of the Federal agencies to improving fish habitat in the tributaries and estuary are far-reaching. Improved survival through the hydrosystem will be in vain if spawning and rearing habitat is insufficient to support a viable number of healthy juvenile fish.

Given the socioeconomic, environmental, and biological complexity of river habitat in the Columbia River Basin, improving conditions for listed stocks presents perhaps the greatest challenge going forward. Only 20 percent of the original natural habitat for salmon and steelhead remains in existence (Brannon 2006). Much of the altered habitat lies on private property. Therefore, the Action Agencies have worked closely with private property owners, and have coordinated planning, funding, and implementation with other Federal, State, Tribal and local entities to improve conditions for stocks in ESUs.

In virtually every subbasin that harbors anadromous fish, teams of biologists are in the field restoring fish habitat long degraded or destroyed due to human activity. These aquatic habitat restorations are being undertaken on a project-by-project basis. Examples include a creek rerouted to its natural path, a culvert removed, an irrigation diversion screened, a cattle fence erected. Improvements on the ground since 1994 are too numerous to list here, but in the Grande Ronde watershed alone, for example, there have been 300 habitat projects of various kinds to address environmental factors influencing water quality and quantity, instream habitat complexity, riparian and upland habitat, and fish passage.

The Federal effort to improve tributary and estuary habitat for listed stocks began in 2000 with a program based on priority subbasins plus the estuary. Accomplishments between 2000 and 2005 on the ground include:

- Restoring fish access to more than 1,280 miles of tributary habitat. In 2005, 19 barriers or obstructions were removed to restore access to more than 180 miles.
- Securing more than 300 cubic feet per second (cfs) of water in tributaries in 2005 alone. Seventeen cfs were delivered in the Wenatchee, Entiat and Methow subbasins. Another 230 cfs secured since 2000 were maintained.
- Installing or retrofitted fish screens at more than 85 water diversions, 15 of them installed in 2005. Federal funding supports three screen shops in the region to manufacture screens and work with farmers in making their irrigation systems safe for fish.
- Acquiring more than 660 acres of habitat in the estuary at Crims Island, Crooked Creek, and Germany Creek.
- Increasing focus on the estuary, where more than 300 acres are now returning to natural condition and another 900 acres are in restoration plans.
- Procurement of volumes of water from water districts that can be left in streams to provide flow and habitat for fish.

Transactions with water districts and individual landowners have secured additional water for tributaries subject to heavy irrigation withdrawals. With Federal funding, the National Fish and Wildlife Foundation operates the Columbia Basin Water Transaction Program. It seeks voluntary, grass roots water transactions to improve flows. In 2004, its third full year of operation, the program completed 42 voluntary transactions. More than 100 were recorded from 2000 to 2004, totaling 530 cfs in 2005 (Corps et al. 2006, p. 9).

A.7. HARVEST

Several programs have been implemented to make fishing methods more selective and less harmful to ESA-listed stocks. The Columbia River Spring Chinook Salmon Tanglenet Fishery, for example, provided river fishers with nets that snared fish by their teeth rather than by their gills. Fishers can extricate natural salmon from nets with less harm, and then revive them in special tanks on the boats before releasing them back into the river. Investment from 2001 to 2003 in this successful program was $1.5 million per year.

In the late 1990s, the Federal system also funded introduction of salmon gillnets with mesh large enough to allow steelhead to slip through. Such nets are now an accepted tool. Funding is also provided for the program to collect coded wire tags from fish caught by commercial and recreational fishers.

The Select Areas Fisheries Evaluation, now a perennial operation in Youngs Bay near Astoria, provides a terminal fishery to bolster salmon harvest, especially in years when the return of other stocks is down. The cost is about $1.5 million a year.

A.8. PERFORMANCE STANDARDS AND RESEARCH, MONITORING, AND EVALUATION

Given the biological complexity of fish passage systems, research, monitoring, and evaluation (RM&E) is essential in designing an effective fish passage system. The technology is essential to ensure that measures to improve fish passage are working.

Historically the agencies have funded the monitoring of adult and juvenile passage at eight sites in the mainstem Snake and Columbia rivers. In recent years, RM&E has moved up the tributaries to remote sites where data are collected on everything from water temperature to nutrients and redd counts.

Subjects studied this year range from hatchery management impacts to turbine survival, passage efficiency, and the relative merits of spill and transportation. In addition, new pilot studies are initiated each year to gather information on the conditions affecting specific weak stocks. The emphasis of these studies has shifted to preservation of natural stocks under the ESA.

A.9. CONCLUSION

The significant changes and technology advancements in the Columbia River hydrosystem since 1994 are in response to Judge Marsh's call for a major overhaul. The reconfiguration of hydrosystem facilities and operations has greatly enhanced the survival of salmonids as they migrate through the system. The willingness and ability of the Action Agencies to adaptively manage the system for fish is an essential feature of the overhaul.

Great challenges remain in the areas of hatcheries, habitat, and harvest. A comprehensive, highly integrated approach to recovery is needed. Evaluation, selection, and implementation of projects under the Northwest Power and Conservation Council broader Columbia River Basin Fish and Wildlife Program must complement ESA programs.

Over one-third of BPA's wholesale rate is attributable to salmon recovery efforts. Needed now is continual improvement of a recovery plan that guides the region's investments to programs where they will prove most beneficial for salmon and steelhead.

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Appendix B
Description of the Proposed Reasonable and Prudent Alternative

The following appendix is divided into two main parts:

- Appendix B.1—Operations for Flood Control, Irrigation, Navigation, and Power Generation and Transmission
- Appendix B.2—Operations to Benefit Listed Fish

Appendix B.1 includes six attachments (Attachments B.1-1 to B.1-6) that describe the operation and maintenance for the 14 facilities on the mainstem Columbia and Snake rivers and major tributaries that comprise the Federal Columbia River Power System (FCRPS). In addition to the 14 FCRPS mainstem facilities, the FCRPS BA also addresses the mainstem Columbia River effects of the operations of several other U.S. Bureau of Reclamation projects as part of the larger FCRPS consultation. The operation and maintenance of these projects is described in Attachment B.1-7.

Appendix B.2 is divided into six sections (Sections B.2.1 to B.2.6) that describe the Proposed Reasonable and Prudent Alternative (RPA) for each resource area (hydropower, habitat, hatchery, harvest, and predation management), as well as the Research, Monitoring, and Evaluation Action. These sections also include a number of attachments (see Appendix B.2).

Section B.1
Operations for Flood Control, Irrigation, Navigation, and Power Generation and Transmission

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ACRONYMS AND ABBREVIATIONS

BPA	Bonneville Power Administration
CBP	Columbia Basin Project
cfs	cubic feet per second
Corps	U.S. Army Corps of Engineers
ESA	Endangered Species Act
FCA	Flood Control Act
FCOP	Flood Control Operating Plan
FCRPS	Federal Columbia River Power System
FERC	Federal Energy Regulatory Commission
GDACS	Generic Data Acquisition Control System
ICF	initial controlled flow
MOP	minimum operating pool
MW	megawatt
Reclamation	U.S. Department of the Interior Bureau of Reclamation
SRD	Storage Reservoir Diagram
TMT	Technical Management Team
Treaty	Columbia River Treaty

B.1. OPERATIONS FOR FLOOD CONTROL, IRRIGATION, NAVIGATION, AND POWER GENERATION AND TRANSMISSION

B.1.1 FCRPS Facilities

The Pacific Northwest is dependent to a large extent upon the Columbia River to derive a multitude of benefits for the region as well as the nation. Since the 1930s, numerous dams—both Federal and private—have been built to provide for flood control throughout the basin, generate hydroelectric power, support fish and wildlife, navigation, recreation and irrigation, and municipal and industrial water supply and quality. The series of Columbia River Basin dams and reservoirs, referred to as the Federal Columbia River Power System (FCRPS), were developed as part of a comprehensive regional plan[1]. The Federal projects operated by the U.S. Army Corps of Engineers (Corps) and the U.S. Department of the Interior Bureau of Reclamation (Reclamation), are operated in a coordinated manner with certain Canadian reservoir projects pursuant to the Columbia River Treaty (Treaty)[2] between the U.S. and Canada, and several Public Utility District projects on the mid-Columbia River.

In furtherance of the intent of Congress, the comprehensive development plan authorizing the Corps to construct, operate, and maintain its FCRPS projects to provide for multiple purpose is provided in Flood Control Acts (FCA), including the FCAs of 1936, 1950, 1958, and 1962, supported by additional legislation and House Documents. These documents specifically address feasibility for achieving project purpose objectives, design, and other aspects of constructing and operating this comprehensive system of projects. The Corps operates 12 of the 14 FCRPS projects for flood control, navigation, hydropower generation, irrigation, recreation, fish and wildlife, water quality, and municipal and industrial water supply. The Corps is obligated to provide for the purposes set forth in the authorizing documents and is not authorized to significantly diminish these purposes unless otherwise provided for by law.

The Reclamation projects described here are authorized, funded, or carried out by Reclamation by virtue of Congressional or Secretarial authorizations, Congressional appropriations, and contracts with Reclamation. Reclamation received authorization for each of its projects from either Congress or the Secretary of the Interior, who had authority under the 1902 Reclamation Act to approve construction after a finding of feasibility. The Congressional and Secretarial authorizations state the purposes to be served by each project. Congress has directed in the Reclamation laws that Reclamation enter into contracts with project water users. These contracts set out, among other things, Reclamation's obligations to store and deliver project water to irrigation districts, municipalities, and other entities. Most early authorizations focused primarily on the irrigation of arid lands; subsequent legislation added other purposes. As a result, some of these projects are for the single purpose of irrigation while others have multiple purposes that may include flood control, hydropower generation, municipal and industrial water supply, recreation, and fish and wildlife. Operations among these projects are not coordinated (except for the coordinated operations for the Deschutes, Wapinitia, and the Crooked River project within the Deschutes River Basin).

[1] House Document No. 531 addresses congressional intent regarding the development of a regional system of projects to serve the Pacific Northwest.
[2] The Treaty Between the United States of America and Canada Relating to Cooperative Development of the Water Resources of the Columbia River Basin, 1964. The Canadian Entity (B.C. Hydro) and the U.S. Entity (represented by the U.S. Army Corps of Engineers and Bonneville Power Administration) are responsible for ensuring the provisions of the Columbia River Treaty are fulfilled.

Additionally, the 1902 Reclamation Act requires that Reclamation comply with state law with regard to control, appropriation, use, and distribution of waters. Water can only be stored and delivered by a project for authorized purposes for which Reclamation has asserted or obtained a state water right in accordance with Section 8 of the Reclamation Act of 1902 and applicable Federal law. Reclamation must honor senior or prior water rights in storing and diverting project water. Conversely, project water is protected from diversion by junior appropriators by state watermasters. The active cooperation of the state water rights administrators is essential in ensuring that any water Reclamation delivers for flow augmentation or any other purpose reaches the targeted points of delivery.

The 14 FCRPS facilities on the mainstem Columbia and Snake rivers and their major tributaries are Bonneville, The Dalles, John Day, McNary, Ice Harbor, Lower Monumental, Little Goose, Lower Granite, Dworshak, Chief Joseph, Grand Coulee, Albeni Falls, Libby, and Hungry Horse dams. Brief descriptions of the purposes and authorities for the facilities included in this consultation can be found in Section 1.5 of the FCRPS Biological Assessment (BA) and within attachments to this appendix. Table B.1-1 also summarizes this information.

A series of attachments to this appendix more fully describe the operation and maintenance for each project or group of projects. For each project, these attachments provide a general project description, a discussion of the facilities' authorizations, a description of the authorized purposes generally broken out by project, and a detailed description of project activities for both operation and maintenance, where appropriate. These discussions occur in the following groupings:

- Attachment B.1-1 – The U.S. Army Corps of Engineers' (Corps') lower Columbia River run-of-river projects (Bonneville, The Dalles, John Day, and McNary dams)
- Attachment B.1-2 – The Corps' lower Snake River run-of-river projects (Ice Harbor, Lower Monumental, Little Goose, and Lower Granite dams)
- Attachment B.1-3 – One Corps Middle Columbia River run-of-river project (Chief Joseph Dam)
- Attachment B.1-4 –Reclamation's storage projects (Grand Coulee and Hungry Horse dams)
- Attachment B.1-5 – The Corps' storage projects (Libby, Dworshak, and Albeni Falls dams)
- Attachment B.1-6 – The Bonneville Power Administration's (BPA's) transmissions operations.

B.1.1.1 Operations for Flood Control

Columbia River storage projects operate as a coordinated system to meet regional flood damage reduction objectives. This section provides a general description of the flood damage reduction operation for the entire river system. In the Flood Control Act of 1936, Section 1, Congress recognized:

> …that destructive floods upon the rivers of the United States, upsetting orderly processes and causing loss of life and property, including the erosion of lands, and impairing and obstructing navigation, highways, railroads, and other channels of commerce between the States, constitute a menace to national welfare; that it is the sense of Congress that flood control on navigable waters or their tributaries is a proper activity of the Federal Government in cooperation with States, their political subdivisions, and localities thereof; that investigations and improvements of rivers and other waterways, including watersheds thereof, for flood-control purposes are in the interest of the general welfare…

Table B.1-1. General Project Characteristics, Mainstem Columbia and Snake Rivers and Major Tributaries

Project	Operator	Location	Year Complete	Type	Authorized Purposes	Attachment with Project Description
Bonneville	Corps	Lower Columbia, at Bonneville, Oregon	1938	Run-of-river	Hydropower, Navigation, Recreation, Fish and Wildlife, Irrigation, and Environmental Protection	B.1-1
The Dalles	Corps	Lower Columbia, at The Dalles, Oregon	1960	Run-of-river	Hydropower, Navigation, Recreation, Fish and Wildlife, Irrigation, and Environmental Protection	B.1-1
John Day	Corps	Lower Columbia, near Rufus, Oregon	1968	Run-of-river [1/]	Flood Control, Hydropower, Navigation, Recreation, Fish and Wildlife, Irrigation, and Environmental Protection	B.1-1
McNary	Corps	Lower Columbia, near Umatilla, Oregon	1954	Run-of-river	Hydropower, Navigation, Recreation, Fish and Wildlife, Irrigation, and Environmental Protection	B.1-1
Ice Harbor	Corps	Lower Snake, near Pasco, Washington	1961	Run-of-river	Hydropower, Navigation, Recreation, Fish and Wildlife, and Irrigation	B.1-2
Lower Monumental	Corps	Lower Snake, near Kahlotus, Washington	1969	Run-of-river	Hydropower, Navigation, Recreation, Fish and Wildlife, and Irrigation	B.1-2
Little Goose	Corps	Lower Snake, near Starbuck, Washington	1970	Run-of-river	Hydropower, Navigation, Recreation, Fish and Wildlife, and Irrigation	B.1-2
Lower Granite	Corps	Lower Snake, near Almota, Washington	1975	Run-of-river	Hydropower, Navigation, Recreation, Fish and Wildlife, and Irrigation	B.1-2
Chief Joseph	Corps	Mid-Columbia, near Bridgeport, Washington	1961	Run-of-river	Hydropower, Flood Control, Navigation, Recreation, Fish and Wildlife, Emergency Preparedness	B.1-3
Grand Coulee	Reclamation	Columbia, at Grand Coulee, Washington	1942	Storage	Flood Control, Hydropower, Irrigation, Navigation, Recreation, Fish and Wildlife	B.1-4
Hungry Horse	Reclamation	South Fork for the Flathead, near Hungry Horse, Montana	1953	Storage	Flood Control, Hydropower, Irrigation, Navigation, Recreation, Fish and Wildlife	B.1-4
Libby	Corps	Kootenai near Libby, Montana	1973	Storage	Flood Control, Hydropower, Recreation, Fish and Wildlife	B.1-5
Dworshak	Corps	North Fork of the Clearwater, near Orofino, Idaho	1973	Storage	Flood Control, Hydropower, Navigation, Recreation, Fish and Wildlife	B.1-5
Albeni Falls	Corps	Pend Oreille, near Newport, Washington	1955	Storage	Flood Control, Hydropower, Navigation, Recreation, Fish and Wildlife	B.1-5

Source: Table 3-1 from BPA et al. (1995).

[1/] John Day has allocated flood control storage but is operated in a manner that is similar to other mainstem dams that are run-of-river projects.

B.1.1.1.1 System Design

The Columbia River system flood damage reduction operations provide flood protection for the Portland, Oregon/Vancouver, Washington area (The Dalles, Oregon, is the reference gage). Although no dam or system of dams and levees can eliminate all downstream flooding (and such an endeavor would be cost prohibitive), the overall goal of flood protection in the Columbia River Basin is to manage the system to minimize flood damages regardless of the conditions presented in any given water year.

B.1.1.1.2 System Flood Control Objectives

To meet Columbia River System flood damage reduction strategies, all storage projects in the system generally operate together to reduce flood damages in the Portland, Oregon/Vancouver, Washington area, as well as within areas in the proximity of the dam. Storage projects include Federal, Canadian, and non-Federal projects. The flood control operations at non-Federal projects are addressed through the Federal Energy Regulatory Commission (FERC) licensing (and re-licensing) of the non-Federal projects.

As stated in the Columbia River Treaty Flood Control Operating Plan (FCOP), "The basic objective for flood regulation is to operate reservoirs to reduce to non-damaging levels the stages at all potential flood damage areas in Canada and the United States insofar as possible, and to regulate larger floods that cannot be controlled to non-damaging levels to the lowest possible level with the available storage space."

Regulating the Columbia River at The Dalles to flows higher than what the system can and is designed to provide (i.e., knowingly causing flooding and associated damages that would otherwise be avoided) is not consistent with the Corps' mission. The Corps' responsibility for flood control is to protect the general welfare of the public by reducing flood damages. As such, the Corps operates the Columbia River system to meet its flood control objective, which is to regulate the system to reduce flows to non-damaging levels using available reservoir storage space.

B.1.1.1.3 Fall Operation, September through December

Generally, there are minimal system flood control operations during the September through December period. Some reservoirs are lowered (drafted) during this period to meet specific end of December flood control upper limit elevations. Each U.S. project in the FCRPS has a specific end of December flood control upper limit, and these limits are unique to each dam. Specific operations are briefly described in the following paragraphs.

B.1.1.1.4 Winter Operation, January through April

During the January through April period, the FCRPS (and Canadian Treaty) dams operate to the storage reservation diagram unique to each dam. During the first 10 days of each month, from January through April, a water supply volume forecast is prepared for each sub-basin and many locations throughout the Columba River Basin to The Dalles, Oregon. Based on the water supply volume forecast, and using the storage reservation diagram, an end of month flood control upper limit elevation is prepared for each dam. In very wet winters where there is abundant snowpack, the objective is to have adequate storage space to accommodate the expected run-off; whereas, in dry winters with lesser snowpack, the objective is to manage so that there is water available for fish during the migration season while also ensuring flood control objectives are met.

In general, all the reservoirs reach their lowest elevation by the end of April to prepare for high spring flows and reduce the potential for flooding – the drawdown period. The end date may vary somewhat because of a dam's location within the Columbia River Basin. Dworshak Reservoir lies in a more southerly location within the Columbia River Basin, and may be drafted to the lowest elevation by the end of March. Canadian reservoirs in the northerly areas of the Columbia River Basin are drafted to the lowest elevation by the end of April.

Often FCRPS reservoirs can refill by June 30, but more northerly basins may not fill until later. For example, Libby Reservoir in Montana may fill after June 30 because much of its drainage basin is in Canada and the snowmelt occurs later in the season. Canadian storage reservoirs refill in late July or August, as the snowmelt season continues late into the summer.

B.1.1.1.5 Spring Operation, May through July

During May through July, the FCRPS refills, following guidance found in the Storage Reservoir Diagrams (SRD). The projects on the Columbia River operate together to meet the initial controlled flow (ICF) at The Dalles, while refilling reservoirs during the refill period.

The ICF is the annual system flood control objective. It is fundamentally a water balance calculated using the available system storage volume at the end of the drawdown period, the forecasted seasonal runoff volume, and the minimum expected volume to be released for flood control during the runoff season. The resultant volume is then converted to a flow rate and labeled the ICF. The simplistic interpretation of this ICF is that all unregulated flow above the ICF during the runoff season at The Dalles can be stored, thereby refilling reservoirs. The ICF, therefore, is the trigger to initiate system refill, and is used to increase project refill probability while minimizing peak runoff at The Dalles. The procedure for determining the ICF is outlined in the FCOP.

Barring unexpected extreme climatic events during the refill period, the Columbia River regulated maximum flows can be regulated to the ICF. It is possible to regulate flows at The Dalles higher than the ICF required for flood control; however, there are two potential adverse impacts from this type of operation. First, the probability of refilling one or more reservoirs is jeopardized; and second, flood damages are incurred above those that would occur when operating to the ICF. On the other hand, regulating the flow at The Dalles to below the ICF, and beginning to refill storage projects prior to reaching the ICF, may compromise system and/or local flood control as unexpected surges of runoff into fuller reservoirs result in the inability to control flows. Consequently, flood damages would be greater than what would occur when operating to the ICF, and increase the likelihood of spill at the projects.

The FCOP (Section 5-5) states, "The ICF established by Chart 1 will be maintained by the regulation of upstream reservoirs until the end of the flood control period, until revised forecasts indicate the necessity for the controlled flow to be changed. Change in the controlled flow at The Dalles will be made based primarily upon day-to-day forecasts of streamflow and reservoir regulation by computer simulations, together with the latest volume forecasts of runoff." Thus, there is no "target flow level" (e.g., 450,000 cubic feet per second [cfs]) at The Dalles. The forecasted basin inflow volume is continuously monitored and compared to available remaining storage volume, and the regulated flow is adjusted so that control is maintained. Chart 3 of the FCOP is used to make this upward adjustment to the ICF. Therefore, flood control regulation is a variable controlled flow objective based on the volume and timing of spring runoff. Whenever possible, the Corps will attempt to regulate the annual peak flow at The Dalles to no higher than the ICF (but not below 200,000 cfs) to minimize damages. Charts 1 and 3 are reproduced here as Figures B.1-1 and B.1-2.

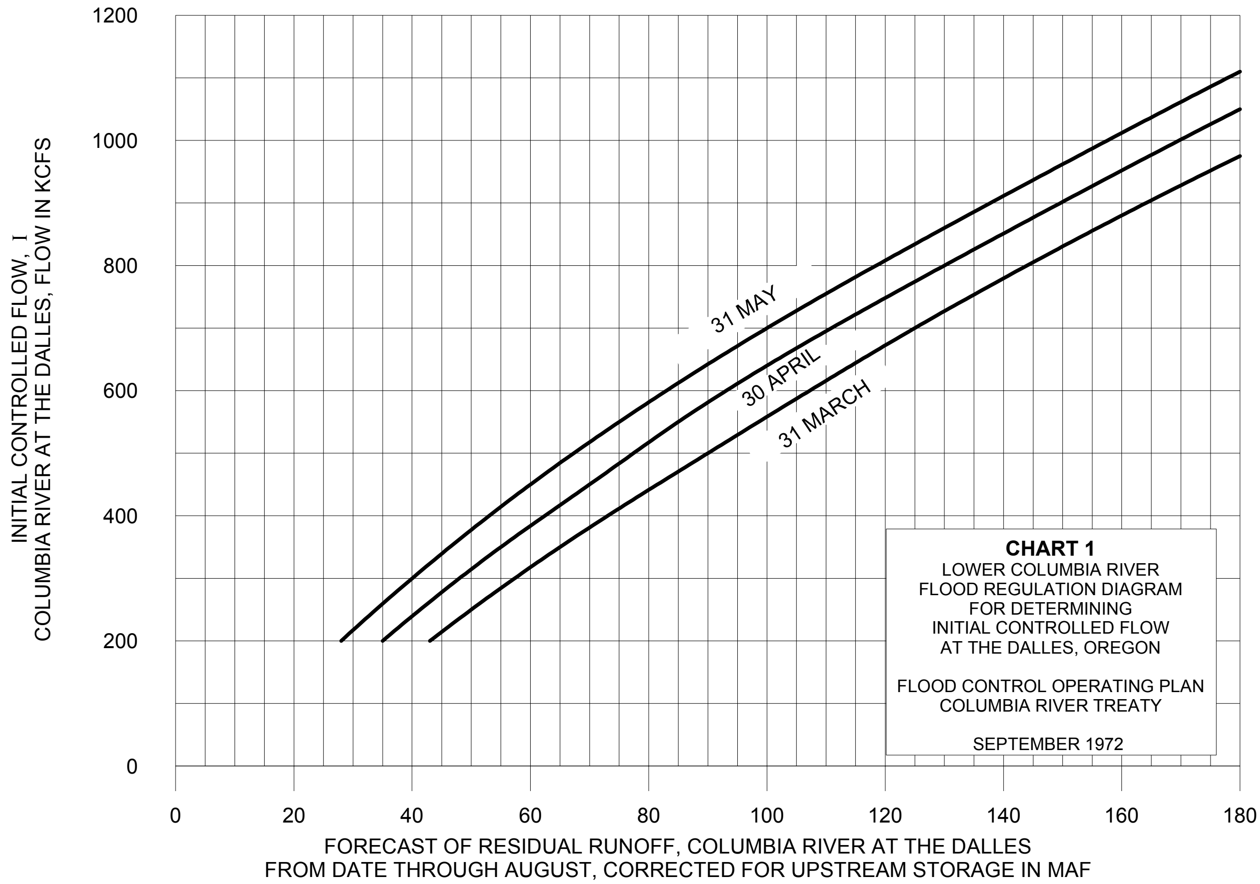

Figure B.1-1. Lower Columbia River Flood Regulation Diagram for Determining Initial Controlled Flow at The Dalles, Oregon

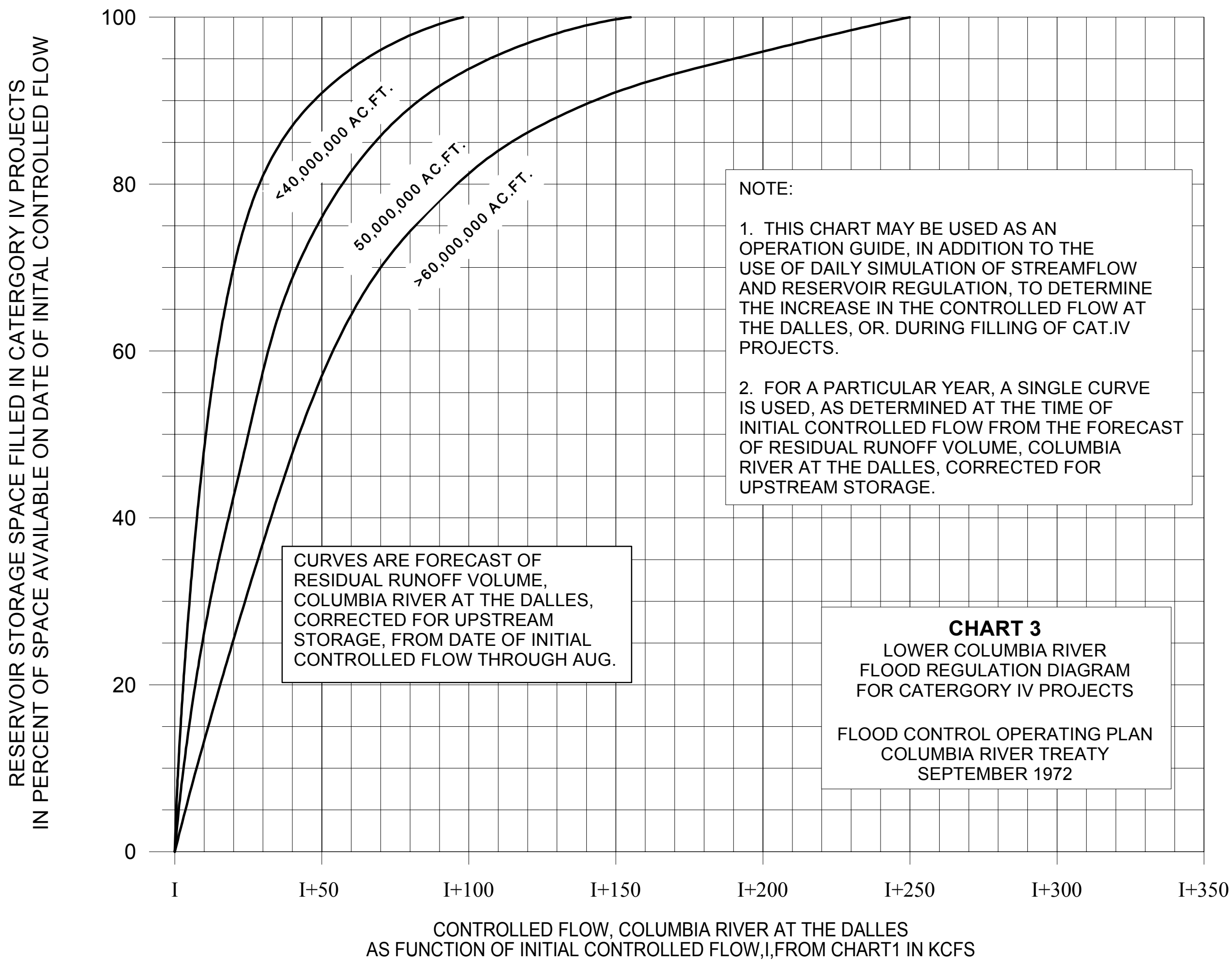

Figure B.1-2. Lower Columbia River Flood Regulation Diagram for Category IV Projects

B.1.1.1.6 Summary

Columbia River storage projects operate as a coordinated system to meet the regional flood damage reduction objectives. The annual system flood damage reduction objective (not the target) during the refill period from May through July is to regulate the peak flow at The Dalles to the ICF. When a regulated peak is different from the ICF, it is usually attributable to a dramatic over- or under-forecasted volume, unanticipated runoff shape, listed species act objectives, or a dramatic unscheduled increase in power generating requirements. The FCOP is available on the Web at http://www.nwd-wc.usace.army.mil/cafe/forecast/FCOP/FCOP2003.pdf.

B.1.1.2 Operations for Irrigation/Water Supply

The Corps' storage of water for irrigation on agricultural lands is used to meet or supplement natural supplies. The Northwestern Division Reservoir Control Center coordinates and modifies operations to benefit irrigation at both John Day and McNary projects. The Lower Snake River Project also provides irrigation water by having stabilized reservoir levels that enable the installation and operation of pumping stations. More detail on irrigation operations along the lower Columbia and lower Snake rivers can be found in Attachments B.1-1 and B.1-2.

Grand Coulee Dam is the primary storage and diversion structure for the Columbia Basin Project (CBP). Reclamation coordinates operation and maintenance for irrigation of the CBP. More detail on the operations of the CBP and Hungry Horse projects can be found in Attachment B.1.4.

B.1.1.3 Operations for Navigation

The Columbia River system is the Northwest's river highway. The 465-mile Columbia-Snake Inland Waterway represents a key link to the Columbia-Snake River Basin interior region. It facilitates barge transport from the Pacific Ocean to Lewiston, Idaho, the most inland port. This transportation system consists of navigation channels and locks, port facilities, and shipping operations. The system is used for commodity shipments from inland areas of the Pacific Northwest and as far away as North Dakota. Today, the Corps maintains a reliable 40-foot-deep, deep-draft navigation channel between the Pacific Ocean and the Portland, Oregon/Vancouver, Washington area, and a shallower channel and system of navigation locks along the Columbia-Snake Inland Waterway to Lewiston, Idaho. Commerce on the Columbia-Snake rivers supports approximately 40,000 jobs in the region, and over $208 million in state and local taxes are generated by maritime activities on the system. The system supports international trade valued at an estimated $15 billion annually and carries about 33 million tons of cargo, making it the second largest export gateway on the West Coast. From January to December 2005, 9,386,000 tons of cargo passed through Bonneville Dam. The average annual tonnage passing through the Ice Harbor lock between 1996 and 2005 was 3,779,474 tons.

Navigation locks at Columbia and Snake River projects are available for locking commercial boat traffic past the dams almost continually 24 hours per day, 7 days a week, approximately 50 weeks of the year. Lockages for recreational boat traffic are provided from May 15 through September 15, according to a lockage schedule. During 2006, five upstream and downstream lockages were provided each day. Unscheduled recreational lockages are allowed during the remaining period of the year.

Navigation locks were designed to allow 15 feet of depth over the concrete sills on the upstream and downstream entrances to the locks. This depth is provided at upstream entrances of the locks within normal operating ranges for the reservoirs, and does not impact operating the reservoirs at minimum operating pool (MOP) for juvenile fish migrations. Depth over downstream entrance sills, however, can be impacted by MOP operations at low river flows (around 40 thousand cubic feet per second [kcfs] and lower). If this happens, reservoir elevations may be raised to provide safe clearance for vessels entering and leaving the navigation locks.

Spill patterns and spill volumes can affect commercial navigation entering and exiting the downstream entrance of the locks. Various spill patterns used for juvenile fish passage can result in eddying conditions that affect towboats and barges entering or leaving the locks. When these conditions occur, spill patterns may be temporarily altered to provide safer navigation conditions for tows entering or leaving the locks. Spill patterns return to the specified juvenile fish passage patterns when the tows are safely past the problem area.

Navigation Maintenance. As previously stated, navigation locks are operated approximately 50 weeks each year. A 2-week annual maintenance outage for all eight lower Columbia River and lower Snake River locks occurs in March. Both routine and non-routine lock maintenance occurs at this time. Work includes inspections and maintenance of underwater filling and emptying conduits, tainter valves, gates, and gate operating equipment. Each lock is dewatered on a 5-year rotation for major inspection. Other inspections take place yearly. Special reservoir levels may be required prior to and after lock outages in order to move floating bulkheads out of and back into their mooring berths. Routine maintenance that does not require outages takes place during other times of the year also. Additional non-routine inspections or maintenance may take place during the year if problems are encountered with any of the locks' operating equipment. If gate problems are encountered during the year, floating bulkheads may need to be used to lock vessels through while repairs are made. This may require a short-term full pool operation of the reservoir (deviation from MOP operations for juvenile fish migrations) in order to move the floating bulkheads into position. Once in position, the floating bulkhead can be used for locking vessels through the lock at any normal pool elevation. Periodic maintenance dredging is performed to maintain the navigation channel at authorized dimensions.

B.1.1.4 Operations for Power Generation and Transmission

The integrated system of 30 Federal hydroelectric facilities in the Columbia River Basin, on average, accounts for approximately 60 percent of total regional energy and 70 percent of total electrical generating capacity. The four dams on the lower Columbia River have a total nameplate capacity of 6,443.5 megawatts (MW), the four dams on the lower Snake River have a total nameplate capacity of 3,033 MW, Grand Coulee Dam has a total capacity of 6,495 MW, Hungry Horse Dam has a total capacity of 428 MW, Libby Dam has a capacity of 600 MW under optimal conditions, Dworshak Dam has a total capacity of 400 MW, and Albeni Falls Dam has a total capacity of 42.6 MW. A surplus of hydropower generated at these Federal projects, when available, is an important export product for the region, and is marketed and distributed by BPA. It is sold to public and private utilities in the region, utilities outside of the region, and some of the region's largest industries. Power lines originate at generators at the dams, and extend outward to form key links in the regional power transmission grid. BPA owns and operates 75 percent of the high-voltage transmission system. The Northwest grid is interconnected with Canada to the north, California to the south, and Utah and other states to the east. Power produced at dams in the Pacific Northwest is provided to customers both locally and thousands of miles away.

Turbine-generator units are operated to meet the electrical needs of the region, depending on river flows. Peak generation loads coincide with spring runoffs with low flows and low generation occurring in late summer and fall. Projects normally attempt to have all turbine units available for spring operations to pass high flows and winter periods when very cold weather may result in emergency generation requirements. Annual outages for maintenance and testing of turbine-generator units and related equipment are normally scheduled in late summer and fall. The Corps' Fish Passage Plan (Corps 2006) contains operating criteria that govern turbine unit operations including operating with fish screens, raking of trashracks, priorities or operating sequences, operating ranges during fish passage seasons, and turbine unit outages. During the juvenile fish passage season, turbine units at each project are operated within the 1 percent best efficiency range at a given level of head. This criterion is contained in the Corps' Fish Passage Plan in Appendix C and in the individual project operating criteria (Corps 2006). Deviations from operating criteria may be coordinated for fish research, maintenance, or other purposes. Project powerhouse operators oversee the operations of turbine-generator units. They are responsible for starting and stopping units based on anticipated generation requirements provided by BPA dispatchers. The actual real-time instantaneous setting of individual turbine-generator loads is controlled by a Generic Data Acquisition Control System (GDACS) at each project. GDACS receives a real-time data signal from BPA and adjusts unit loadings within specified parameters to meet generation load requirements, which include operating within the 1 percent best operating efficiency range.

Hydropower Maintenance. Maintenance of turbine-generator units, transformers, and other associated equipment is normally timed to provide as much uninterrupted operation of the units to meet electrical generation needs as possible. This scheduling also minimizes impacts to adult and juvenile fish passage from taking units out of service when their operations may be needed for fish passage. The Corps' Fish Passage Plan (Corps 2006) contains criteria to minimize impacts to fish from maintenance activities. Outages for annual maintenance or overhauls are scheduled as much as possible for the mid-to-late summer and fall when river flows are lower. Annual outage schedules are prepared each winter and coordinated with the region. Schedules detail outages for each turbine unit for installation and removal of fish screens, monthly inspections of fish screens, installation of fish research equipment, and testing and maintenance of turbine units and/or related equipment. Schedules are updated throughout the year as required to reflect maintenance requirements and are provided to the Reservoir Control Center for regional coordination through the Regional Forum Technical Management Team (TMT).

Maintenance of turbine units may or may not require them to be dewatered. Dewatering is normally done only when personnel need to enter the waterways of the turbine intake to inspect or work on the turbine itself or if the turbine and generator must be disassembled for major repair work. Stoplogs and operating (intake) gates are installed for safety precautions when maintenance activities require that the units not turn for any reason. Projects have written dewatering plans that detail how to dewater turbine units to minimize impacts to fish. These plans detail how to operate the turbine units and install stoplogs to minimize fish entrainment in the units and how to handle fish when they are encountered during the dewatering process. Project fishery biologists oversee the dewatering and fish removal process. The Corps' Fish Passage Plan contains criteria that require all turbine unit trashracks to be raked prior to installing fish screens and periodically during the fish passage season when warranted by the criteria (Corps 2006).

Testing of major generating equipment may require special project operations. Electrical testing of generator step-up transformers requires that the transformers be disconnected from the transmission lines. All the lower Columbia River projects have two or more transmission lines per powerhouse, so an outage required for transformer insulation testing does not require an outage of more than four turbine-generators. Testing is normally scheduled in late summer to minimize impacts on migrating fish and to keep total dissolved gas levels within allowable standards. Periodic testing of other generation-related equipment may require short-term departure from normal operating criteria to conduct.

B.1.1.5 Operations for Recreation

There are 51 developed recreation sites along the lower Columbia River and 33 developed recreation sites adjacent to the lower Snake River reservoirs—all on Corps land. There are also a number of recreation sites on Reclamation-owned lands along the Columbia River, including 2 state parks, 35 Department of Fish and Wildlife access sites, and 4 sites managed directly by Reclamation. Nearly all of these sites provide recreation opportunities that either depend on water or are enhanced by the proximity of water. Several of the sites were constructed by the Corps, but are operated by counties, port districts, or through commercial leases. Sites on Reclamation lands were constructed and are operated in partnership with Washington State and several municipalities.

Recreation at Corps facilities was authorized by the Flood Control Act of 1944, the Federal Water Project Recreation Act of 1965, and language in specific project authorization acts. The Corps and Reclamation are among the Federal government's largest providers of outdoor recreational opportunities, which include both water- and land-based activities such as boating, water skiing, sail/kite boarding, fishing, sightseeing, swimming, picnicking, camping, hunting, and hiking. Boat launch ramps, swim beaches, marinas, lawns with irrigation and domestic water supplies, and other facilities have been developed to support these activities. In general, project lands and most facilities are open for these activities year round.

Recreation Maintenance. Maintenance of Corps recreation areas is generally done by Federal maintenance personnel and contractors. Maintenance of recreation sites on Reclamation lands is primarily done through its managing partners. Along the lower Columbia River, the partner is primarily the State of Washington. Maintenance includes mowing and general care of irrigated lawns, restroom servicing, refuse pickup, and overall maintenance of parks and campgrounds. Removal of hazardous tree branches or trees may also be required in parks with mature trees. Swim beaches contain area float systems for marking the area off limits for boaters. These float systems may require periodic maintenance or replacement to keep them in good condition. Boat ramps and courtesy docks require periodic maintenance. Gravel at the bases of ramps needs to be replaced periodically since boat prop washes erode it as boats are loaded onto trailers. Courtesy docks require periodic maintenance to replace rubber bumpers, skirting, floats, or complete replacement when damaged or deteriorated. Maintenance is frequently completed by unbolting the docks from their support structures, and pulling them up onto the boat ramps where repairs are made. As dock sections are replaced, new dock sections using a more fish-friendly design and method recommended by fishery agencies are installed.

B.1.1.6 Operations for Fish and Wildlife

Fish Passage. The Columbia and Snake mainstem run-of-river projects are operated in accordance with the operative biological opinions and the Corps' Fish Passage Plan (Corps 2006), which is updated yearly based on regional fish manager input. Adult fish facilities operate year round, with a window for maintenance that varies at each project. Juvenile fish are transported from Lower Granite, Little Goose, Lower Monumental, and McNary dams, again under criteria and guidelines detailed in the Fish Passage Plan. Spill at mainstem projects is provided for juvenile fish passage under the Fish Passage Plan, as well. Details of fish passage operations can be found in attachments to this appendix.

Project Releases for Fish Flows. The FCRPS storage projects are operated to provide flows for Endangered Species Act (ESA)-listed fish. This includes releases for Kootenai River white sturgeon, Columbia River bull trout, and anadromous listed species. Through coordination with the Regional Forum TMT, the FCRPS is operated in conjunction with Canadian project operations to provide for anadromous species flow objectives.

Wildlife. Management responsibilities for the natural resources on lands acquired for the Corps' and Reclamation's multipurpose projects involve both the Corps, Reclamation, and a number of other Federal and State agencies. Further information regarding wildlife programs can be found in attachments to this appendix.

B.1.2 Reclamation's Columbia River Tributary Projects

In addition to the 14 FCRPS mainstem facilities, the FCRPS BA also addresses the mainstem Columbia River effects of the operations of several other Reclamation projects as part of the larger FCRPS consultation (see Table B.1-2). The tributary effects of these separate Federal actions are currently being addressed by Reclamation in other ESA Section 7 consultations. Reclamation incorporates these consultations by reference.

These separate Federal actions are authorized, funded, or carried out by Reclamation by virtue of Congressional or Secretarial authorizations, Congressional appropriations, contracts with Reclamation, and facility ownership. Most early authorizations focused primarily on the irrigation of arid lands; subsequent legislation added other purposes. As a result, some of these projects are for the single purpose of irrigation while others have multiple purposes that may include flood control, hydropower generation, municipal and industrial water supply, recreation, and fish and wildlife. Operations among these projects are not coordinated (except for the coordinated operations for the Deschutes, Wapinitia, and the Crooked River project within the Deschutes River Basin).

Table B.1-2. Reclamation Projects in the 2006 FCRPS Consultation [1/]

Project	Location	Subbasin or Stream
Chief Joseph Dam	North-central Washington, north of Wenatchee	Okanogan and Columbia rivers
Columbia Basin	Central Washington	Columbia River
Crooked River	Central Oregon, north of Bend	Crooked River
Deschutes	Central Oregon, north of Bend	Deschutes River
Hungry Horse	Western Montana, north of Flathead Lake	South Fork Flat Head River
Okanogan	North-central Washington, near Okanogan	Okanogan River
The Dalles	North-central Oregon, near The Dalles	Columbia River
Tualatin	Northwest Oregon, west of Portland	Tualatin River (Willamette River)
Umatilla	Northeast Oregon	Umatilla and Columbia rivers
Wapinitia	North-central Oregon, south of The Dalles	Deschutes River
Yakima	Central Washington, near Yakima	Yakima River

[1/] Avondale, Dalton Gardens, Frenchtown, Lewiston Orchards, Missoula Valley, Rathdrum Prairie, and Spokane Valley were included in previous assessments and opinions, but are not included in this consultation because they have unmeasureable effects. Twelve upper Snake River projects upstream from Hells Canyon Dam are undergoing separate Section 7 consultations, and are included in the Comprehensive Analysis. This table also lists the Columbia Basin Project and the Hungry Horse Project that are part of the FCRPS.

Some of these projects involved the development of full water supplies for the irrigation of new lands, others involved only the rehabilitation of privately developed facilities, while still others involved various combinations of full water supplies for new lands and full or supplemental water supplies for previously irrigated lands. Water supplies for these projects may include a single source or some combination of storage, natural flow, and ground water. The water rights for these projects are generally, but not always, held by Reclamation. Where the projects provide a supplemental water supply, irrigation entities generally retain the water rights for the primary (or first developed) water supply. However, in some cases, the original holder of a natural flow right has exchanged that right for Reclamation storage space or natural flow rights. Irrigators typically use natural flows early in the season and storage releases later in the season as natural flows subside.

The operation and maintenance of these projects is described in more detail in Attachment B.1-7. Other documents are incorporated in this discussion by reference, where possible. Other references include biological assessments and opinions for completed tributary consultations, operations reports for several projects, and standing operating procedures for most larger facilities.

B.1.3 References

BPA (Bonneville Power Administration), U.S. Army Corps of Engineers, and U.S. Bureau of Reclamation. 1995. Final Columbia River System Operation Review Environmental Impact Statement. Portland, Oregon. November.

Corps (U.S. Army Corps of Engineers). 2006. Fish Passage Plan for Corps of Engineers Projects. U.S. Army Corps of Engineers, Northwestern Division, Portland, Oregon. March.

Appendix B—Description of the Proposed Reasonable and Prudent Alternative
Section B.1—Operations for Flood Control, Irrigation, Navigation, and Power Generation and Transmission

Attachment B.1-1
U.S. Army Corps of Engineers Lower Columbia River Projects

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ACRONYMS AND ABBREVIATIONS

BPA	Bonneville Power Administration
cfs	cubic feet per second
Corps	U.S. Army Corps of Engineers
ESBS	extended submerged bar screen
HMU	Habitat Management Unit
MW	megawatt
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
RM	river mile
STS	submerged traveling screen
TIE	turbine intake extension
UMT	upstream migrant transportation
VBS	vertical barrier screen

1. GENERAL PROJECT DESCRIPTION

The U.S. Army Corps of Engineers (Corps) operates four projects on the lower Columbia River: Bonneville, The Dalles, John Day, and McNary Dams.

The Columbia River is the fourth largest river in North America. It originates at Columbia Lake in the Columbia Mountains of British Columbia, Canada, and flows 1,214 miles to the Pacific Ocean. From its source, the river flows northwest for approximately 200 miles, then turns south and travels for nearly 300 miles southwards through mountainous terrain in southeastern British Columbia. The Columbia River crosses into the United States near the northeastern corner of Washington State and continues south through highlands before bending westward. After looping again to the east, the river turns westward and flows for more than 300 miles between the states of Washington and Oregon to the sea. The Columbia River Basin drains more than 259,000 square miles. It produces an average annual runoff at The Dalles of about 173 million acre-feet (enough water to cover 173 million acres to a depth of 1 foot). The drainage area comprises most of Washington, Oregon, and Idaho; the western quarter of Montana; the southeastern corner of British Columbia; and small portions of Wyoming, Utah, and Nevada.

Bonneville, The Dalles, and McNary are run-of-river projects, and are not operated for flood control. These projects have limited storage capacity, and pass water at nearly the same rate as the water enters each reservoir. Reservoir levels behind these dams vary only a few feet during normal operations. This limited storage is used for hourly regulation of powerhouse discharges to follow daily and weekly demand patterns. This storage is not enough to allow seasonal regulation of streamflows. John Day Dam was developed for flood control, as well as the hydropower and navigation, and is considered a storage facility. Storage reservoirs such as Lake Umatilla (behind John Day) are used to store water and adjust the river's natural flow patterns to conform more closely with water uses.

2. AUTHORIZATION

The Columbia River projects were constructed and are operated and maintained under laws that may be grouped into three general categories: 1) laws initially authorizing project construction; 2) laws specific to the projects passed subsequent to construction; and 3) laws that generally apply to all Corps projects within the United States. Using these and other authorities, the Corps operates multiple-use water resource development projects to balance operation of individual functions with operations for all functions. This operation is coordinated with Bonneville Power Administration (BPA), U.S. Department of the Interior Bureau of Reclamation (Reclamation), and other regional interests. Authorized uses for the lower Columbia River dams are flood control, power generation, navigation, fish and wildlife, irrigation, recreation, and environmental protection, authorized under several public laws.

3. AUTHORIZED PURPOSES

The lower Columbia River dams are multiple-use projects that provide public benefits in a number of different ways. Project facilities include dams and reservoirs, hydroelectric powerplants and high-voltage transmission lines, navigation channels and locks, juvenile and adult fish passage structures, fish hatcheries, parks and recreational facilities, lands dedicated to project operations, and areas set aside as wildlife habitat. The projects' primary functions are to produce electrical power and provide navigation on the Columbia River as part of the Columbia-Snake River Inland Waterway. Land for public access, recreation development, and wildlife management is limited at Bonneville and The Dalles due to minimal Corps ownership and physical constraints (i.e., topography and highway and railroad development paralleling both shores). The John Day and McNary facilities have fewer limitations and more land under Corps ownership.

Summary information is presented for the four lower Columbia River projects in Table 1. More detailed information is presented for each project in Table 2.

Table 1. Lower Columbia River Projects Summary Information

Dams	Type of Dam	Year Completed	River Mile	Reservoir Name	Useable Capacity (acre-feet)[1/, 2/]
Bonneville	Run-of-River	1938	145.5	Lake Bonneville	100,000
The Dalles	Run-of-River	1960	192.5	Lake Celilo	53,000
John Day	Storage	1971	215.6	Lake Umatilla	535,000
McNary	Run-of-River	1957	292.0	Lake Wallula	185,000

Notes:
1/ Corps 2007
2/ Useable capacity = water occupying active storage capacity of a reservoir

Table 2. Lower Columbia River Projects Facility Operations and Structures

	Bonneville (B1)[1/]	Bonneville (B2)[1/]	The Dalles	John Day	McNary
Reservoir					
Normal Pool Operating Range (feet above NGVD)	70 - 77	-	155 – 160	257 - 268	335-340
Total Length (miles)	48	-	23.6	76.4	61.6
Surface Area (acres)	20,600	-	9,400	49,300	38,800
Flood Control Storage (acre-feet)	0	-	0	500,000	0
General (Dam)					
Dam Length (feet)	2,477	-	8,735	5,900	7,365
Hydraulic Head (feet)	50	-	85	105	83
Powerhouse					
Powerhouse Length (feet)	1,027	986	2,089	1,975	1,422
Nameplate Capacity (MW)	612.5	612	1,807	2,160	986
Total Number of Units Installed	10	8	24	16	14
Spillway					
Spillway Length (feet)	1,070	-	1,467	1,288	1,320
Number of Spillway Bays	18	-	23	20	22
Stilling Basin Length (feet)	147	-	170	182	276
Navigation Lock and Channels					
Lock Chamber Length (feet)	500	675	650	675	675
Lock Chamber Width (feet)	76	86	86	86	86
Maximum Operating Lock Lift (feet)	70	70	90	113	84

Notes:
1/ Data for Bonneville Dam are presented by powerhouse. The first powerhouse (B1) went into operation in 1938. The second powerhouse (B2) was completed in 1981.

3.1 BONNEVILLE LOCK AND DAM

Bonneville Lock and Dam is located at the head of tidewater on the Columbia River at river mile (RM) 145.5, in the heart of the Columbia River Gorge, approximately 42 highway miles east of Portland, Oregon. The Oregon-Washington state boundary lies along the main Columbia River channel, dividing the project between the two states. The facility includes two navigation locks, two powerhouses, spillway, fish passage facilities, fish hatchery, and one of the largest visitor complexes administered by the Corps.

In 1937, the 75th Congress authorized the completion, maintenance, and operation of the facility under the Corps' supervision and, in 1938, the first powerhouse went into operation. The original authorized project purposes are navigation and hydropower, with recreational opportunities added as an authorized uselater. A second powerhouse was completed in 1981, which more than doubled generating capacity. Bonneville Lock and Dam was placed on the National Register of Historic Places in June 1986. The Bonneville Project Authorizations are described in Table 3.

Table 3. Bonneville Lock and Dam Authorizations

Operating Purposes	Authorized Purposes	Authorizing Laws
Hydroelectric Power	Hydroelectric Power	PL 75-329
Recreation	Recreation	PL 78-534
Navigation	Navigation	PL 75-329
Water Quality	Water Quality	PL 92-500
Fish/Wildlife	Fish/Wildlife	PL 85-624, PL 98-396

1/ Project originally authorized by the Federal Emergency Administration of Public Works on September 30, 1933. Authorized by Congress on August 30, 1935 (Senate Committee Print, 73rd Congress, Second Session). PL 75-329 authorized the completion, operation and maintenance of the project by the Department of Defense on August 20, 1937.

Through treaties signed in the 1850s, Indian Tribes in the Pacific Northwest reserved the right to access and fish at usual and accustomed fishing stations along the Columbia River. Several fishing sites were submerged or destroyed during the construction of Bonneville Dam. In response to this, the United States entered into an agreement with Northwest Tribes. The Secretary of the Army was authorized to acquire lands and provide facilities in Oregon and Washington to replace Indian fishing grounds along the Columbia River "in-lieu" of those sites inundated by Bonneville Dam.

At present, the 1938 lock on the first powerhouse is in the process of being decommissioned. The new navigation lock at Bonneville opened to traffic in 1993. The new navigation lock is 675 feet long by 86 feet wide, with a maximum lift of 70 feet.

Juvenile fish passage facilities at Bonneville Dam are powerhouse and spillway specific. Fish entering the first powerhouse (B1) pass either deep through turbine units or may pass through a more shallow route over lowered gates into a debris-type sluiceway. The spillway, sited between the Bradford and Cascades Islands, has 18 vertical lift gates used for passing excess powerhouse discharge and for smolt passage. The second powerhouse (B2) connects to the Washington shore on the north end and is separated from the spillway on the south end by Cascades Island. The second powerhouse contains eight screened turbine units (i.e., juvenile bypass system). A modified ice and trash sluiceway, referred to as the B2 corner collector, is the result of extensive modification of the original B2 sluice-chute. Adult fish passage facilities are composed of the Bradford Island ladder, the Cascades Island ladder, and the Washington Shore ladder.

Developed recreation areas around Bonneville Lock and Dam and Lake Bonneville include the dam visitor center, campground, state parks, and boat basins. The Bonneville Dam facilities drew nearly 2.74 million recreational visits in fiscal year 2005. Total acreage for the Bonneville Project, including pool, fee lands, and lesser interests, is over 25,000 acres.

3.2 THE DALLES DAM

The Dalles Dam is located on the Columbia River at RM 192.5, approximately 90 miles east of Portland, Oregon, and 3 miles upstream from the city of The Dalles, Oregon. The development and construction of The Dalles Lock and Dam Project was authorized by the Flood Control Act of 1950. Construction began in 1952 and was completed in 1960. The authorized principal objectives of the facility are to provide improved navigation and hydropower. Authorizations for The Dalles Lock and Dam Project are contained in Table 4.

Table 4. The Dalles Dam Authorizations

Operating Purposes	Authorized Purposes	Authorizing Laws
Irrigation	Irrigation	PL 81-516
Navigation	Navigation	PL 81-516, 87-874
Recreation	Recreation	PL 78-534
Fish/Wildlife	Fish/Wildlife	PL 85-624, PL 98-396
Water Quality	Water Quality	PL 81-516, PL 92-500
Hydroelectric Power	Hydroelectric Power	PL 81-516

The Dalles Dam extends 1.5 miles from the Oregon shore to the navigation lock on the Washington shore. The project consists of a navigation lock, spillway, powerhouse, fish-passage facilities, and the non-overflow sections of the dam. Various recreational facilities are provided along Lake Celilo, the 24-mile-long impoundment behind the dam.

Lake Celilo provides slackwater navigation at a minimum depth of 15 feet in the main channel. The facility's navigation lock, on the Washington shore, is 86 feet wide and 675 feet long. It has an 88-foot normal lift, and provides a 15-foot minimum depth over the sills.

The powerhouse, with 1,807,000 kilowatts of installed generating capacity, has 22 main generators—14 original units rated at 78,000 kilowatts and eight newer units rated at 86,000 kilowatts—and two auxiliary units of 13,500 kilowatts each. The auxiliary units also provide water to attract adult migrating fish to the fish ladders.

Juvenile fish passage facilities at The Dalles Dam consist of an ice-and-trash sluiceway, gatewell orifices, and the spillway. Turbine units at The Dalles are not screened. Adult fish passage facilities consist of a north shore fish ladder and an east fish ladder.

There are several recreation sites on both the Washington and Oregon shores at The Dalles Dam. Some are operated by the Corps, others are operated by the states of Oregon or Washington. Total acreage for The Dalles Project, including pool, fee lands, and lesser interests, is over 12,000 acres.

3.3 JOHN DAY DAM

John Day Dam is located 24 miles upstream from The Dalles Dam, at the head of Lake Celilo at RM 215.6. The primary authorized purposes of the project are flood damage reduction, navigation, and hydropower generation. Authorizations for the John Day Project are found in Table 5. The facility consists of a navigation lock, spillway, powerhouse, non-overflow sections, and fish passage facilities on both shores. Construction began in 1958 and the first power generator went into operation in 1968. Lake Umatilla is the second largest reservoir on the Columbia River, extending upstream about 76 miles to the foot of McNary Dam.

Table 5. John Day Dam Authorizations

Operating Purposes	Authorized Purposes	Authorizing Laws
Flood Control	Flood Control	PL 81-516
Irrigation	Irrigation	PL 81-516
Navigation	Navigation	PL 81-516, PL 87-874
Recreation	Recreation	PL 78-534
Fish/Wildlife	Fish/Wildlife	PL 81-516
Water Quality	Water Quality	PL 81-516, PL 92-500
Hydroelectric Power	Hydroelectric Power	PL 81-516

Lake Umatilla provides slackwater for navigation, with a minimum 15-foot depth in the main channel. The navigation lock, located on the Washington shore, is 86 feet wide, 669 feet long, and provides 15 feet of water depth over the sills, with a 113-foot maximum lift.

The powerhouse, with 16 main generators of 135,000-kilowatt capacity each, has a total generating capacity of 2,160,000 kilowatts. The last of the 16 generators went on line in November 1971.

Unlike the other dams on the lower Columbia River, John Day Dam is also operated for flood damage reduction. When high runoff is forecast, the Lake Umatilla pool is lowered to provide space for control of about 500,000 acre-feet of floodwaters.

Juvenile fish passage facilities at John Day Dam consist of a screened juvenile bypass system, and the spillway. The adult fish passage facilities at John Day are composed of north and south shore fish ladders.

In addition to the two visitor areas at John Day Dam, recreation is available at more than a dozen areas along Lake Umatilla. Most of the areas are managed by the Corps, but there are also parks operated by local entities in several locations. Total acreage for the John Day Project, including pool, fee lands, and lesser interests, is over 52,000 acres.

3.4 MCNARY DAM

McNary Dam is located on the Columbia River at RM 292 near Umatilla, Oregon. Major cities in the local vicinity include Umatilla and Hermiston, which are near the dam; Kennewick and Pasco, located upstream of the confluence of the Snake and Columbia rivers; and Richland, located at the confluence of the Yakima and Columbia rivers. Authorized purposes for McNary Dam are hydropower, navigation, irrigation, recreation, fish and wildlife, and water quality. Authorizations for these project purposes can be found in Table 6.

Table 6. McNary Dam Authorizations

Operating Purposes	Authorized Purposes	Authorizing Laws
Hydroelectric Power	Hydroelectric Power	PL 79-14, PL 99-662
Navigation	Navigation	PL 79-14, PL 87-874
Irrigation	Irrigation	PL 79-14
Recreation	Recreation	PL 78-534
Fish/Wildlife	Fish/Wildlife	PL 85-624
Water Quality	Water Quality	PL 92-500

Lake Wallula, the reservoir behind McNary Dam, extends 42.7 miles upstream to Ice Harbor Dam on the Snake River and 58 miles upstream to Columbia River mile 350. McNary Dam was placed into service in November 1954.

McNary Dam has several major components. From south to north, they are the south non-overflow embankment and adult fish passage facilities (also located between the spillway and the navigation lock), the powerhouse, spillway, navigation lock, and north non-overflow embankment. Near the upper end of the reservoir are levee systems designed to protecting low-lying areas within and adjacent to the cities of Kennewick, Pasco, and Richland, Washington. The levee systems are essentially dams, as the reservoir level is higher than some of the surrounding land areas. In other locations, the levee systems protect surrounding lands in the event of a standard project flood. The levee systems include interior drains to collect groundwater and surface runoff, along with catchment ponds and pumping plants to manage water levels.

McNary Dam is 7,365 feet long, with an effective height of 83 feet (post John Day Dam construction). The powerhouse is 1,422 feet long and houses fourteen 70-megawatt (MW) generators. Next to the powerhouse is a 1,310-foot-long concrete spillway equipped with steel fixed-wheel lift gates. The spillway has 22 spillbays, each 50 feet wide. The fixed-wheel lift gates are each 50 feet wide by 51.8 feet high (in two sections). A concrete-lined stilling basin extends 276 feet downstream from the spillway along the river bottom.

The navigation lock at McNary Dam is a single-lift type, 675 feet long by 86 feet wide, with a 15-foot minimum depth and a maximum lift of 84 feet (post John Day Dam construction). Next to the navigation lock is the north dam embankment, which is 1,620 feet long.

The powerhouse, with 986,000 kilowatts of installed generating capacity, has 14 main generators rated at 70,000 kilowatts and two auxiliary station service units of 3,000 kilowatts each.

Juvenile fish passage facilities at McNary Dam consist of a bypass system and transportation facilities. Adult fish passage facilities are made up of separate north and south shore facilities. The north shore facilities include a fish ladder, a small collection system, and an auxiliary water supply system. The south shore facilities are comprised of a fish ladder, powerhouse collection system, and auxiliary water supply system.

There are 13,562 acres of fee-owned project lands surrounding Lake Wallula. An additional 5,530 acres of privately-owned lands have flowage easements. The majority of Corps-managed lands are used for public recreation, wildlife habitat, project structures and levees, and water-connected industrial development. There are 17 Habitat Management Units (HMUs), totaling 8,414 acres, managed for wildlife habitat. A total of 3,530 acres are leased to the U.S. Fish and Wildlife Service as part of McNary National Wildlife Refuge. Water pumped from the pool is used to irrigate two of these HMUs.

There are 22 developed recreation areas adjacent to Lake Wallula. Ten of these areas are managed by the Corps, while others are managed by U.S. Fish and Wildlife Service, Oregon State Parks, Washington State Parks, Benton County, and the cities of Richland, Kennewick, and Pasco (Tri-Cities).

There are eight port sites on Lake Wallula used for the transportation of grain, wood products, fertilizers, fuel, and other commodities. McNary project lands are adjacent to agricultural, municipal, and commercial developments and, therefore, there are numerous agricultural, industrial, and municipal pumping stations along the reservoir, along with storm water and sewer outfalls. Reclamation maintains two facilities on McNary project lands for providing water to local irrigation districts as part of the Umatilla River water exchange program.

4. PROJECT ACTIVITIES

4.1 FLOOD CONTROL

The John Day Dam Reservoir (Lake Umatilla) provides the only flood control storage space on the lower Columbia River. John Day has been operated for flood control since 1969. The facility contains approximately 500,000 acre-feet of flood storage capacity. This is a relatively small amount of total storage capacity compared to some upper Columbia River projects but, despite this limited storage capacity, John Day's proximity to the Portland metropolitan area makes it valued for its ability to provide water management.

The Corps' Flood Control Operating Plan for the Columbia River considers John Day a Category IV reservoir, meaning that it is operated with variable releases primarily for flood control on the lower Columbia. The outflows from these projects have a relatively brief travel time (two days or less) to the lower Columbia flood area, and have sufficient flexibility to permit variable releases on a day-to-day forecast basis. These reservoirs provide the final major storage regulation of the flood control system used primarily to maintain the desired controlled flows in the lower Columbia and, at the same time, provide local flood protection. The use of John Day's storage capacity is occasionally limited due to other operating goals such as irrigation and fish and wildlife considerations.

4.2 HYDROPOWER

Hydropower operations and maintenance at the lower Columbia River dams is discussed in Section B.1, paragraph B.1.1.4, Operations for Power Generation and Transmission.

4.3 NAVIGATION

The Columbia-Snake River Navigation System includes:

- A 55-foot-deep entrance supported by a 6.6-mile-long south jetty, 2.5-mile-long north jetty, and a 1-mile-long auxiliary jetty
- A 40-foot-deep, 106.5-mile-long deep-draft navigation channel supported by a system of pile dikes
- A 27-foot-deep navigation channel, supported by eight dams and navigation locks, providing waterborne access between Portland, Oregon, and Lewiston, Idaho
- 30 ports with turning basins, berthing, and related support facilities.

Navigation Maintenance. Timing of In-Water Work to Protect Fish and Wildlife Resources is specified by the state agencies as part of water quality certifications. The normal in-water timing for the lower Columbia River is from November 1 through February 28, and above Bonneville from November 15 through March 15.

4.4 RECREATION

The Columbia River recreational fishery for anadromous species and sturgeon is a concern with respect to management of the Columbia River projects. Columbia River tributary streams and the tailraces below each dam are particularly important recreational fishery sites.

In addition, professional boat races, performances, and spectator sports have been growing in importance as a recreation activity and as a source of economic growth in the Columbia River Gorge and Tri-Cities areas. These activities came to the Columbia River in the early 1980s, and have grown to yearly draw hundreds of thousands of participants and spectators.

4.5 FISH AND WILDLIFE

4.5.1 Fish Passage Facilities and Operation

As mentioned in Section B.1, the lower Columbia River projects and adult fish passage facilities are operated in accordance with the Corps Fish Passage Plan (Corps 2006). Adult fish passage facilities typically operate all year, with a 3-month shutdown for maintenance from December through February at Bonneville, The Dalles, and John Day dams and a 2–month shutdown (January and February) at McNary Dam. Adult fish counting is done by direct observation from April through October. Adult fish passage is also counted by video taping from November through March at some projects. The Fish Passage Plan contains operating criteria for various parts of the adult facilities, including fishway entrances weir depth and head differential; collection channel velocities; fish ladder water depth; fish counting station passage conditions; and ladder exit conditions. Project fish biologists and powerhouse operators inspect the operations of adult fish passage facilities several times per day. Individual project biologists inspect the facilities in a quality control role at least three times per week. Any deficiencies observed during inspections are normally corrected as soon as practical.

Details regarding seasonal in-water work windows are summarized Table 7.

Table 7. Fish Facilities Operations

Dam	Winter In-Water Maintenance Window (Adult)	Winter In-Water Maintenance Window (Juvenile)
Bonneville	1 Dec–28 Feb	16 Dec–28 Feb
The Dalles	1 Dec–28 Feb	1 Dec–31 Mar
John Day	1 Dec–28 Feb	16 Dec–31 Mar
McNary	1 Jan–28 Feb	16 Dec–31 Mar

4.5.1.1 Bonneville Dam

Juvenile fish passage facilities at the first Bonneville powerhouse (B1) consist of chain gates and an ice-and-trash sluiceway. This first powerhouse was equipped with a juvenile bypass system consisting of turbine intake screens, vertical barrier screens, gatewell orifices, a bypass channel, and an outfall. However, the juvenile bypass system has not been operated for juvenile fish passage since 2003 due to low survival through that route relative to other passage routes at the dam. During the juvenile fish passage season, B1 is operated as a second priority to the second powerhouse (B2).

Juvenile fish passage facilities at B2 consist of turbine intake extensions (units 15 to 18) (TIEs); streamlined trash racks; submerged traveling screens (STSs); vertical barrier screens (VBSs); two 12.5-inch orifices per gatewell in units 11 to 14 and fish unit 2; one 12.5-inch orifice in all other gatewells flowing into a fish bypass channel; a dewatering facility; and a 48-inch fish transport pipe that connects the bypass channel to a mid-river release point approximately 1.5 miles downstream. Transport pipes (48 inches) at the high and low outfall transport fish to the tailrace at the outfall location. A juvenile fish sampling facility is included in the bypass. Two smaller turbines that supply adult fishway auxiliary water do not have STSs, TIEs, or streamlined trashracks; however, they have a fine trashrack with a 0.75-inch clear opening.

The B2 corner collector is located on the south side of the powerhouse. The associated flume extends several thousand feet west on the south side of the B2 tailrace, and empties at the tip of Cascades Island.

The Bonneville Dam spillway is also operated for juvenile fish passage, as specified in the Fish Passage Plan.

Adult fish passage facilities at Bonneville Dam consist of two main fishway segments. The B1 collection channel and A-branch ladder join the south spillway entrance and B-branch ladder at the junction pool at the Bradford Island ladder to form the Bradford Island fishway. The Cascades Island ladder at the north side of the spillway is connected to the Washington shore ladder by the upstream migrant transportation (UMT) channel. The B2 collection channel and north and south monoliths join the UMT to form the Washington shore fishway. Bradford Island, Cascades Island, and the Washington shore fishways have counting stations. The Washington Shore ladder has an adult fish sampling facility. All four collection systems have auxiliary water supplies for fish attraction. The B1 auxiliary system is gravity supplied, while the B2 system is fed by two 15-MW fish turbines and water is introduced at the B2 junction pool.

4.5.1.2 The Dalles Dam

Turbine units at The Dalles Dam are not screened. Juvenile fish passage consists of the ice-and-trash sluiceway and one 6-inch-orifice in each gatewell. The ice-and-trash sluiceway is a rectangular channel extending along the total length of the 22-unit powerhouse, and is located in the forebay side of the powerhouse. Gatewell orifices allow flow into the sluiceway, providing a potential means of passing fish from the gatewells to the sluiceway. When any of the sluiceway gates (located in the forebay side of the sluiceway) are opened, water and juvenile migrants are skimmed from the forebay into the sluiceway and deposited in the tailrace downstream of the project. Starting in 2000, 40 percent spill has been provided 24 hours per day during the juvenile fish passage season. In 2004, a spillway divider wall (spillwall) was constructed between spillbays 6 and 7 in order to improve the survival of juvenile fish that pass through the spillway. The current spill operation for fish passage places nearly all spill into bays 1 through 6. Spill operations are specified in the Fish Passage Plan.

Adult fish passage facilities at The Dalles Dam are composed of a north shore fish ladder, which passes fish collected at the north end of the spillway, and an east fish ladder that passes those fish collected at the south end of the spillway and across the downstream face of the powerhouse. A small hydropower facility, utilizing the north fishway ladder auxiliary water supply, was constructed in 1991 and is operated by the Northern Wasco County People's Utility District. Adult fishway criteria associated with this facility are monitored and maintained during the daily fishway inspections. A backup auxiliary water supply system, unscreened for juveniles, has been upgraded to facilitate its use, if required.

4.5.1.3 John Day Dam

Juvenile fish bypass facilities at John Day Dam completed in 1987, include one VBS, an STS, and one 14-inch-diameter orifice per gatewell in each of the project's 16 turbine units, for a total of 48 orifices. The new smolt monitoring facility was completed in 1998. The bypass collection conduit leads to a transport channel that carries collected juvenile fish to the river below the dam when the smolt monitoring facility is not in operation (bypass mode). Differential between the forebay and bypass conduit is controlled by the tainter gate, and has a criterion of 4-foot to 5-foot (water level in the conduit is measured at unit 16).

During the juvenile sampling season, flow with collected fish from the juvenile bypass system is sent over the crest gate and down an elevated chute to the dewatering structure. Most of the flow is dewatered and the remaining water, 30 cubic feet per second (cfs), is directed to the transport flume and past a switch gate. This gate directs fish to either the sampling building or directly to the outfall (emergency bypass only). Fish diverted for sampling pass a fish and debris separator, where debris and adult fish are directed into a separate discharge flume that leads to the outfall. Juvenile fish are interrogated by passive integrated transponder tag detectors, and are diverted either to the outfall or to the laboratory building for sampling. The John Day Dam spillway operates during the juvenile migration season for fish passage, as specified in the Fish Passage Plan.

The adult fish passage facilities at John Day Dam include a north shore fish ladder that passes fish from entrances at the north end of the spillway, and a south shore fish ladder that passes fish from entrances along a collection channel that extends the full length of the powerhouse. Auxiliary water is provided to all collection systems by pumping from the tailrace. Counting stations are provided in both fishways.

4.5.1.4 McNary Dam

Juvenile fish passage facilities were added to McNary Dam in the early 1980s. The facilities were modified in 1994, with the construction of a new juvenile bypass system and transportation facilities. Extended-length bar screens were installed in 1996 and 1997. The juvenile bypass system operates from

April 1 through December 15, according to criteria contained in the Fish Passage Plan. While McNary Dam has juvenile fish transportation facilities, juvenile fish collected during the spring are bypassed to the river. Fish collected during the summer are transported to below Bonneville Dam when river conditions are no longer "spring-like," as defined in the operating criteria. Once juvenile fish transportation begins in the summer, it continues through September 30. Fish collected through August 15 are normally transported by barge, while trucks are used after that date for transport. The McNary project also spills for juvenile fish passage in accordance with operating criteria. In the past, spill was provided 12 hours per day (1800 to 0600 hours), from April 10 through June 20, at a level to meet the 120 percent total dissolved gas cap established forthe project (approximately 150,000 cfs). Research was conducted in 2005 and 2006 to evaluate 12- versus 24-hour spill and spill of different volumes. These studies were conducted to determine the most appropriate levels of spill to use for juvenile fish passage. Final spill determinations will be incorporated into future operating criteria.

The adult fish passage facilities at McNary Dam include a north shore fish ladder that passes fish from entrances at the north end of the spillway, and a north shore gravity auxiliary water supply system. Northern Wasco County People's Utility District installed a turbine unit on this auxiliary water supply in the 1990s, changing the system from a high head system to a low head system. Fish passage on the south side of the river is accomplished with a south shore fish ladder that passes fish from entrances along a collection channel that extends the full length of the powerhouse. Auxiliary water is provided by a combination of gravity flow from the forebay and pumped water from the tailrace. Counting stations are provided in both fish ladders.

4.5.2 Fish Passage Maintenance

Both adult and juvenile fish passage facilities have established winter maintenance seasons outlined in the Fish Passage Plan (see Table 7). Adult and juvenile fish passage facilities may be dewatered and maintained during part or all of these time periods. All routine maintenance activities or facility modifications that require the dewatering of facilities or that may impact the operation of facilities are scheduled for these periods. The Fish Passage Plan contains criteria on how to operate fish passage facilities during the normal operating season in the event that a facility component fails and there may be an impact on facility operations or fish passage. The Fish Passage Plan also contains criteria for coordinating facility operations or fish passage issues with regional parties and how to operate facilities during major component failures.

All adult fish ladders are dewatered for a brief time period each winter. During the outages, project personnel inspect the fish passageways, remove any debris encountered, and maintain all ladder and fish counting equipment. Annual maintenance on auxiliary water supply pumps and fish turbines is also conducted during the winter maintenance period. Project personnel inspect diffuser gratings each year either by dewatering the collection channels, by using an underwater camera, or divers. Any deficiencies found during winter maintenance periods are repaired or corrected.

Periodic maintenance of adult fishway equipment that does not seriously impact facility operations or fish passage may also be performed during the fish passage season. Some fishway equipment requires periodic lubrication, adjustment, or other preventative maintenance type of work that must be done during the fish passage season for continued operations. Other maintenance activities such as cleaning debris off of fish ladder exit trashracks or fish counting station picketed leads is done on an as-needed basis to maintain the facilities within established operating criteria.

Annual maintenance of juvenile bypass systems requires the removal of fish screens from turbine intakes and the dewatering of juvenile fish collection channels, dewatering structures, and various fish transportation and/or sampling facilities. After the facilities are removed from service, they are inspected, and repairs and annual maintenance are performed. Overhauls and/or modification of facilities take place during the annual maintenance period as well. The fish passage equipment is all placed back in service prior to the beginning of the next operating season.

Juvenile bypass systems require almost continual oversight and maintenance during the operating season. Juvenile fish transportation facilities and monitoring facilities are manned either 24 hours per day or when they are collecting fish for sampling, to ensure they operate according to established operating criteria. Fishway passages (gatewell orifices, flumes, separators, and piping) must be checked for debris and other obstacles that may injure juvenile fish. Fish screens (STSs and extended submerged bar screens [ESBSs]) have annunciation systems connected to them to ensure that they are operating as programmed. The annunciation systems, in turn, ensure that mesh rotates as planned on STSs or cleaning brushed cycle on ESBSs to keep screens free of debris. At the Bonneville Second Powerhouse, the VBSs in the currently modified units for fish guidance efficiency improvements require drawdown monitoring to detect plugging of the VBSs. Water level monitors relay drawdown information to the control room and alarm when drawdown criteria are exceeded, meaning the VBSs need to be cleaned. When annunciation systems indicate screen failures, the turbine units are operated according to criteria in the Fish Passage Plan, and the screens repaired as soon as possible. Fish screens are also inspected by either maintenance personnel or biologists, utilizing underwater cameras, on a monthly basis to ensure they are operating correctly.

4.5.3 Wildlife Program

Management responsibilities for the natural resources on lands acquired for the multi-purpose projects of Bonneville, The Dalles, and John Day locks and dams involve the Corps and a number of Federal and State agencies. Principal administrative authority, however, remains under the Corps for authorized project purposes. Water storage at the projects also provides for irrigation, recreation, and fish and wildlife habitat. Leasing lands are to the U.S. Fish and Wildlife Service for refuges under the umbrella of the Fish and Wildlife Coordination Act of 1938.

The lower Columbia River region provides important habitat for migratory birds. Most waterfowl operations focus around the intensively managed Umatilla National Wildlife Refuge, McNary National Wildlife Refuge, and the lands leased by the Oregon and Washington departments of fish and wildlife. The Corps maintains other management units for fish and wildlife by implementing habitat improvements, including fencing to protect riparian habitats and water quality and planting of native grasses, trees, and shrubs. Riparian and other wildlife habitat units are open to the public for recreational uses.

4.6 IRRIGATION

Storage of water for irrigation on agricultural land is used to meet or supplement natural supplies. The Corps' Northwestern Division Reservoir Control Center coordinates operation with an irrigation point of contact, and modifies operations to benefit irrigation at both John Day and McNary. John Day is operated within 1.5 feet of the minimum level that provides irrigation pumping from April 10 to September 30. The rest of the year, John Day is operated within 2.5 feet of the minimum level that provides irrigation pumping. Irrigation pumping at Bonneville and The Dalles occurs within normal operating ranges, and little or no coordination with irrigators is necessary.

There are approximately 182,000 acres of irrigation lands supported by the John Day reservoir. Twelve irrigation pump stations on the Washington side serve 92,000 acres. Eighteen pump stations on the Oregon side irrigate 90,000 acres.

REFERENCES

Corps (U.S. Army Corps of Engineers). 2006. Fish Passage Plan for Corps of Engineers Projects. U.S. Army Corps of Engineers, Northwestern Division, Portland, Oregon. March.

Corps. 2007. Lower Columbia River Project information, available online at http://www.nwp.usace.army.mil/home.asp.

Appendix B—Description of the Proposed Reasonable and Prudent Alternative
Section B.1—Operations for Flood Control, Irrigation, Navigation, and Power Generation and Transmission

Attachment B.1-2
U.S. Army Corps of Engineers Lower Snake River Projects

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ACRONYMS AND ABBREVIATIONS

BPA	Bonneville Power Administration
Corps	U.S. Army Corps of Engineers
ESBS	extended submerged traveling screen
HMU	Habitat Management Unit
kcfs	thousand cubic feet per second
MOP	minimum operating pool
MW	megawatt
NGVD	National Geodetic Vertical Datum
PIT	passive integrated transponder
Reclamation	U.S. Bureau of Reclamation
RM	river mile
RSW	removable spillway weir
STS	submerged traveling screen
TMT	Technical Management Team

1. GENERAL PROJECT DESCRIPTION

The Lower Snake River Project is the name for the U.S. Army Corps of Engineers' (Corps') series of four dams on the lower Snake River: Lower Granite, Little Goose, Lower Monumental, and Ice Harbor.

The Snake River is the principal tributary to the Columbia River. It drains an area of about 109,000 square miles, including portions of Idaho, northwestern Wyoming, northern Utah and Nevada, southeastern Washington, and eastern Oregon. Major tributaries downstream of Hells Canyon Dam include the Salmon, Grand Ronde, Imnaha, Clearwater, Tucannon, and Palouse rivers. The Snake River flows through a canyon of varying depths, from about 5,500 feet in upstream Hells Canyon to less than 450 feet near its confluence with the Columbia River. Much of the lower Snake River Canyon is steep, with basalt bluffs rising up to 2,000 feet to rolling uplands.

The Snake River projects include a navigation channel 250 feet wide by 14 feet deep, measured at minimum operating pool (MOP) in each reservoir, which extends from the confluence of the Snake and Columbia rivers to a point at River Mile (RM) 1.3 on the Clearwater River at Lewiston, Idaho. This channel is the upper end of the Columbia-Snake River Inland Waterway, which includes the deep draft navigation channel on the lower Columbia River and is an important link for regional, national, and international commerce.

All four lower Snake River dams are run-of-river facilities, meaning that they are not authorized, designed, or operated for flood control. These facilities have limited storage capacity, and pass water at nearly the same rate as the water enters each reservoir. Reservoir levels behind these dams vary only a few feet during normal operations. This limited storage is used for hourly regulation of powerhouse discharges to follow daily and weekly demand patterns, but is not enough to allow seasonal regulation of streamflows. Other Federal dams on the Columbia River and its tributaries were developed for storage purposes. Storage reservoirs, such as Dworshak Reservoir on the North Fork of Clearwater River, are used to store water and adjust the river's natural flow patterns to conform more closely to water uses.

2. AUTHORIZATION

The Lower Snake River Project was constructed and is operated and maintained under laws that may be grouped into three categories: 1) laws initially authorizing construction of the project; 2) laws specific to the project passed subsequent to construction; and 3) laws that generally apply to all Corps projects within the United States. Using these and other authorities, the Corps operates multiple-use water resource development projects to balance operation of individual functions with operations for all functions. This operation is coordinated with Bonneville Power Administration (BPA), U.S. Bureau of Reclamation (Reclamation), and other regional interests. Authorized uses for the Lower Snake River Project are hydropower generation, inland navigation, fish and wildlife, irrigation, and recreation. These facilities operate as run-of-river dams and are not authorized for flood control. Project uses have been authorized under several public laws.

3. AUTHORIZED PURPOSES

The four lower Snake River dams are multiple-use facilities that provide public benefits in a number of different ways. Project facilities include dams and reservoirs, hydroelectric powerplants and high-voltage transmission lines, navigation channels and locks, juvenile and adult fish passage structures, fish hatcheries, parks and recreational facilities, levee systems, lands dedicated to project operations, and areas set aside as wildlife habitat. While it is physically possible to draw run-of-river reservoirs well below their normal minimum pool levels, the four lower Snake River facilities are not designed to operate below minimum pool levels.

Summary information is presented for the four lower Snake River projects in Table 1. More detailed information is presented for each project in Table 2.

Table 1. Lower Snake River Project Summary Information

Facility	Type of Dam	Year Completed	Snake River Mile	Reservoir Name	Usable Capacity [1/] (acre feet)
Ice Harbor	Run-of-River	1961	9.7	Lake Sacajawea	25,000
Lower Monumental	Run-of-River	1969	41.6	Lake Herbert G. West	20,000
Little Goose	Run-of-River	1970[2/]	70.3	Lake Bryan	49,000
Lower Granite	Run-of-River	1975[3/]	107.5	Lower Granite Lake	49,000

Source: Corps and NMFS 1994

[1/] normal operating range

[2/] The Little Goose facility was open to navigation in May 1970. The installation of power generating units 1 through 3 was completed in March 1970. Additional power units 4 through 6 were installed, and power came online in July 1978.

[3/] Additional power units 4 through 6 were installed, and power came online in April 1978.

Table 2. Lower Snake River Project Facility Operations and Structures

	Ice Harbor	Lower Monumental	Little Goose	Lower Granite
Reservoir				
Normal Pool Operating Range (feet above NGVD)	437 - 440	537 - 540	633 - 638	733 - 738
Total Length (miles)	31.9	28.7	37.2	43.9
Surface Area (acres)1/	9,002	4,960	10,825	8,448
General (Dam)				
Dam Length (feet)	2,822	3,791	2,655	3,200
Hydraulic Head (feet)	100	100	98	100
Powerhouse				
Powerhouse Length (feet)	671	656	656	656
Nameplate Capacity (MW)	600	810	810	810
Total Number of Units Installed	6	6	6	6
Spillway				
Spillway Length (feet)	590	498	512	512
Number of Spillway Bays	10	8	8	8
Stilling Basin Length (feet)	168	180	118	188
Navigation Lock and Channels				
Lock Chamber Length (feet)	675	666	668	675
Lock Chamber Width (feet)	86	86	86	86
Maximum Operating Lock Lift (feet)	105	103	101	105
Navigation Channel (at MOP) extending from mouth of Snake River to Lewiston/Clarkston at Clearwater River Mile 1	250 feet wide by 14 feet deep	250 feet wide by 14 feet deep	250 feet wide by 14 feet deep	250 feet wide by 14 feet deep

NGVD = National Geodetic Vertical Datum
1/ At normal operating pool elevation (highest level of range)
Source: Corps 1999

3.1 ICE HARBOR DAM

Ice Harbor Dam is located on the Snake River at RM 9.7 near Burbank, Washington. Major cities in the local vicinity include Kennewick and Pasco, which are located upstream of the confluence of the lower Snake and Columbia rivers, and Richland, which is located at the confluence of the Yakima and Columbia rivers. Ice Harbor Lock and Dam is authorized for hydroelectric power, navigation, irrigation, recreation, fish and wildlife enhancements, and water quality, as shown in Table 3.

Table 3. Ice Harbor Lock and Dam, Lake Sacajawea
Snake River, Walla Walla, and Franklin Counties, Washington
North Pacific Division, Walla Walla District

Operating Purposes	Authorization Purposes	Authorizing Laws
Navigation	Navigation	PL 79-14, 87-874
Irrigation	Irrigation	PL 79-14
Recreation	Recreation	PL 78-534
Hydroelectric Power	Hydroelectric Power	PL 79-14
Fish/Wildlife	Fish/Wildlife	PL 85-624
Water Quality	Water Quality	PL 92-500

The reservoir at Ice Harbor Dam, known as Lake Sacajawea, extends 31.9 miles upstream to Lower Monumental Dam. Ice Harbor Dam was placed into service in 1961 and includes, from south to north, the following major components: fish passage facilities (also located between the spillway and the navigation lock), powerhouse, spillway, navigation lock, and non-overflow embankment. The dam is 2,822 feet long, with an effective height of 100 feet. The normal operating range of Lake Sacajawea extends from 437 to 440 feet National Geodetic Vertical Datum (NGVD)29. The powerhouse is 671 feet long, and houses three 90-megawatt (MW) and three 110-MW generators. Next to the powerhouse is a 590-foot-long concrete spillway equipped with steel tainter gates. The spillway has 10 spillbays, each 50 feet wide. The tainter gates are each 50 feet wide by 52.9 feet high. A concrete-lined stilling basin extends 168 feet downstream from the spillway along the river bottom.

The navigation lock at Ice Harbor Dam is a single-lift type, 675 feet long by 86 feet wide, with a 15-foot minimum depth and a maximum lift of 105 feet. Next to the navigation lock is the north dam embankment, which is 624 feet long.

Juvenile fish passage facilities at Ice Harbor Dam consist of a bypass system, juvenile sampling facilities, and a removable spillway weir (RSW). Adult fish passage facilities are made up of separate north and south shore facilities (see Table 4). The north shore facilities include a fish ladder, a small collection system, and an auxiliary water supply system. The south shore facilities comprise a fish ladder, a powerhouse collection system, and an auxiliary water supply system.

There are 4,037.7 acres of project lands surrounding Lake Sacajawea, including both fee and easement lands. The majority of the Corps-managed lands, 3,517.3 acres, are used for public recreation, wildlife habitat, wildlife mitigation, and water-connected industrial development.

Seven developed recreation areas lie adjacent to Lake Sacajawea, including boat ramps, a marina, moorage facilities, and campgrounds. There are several Habitat Management Units (HMUs), totaling 2,032 acres, along the reservoir. Water pumped from the pool is used to irrigate three of these HMUs. There are two ports on Lake Sacajawea (Windust and Sheffler).

Approximately 37,000 acres of non-Federal land are presently irrigated with water pumped from Lake Sacajawea. There are approximately 75 pumps located at the 14 irrigation pumping stations along the reservoir.

Table 4. Components of Juvenile and Adult Fish Passage Facilities at the Lower Snake River Project

	Juvenile Fish Passage Facilities	Adult Fish Passage Facilities
Ice Harbor Dam	**Bypass System** • Submerged traveling screens (STSs) • balanced flow vertical barrier screens • gatewell orifices (12 inch) • bypass channel running the length of the powerhouse • dewatering structure • full flow PIT- tag detection • bypass flume to sampling facilities or river **Sampling Facilities** • juvenile/adult separator structure • distribution system (to holding tank or river) • office and sampling building **Removable Spillway Weir**	**North Shore Fish Ladder** • two downstream entrances • one side entrance • counting station • adult PIT- tag detection **North Shore Auxiliary Water Supply System** **South Shore Fish Ladder** • two south shore entrances • counting station • adult PIT- tag detection **Powerhouse Collection System** • two downstream entrances • one side entrance • common transportation channel • floating orifices **South Shore Auxiliary Water Supply System**
Lower Monumental Dam	**Bypass System** • STSs • balanced flow vertical barrier screens • gatewell orifices (12 inch) • bypass channel running the length of the powerhouse • dewatering structure • one emergency bypass route • bypass flume to transportation facilities or river **Transportation Facilities** • juvenile/adult size separator structure • raceways for holding fish • distribution system (to raceways, barge, or river) • office and sampling/marking building	**North Shore Fish Ladder** • two north shore entrances • connects to powerhouse collection system • counting station **South Shore Fish Ladder** • two downstream entrances • one side entrance • counting station **Powerhouse Collection System** • two downstream entrances • one side entrance • common transportation channel

Table 4. Components of Juvenile and Adult Fish Passage Facilities at the Lower Snake River Project (continued)

	Juvenile Fish Passage Facilities	Adult Fish Passage Facilities
	• truck and barge loading facilities • PIT- tag detection and diversion systems	• floating orifices **Auxiliary Water Supply System**
Little Goose Dam	**Bypass System** • Extended submerged bar screens (ESBSs) with flow vanes • balanced flow vertical barrier screens • gatewell orifices (12 inch) • bypass channel running the length of the powerhouse • metal flume to dewatering structure • dewatering structure • two emergency bypass routes • bypass flume to transportation facilities or river **Transportation Facilities** • juvenile/adult size separator structure • raceways for holding fish • distribution system (to raceways, barge, or river) • office and sampling/marking building • truck and barge loading facilities • PIT- tag detection and diversion systems	**North Shore Fish Collection** • two downstream entrances • one side entrance • tunnel connecting to powerhouses collection system **South Shore Fish Ladder** • two south shore entrances • counting station **Powerhouse Collection System** • two downstream entrances • one side entrance • common transportation channel • floating orifices **Auxiliary Water Supply System**
Lower Granite Dam	**Bypass System** • ESBSs with flow vanes • balanced flow vertical barrier screens • gatewell orifices (10 inch) • bypass channel running the length of the powerhouse • bypass pipe to transportation facilities or river **Transportation Facilities** • upwell and juvenile/adult separator structure • raceways for holding fish • distribution system (to raceways, barge, or river) • office and sampling/marking building • truck and barge loading facilities	**North Shore Fish Collection** • two downstream entrances • one side entrance • tunnel connecting to powerhouse collection system **South Shore Fish Ladder** • two south shore entrances • counting station • adult trap • adult PIT- tag detection **Powerhouse Collection System**

Table 4. Components of Juvenile and Adult Fish Passage Facilities at the Lower Snake River Project (continued)

Juvenile Fish Passage Facilities	Adult Fish Passage Facilities
Transportation Facilities • PIT-tag detection and diversion systems **Removable Spillway Weir**	**South Shore Fish Ladder** • two south shore entrances • two downstream entrances • one side entrance • common transportation channel • floating orifices **Auxiliary Water Supply System**

3.2 LOWER MONUMENTAL DAM

Lower Monumental Dam is located on the Snake River at RM 41.6 near Kahlotus, Washington. The reservoir at Lower Monumental, known as Lake Herbert G. West, extends 28.7 miles upstream to Little Goose Dam. The project is authorized for hydroelectric power, navigation, recreation, fish and wildlife enhancements, irrigation, and water quality, as shown in Table 5.

Table 5. Lower Monumental Lock and Dam, Lake Herbert G. West
Snake River, Walla Walla, and Franklin Counties, WA
North Pacific Division, Walla Walla District

Operating Purposes	Authorization Purposes	Authorizing Laws
Fish/Wildlife	Fish/Wildlife	PL 85-624
Irrigation	Irrigation	PL 79-14
Recreation	Recreation	PL 78-534
Hydroelectric Power	Hydroelectric Power	PL 79-14
Navigation	Navigation	PL 79-14, 87-876
Water Quality	Water Quality	PL 92-500

Lower Monumental was placed into service in 1969 and includes, from south to north, the following major components: south non-overflow embankment, navigation lock, fish passage facilities (also located between the powerhouse and the north non-overflow embankment), spillway, powerhouse, and the north non-overflow embankment. The dam, located at the head of Lake Sacajawea, is 3,791 feet long, with an effective height of 100 feet. The normal operating range of Lake West is from 537 to 540 feet NGVD29. The powerhouse is 656 feet long and houses six 135-MW generators. Next to the powerhouse is a 498-foot-long concrete spillway equipped with steel tainter gates. The spillway has eight spill bays, each 50 feet wide. The tainter gates are each 50 feet wide by 60 feet high. A concrete-lined stilling basin extends 180 feet downstream from the spillway on the river bottom.

The navigation lock at Lower Monumental is a single-lift type, 666 feet long by 86 feet wide, with a 14-foot minimum operating depth and a maximum lift of 103 feet. Next to the navigation lock is the 968-foot-long north dam embankment. Juvenile fish passage facilities at Lower Monumental consist of a bypass system and transportation facilities (see Table 4). Adult fish passage facilities comprise north and south shore fish ladders, a powerhouse collection system, and an auxiliary water supply system.

There are 9,143.6 acres of project lands surrounding Lake West, including both fee and easement lands. Port districts own land for industrial development both on and adjacent to project lands. The majority of Corps-managed lands, 7,024.0 acres, are used for public recreation, wildlife habitat, wildlife mitigation, and water-connected industrial development. Approximately 1,177 acres are leased to Washington State for Lyons Ferry State Park.

There are six developed recreation areas adjacent to the Lake West, with boat ramps, a marina, day-use facilities, and a campground. There are multiple HMUs, totaling 4,381 acres, along the reservoir. Water pumped from the Lower Monumental pool is used to irrigate two of these HMUs. There is one port on the reservoir (Lyons Ferry).

3.3 LITTLE GOOSE DAM

Little Goose Dam is located on the Snake River at RM 70.3 near Starbuck, Washington. Little Goose Reservoir, known as Lake Bryan, extends 37.2 miles upstream to Lower Granite Dam. Authorized purposes for the project are shown in Table 6.

Table 6. Little Goose Lock and Dam, Lake Bryan
Snake River, Walla Walla, and Franklin Counties, Washington
North Pacific Division, Walla Walla District

Operating Purposes	Authorization Purposes	Authorizing Laws
Fish/Wildlife	Fish/Wildlife	PL 85-624
Irrigation	Irrigation	PL 79-14
Navigation	Navigation	PL 79-14, 87-874
Hydroelectric Power	Hydroelectric Power	PL 79-14
Recreation	Recreation	PL 78-534
Water Quality	Water Quality	PL 92-500

Little Goose Dam was placed into service in 1970, and includes, from south to north, several major components: navigation lock, fish passage facilities, powerhouse, spillway, and non-overflow embankment. The dam, located at the head of Lake Herbert G. West, is 2,655 feet long with an effective height of 98 feet. The normal operating range of Lake Bryan extends from 633 feet to 638 feet NGVD29. The powerhouse is 656 feet long and 243 feet wide, and houses six 135-MW generators. Next to the powerhouse is a 512-foot-long concrete spillway equipped with steel tainter gates, each 50 feet wide by 60 feet high. The spillway has eight spill bays. A concrete-lined stilling basin extends 118 feet downstream from the spillway along the river bottom.

The navigation lock at Little Goose project is a single-lift type, 668 feet long by 86 feet wide, with a 15-foot minimum depth and a maximum lift of 101 feet. Next to the navigation lock is the north dam embankment. Juvenile fish passage facilities at Little Goose consist of a bypass system and transportation facilities (see Table 4). Adult fish passage facilities are composed of one fish ladder on the south shore, a powerhouse collection system, and an auxiliary water supply system.

There are 4,859.6 acres of project lands surrounding Lake Bryan, including both fee and easement lands. The majority of the Corps-managed lands are used for public recreation, wildlife habitat, wildlife mitigation, and water-connected industrial development. Currently, two areas of approximately 150 acres are leased either to the state or local ports for recreation.

There are seven developed recreation areas adjacent to Lake Bryan with boat ramps, a marina, day-use facilities, and campgrounds. There are multiple HMUs, totaling 3,019 acres, along the reservoir. Water pumped from the pool is used to irrigate two of these HMUs. There are three port facilities on Lake Bryan (Almota, Central Ferry, and Garfield).

3.4 LOWER GRANITE DAM

Lower Granite Dam is located on the Snake River at RM 107 near Almota, Washington. Lower Granite Lake, the reservoir behind Lower Granite Dam, extends 39.3 miles upstream on the Snake River and a further 4.6 miles on the Clearwater River. Lewiston, Idaho is located 33 miles upstream of the dam. Lower Granite Dam is authorized to provide navigation, hydroelectric power, recreation, fish and wildlife enhancements, irrigation, and water quality, as shown in Table 7.

Table 7. Lower Granite Lock and Dam
Snake River, Whitman, and Garfield Counties, Washington.
North Pacific Division, Walla Walla District

Operating Purposes	Authorization Purposes	Authorizing Laws
Navigation	Navigation	PL 79-14, 87-874
Hydroelectric Power	Hydroelectric Power	PL 79-14
Recreation	Recreation	PL 78-534
Fish/Wildlife	Fish/Wildlife	PL 85-624
Irrigation	Irrigation	PL 79-14
Water Quality	Water Quality	PL 92-500

Lower Granite Dam was placed into service in 1975 and includes, from south to north, five major components: fish passage facilities, powerhouse, spillway, navigation lock, and non-overflow embankment. The dam, located at the head of Lake Bryan, is 3,200 feet long, with an effective height of 100 feet.

At the upper end of Lower Granite Lake, at the confluence of the Snake and Clearwater rivers, is a levee system designed to protect low-lying areas within the city of Lewiston, Idaho. The levee system essentially functions as a dam, as the reservoir level is higher than some of the surrounding land areas. It includes interior drain systems to collect groundwater and surface runoff and catchment ponds. Pumping plants are used to control water levels and maintain water quality in the catchment ponds. The levee system also contains recreation facilities for the public.

The normal operating range of Lower Granite Lake extends from 733 to 738 feet above NGVD29. The powerhouse is 656 feet long and 243 feet wide, and houses six 135-MW generators. Next to the powerhouse is a 512-foot-long concrete spillway equipped with steel tainter gates, each 50 feet wide by 60 feet high. The spillway has eight spill bays, each 50 feet wide. A concrete-lined stilling basin extends 188 feet downstream from the spillway along the river bottom.

The navigation lock at Lower Granite is a single-lift type, 675 feet long by 86 feet wide, with a 15-foot minimum depth and a maximum lift of 105 feet. Next to the navigation lock is the 756-foot-long north dam embankment.

Juvenile fish passage facilities at Lower Granite consist of a bypass system, transportation facilities, and RSW. Adult fish passage facilities include one fish ladder on the south shore, a powerhouse collection system, adult fish trap, and an auxiliary water supply system. Components of the juvenile and adult fish passage facilities are identified in Table 4.

There are 9,220.4 acres of project lands surrounding Lower Granite Lake, including fee lands that are Federally owned and managed by the Corps, as well as easement lands on which the Corps has designated rights (i.e., flowage or access). Approximately 515 acres are leased either to state or local public agencies. Port districts own lands adjacent to the project for industrial development. The majority of these project lands are used for public recreation, wildlife habitat, wildlife mitigation, and water-connected industrial development.

There are 13 developed recreation areas adjacent to Lower Granite Lake, with boat ramps, moorage/marina facilities, day-use facilities, and campgrounds.

There are several HMUs, totaling 5,002 acres, along Lower Granite Lake. Water pumped from the reservoir is used to irrigate one of these HMUs.

Water is withdrawn from Lower Granite Lake by municipal and industrial pump stations. The water is used for municipal water system backup, irrigation, and industrial purposes. There are three port facilities on Lower Granite Lake (Lewiston, Clarkston, and Wilma).

4. PROJECT ACTIVITIES

4.1 HYDROPOWER

Hydropower operations and maintenance at the lower Snake River dams is discussed in Section B.1, paragraph B.1.1.2, Operations for Power Generation and Transmission.

4.2 NAVIGATION

The lower Snake River is part of the shallow draft portion of the Columbia-Snake River Inland Waterway, and connects to the deep draft channel where products can be transferred to deep-draft vessels for national and international markets. The Corps maintains a shallow-draft navigation channel 250 feet wide and 14 feet deep from below Bonneville Dam up through Richland, Washington on the Columbia River, and from the mouth of the Snake River to the confluence of the Snake and Clearwater rivers (RM 1.3 on the Clearwater River).

The navigation channel accommodates numerous types of vessels for commercial and private purposes, and connects the interior of the basin with deepwater ports on the lower Columbia River. The average annual tonnage passing through Ice Harbor lock between 1996 and 2005 was 3,779,474 tons. Commodity movement on the lower Snake River is dominated by grains.

4.3 RECREATION

There are 33 developed recreation sites adjacent to the lower Snake River reservoirs. Nearly all of these sites provide recreation opportunities that either depend on water or are enhanced by the proximity of water and most are located in rural areas removed from population centers. Exceptions include the sites at Ice Harbor, which are close enough to be used by residents of the Tri-Cities, and sites at Lower Granite near the Lewiston-Clarkston area. Several of the larger developed sites were constructed by the Corps and are operated by counties, port districts, or commercial leases.

4.4 FISH AND WILDLIFE

4.4.1 Fish Passage

The Lower Snake River Project was originally designed and constructed with adult passage facilities at the four dams. These facilities include fish ladders, pumped attraction water supplies, and powerhouse fish collection systems (Table 4), and have certain features in common. In general, there is a set of main fishway entrances near the far end of the spillway, between the spillway and powerhouse, and at the near end of the powerhouse. Two entrances are typically used at each location, and additional smaller entrances (floating orifice gates) are provided across the face of the powerhouse.

Lower Granite Dam was the only dam on the Columbia and Snake rivers constructed to accommodate a screened juvenile bypass system. Improved facilities were added to Little Goose Dam in 1980. The Columbia River Fish Mitigation Program (CRFM) began in the late 1980s, leading to a system-wide project for evaluation of mitigation needs and implementation of improvements at the Corps' four lower Snake River and four lower Columbia River dams beginning in 1991. Under this program, new juvenile fish bypass/collection facilities were constructed at Ice Harbor (1996), Lower Monumental (1993), and Little Goose (1990) dams. Additional improvements have been made as new technology developed. Other improvements (i.e., spillway flow deflectors at Ice Harbor and Lower Monumental and extended submerged bar screens (ESBS) at Little Goose and Lower Granite) have also been added. Lower Granite, Little Goose, and Lower Monumental dams have facilities for collecting and transporting juvenile fish (see Table 4). Current programs include installation of RSWs at the facilities to improve in-river migration of juvenile fish through more effective spill programs. Currently, RSWs are in place at Lower Granite and Ice Harbor dams, and one is under construction at Lower Monumental Dam.

4.4.1.1 Fish Passage Operations

Lower Snake River projects and adult fish passage facilities are operated in accordance with the Corps Fish Passage Plan, which is updated annually. Adult fish passage facilities typically operate all year with a 2- to 4-week shutdown for maintenance in the January through February timeframe (Table 8). Adult fish counting is done from April through October at Ice Harbor, Lower Monumental, and Little Goose, and March through mid-December at Lower Granite. The Fish Passage Plan contains operating criteria for various parts of the adult facilities including fishway entrances weir depth and head differential; collection channel velocities; fish ladder water depth; fish counting station passage conditions; and ladder exit conditions. Project powerhouse operators inspect the operations of adult fish passage facilities several times per day. Project biologists inspect the facilities in a quality control role at least 3 times per week. Any deficiencies observed during inspections are corrected as soon as practical.

Table 8. Fish Facilities Operations

Dam	Winter In-Water Maintenance Window (Adult)	Winter In-Water Maintenance Window (Juvenile)
McNary	1 Jan–28 Feb	16 Dec–31 Mar
Ice Harbor	1 Jan–28 Feb	16 Dec–31 Mar
Lower Monumental	1 Jan–28 Feb	16 Dec–31 Mar
Little Goose	1 Jan–28 Feb	16 Dec–31 Mar
Lower Granite	1 Jan-28 Feb	16 Dec–24 Mar

Juvenile fish passage facilities operate from March 25 through December 15 at Lower Granite Dam and from April 1 through December 15 at Little Goose, Lower Monumental, and Ice Harbor dams in accordance with the Corps Fish Passage Plan (Table 5). The Fish Passage Plan also contains operating criteria for the Juvenile Fish Transportation Program and covers the operations of turbine units, spillways, and various components of the juvenile bypass and transportation programs.

Juvenile fish migrating downstream past the projects have three passage routes for passing the projects: through the spillway, through the juvenile bypass system, or through the turbine units. Typical facilities for juvenile fish that enter the turbine area (compared to those that would pass over the spillway) include the following:

- Turbine Intakes— Each generating unit at the lower Snake River dams has three turbine intakes. These intakes are similar at all four dams, except that they are slightly smaller at Ice Harbor Dam.
- Turbine Intake Screens—Standard-length submerged traveling screens (STSs) are devices that are lowered into the turbine bulkhead slots to guide fish from the turbine intake and subsequent turbines. The screened area is 20 feet high and 20 feet wide. The screen is a continuous belt that travels around the frame like a conveyor belt. The screen revolves so that debris collected on the front face is carried over to the back side where it is washed off by the flow through the screen. The STSs are used at all the lower Snake River dams, but were replaced with ESBSs at Lower

Granite in 1996 and Little Goose in 1997. The ESBSs are 40 feet long and 20 feet wide, and significantly increase the number of fish guided away from turbines.

- Bulkhead Channel—Fish guided into the bulkhead slot swim or are carried upward by the flow deflected by the fish screen. Fish not guided by the screen pass through the turbine.
- Collection Channel—The fish move through an orifice into the collection channel within the powerhouse. At Lower Granite, a collection channel was constructed in the dam and became operational in 1975. Little Goose and Lower Monumental were constructed with imbedded pipelines for juvenile bypass systems. Subsequent modifications at Little Goose in 1978 and 1979 and Lower Monumental in1991 resulted in the mining of tunnels similar to the collection channel at Lower Granite. At Ice Harbor Dam, a collection channel was constructed in the ice-and-trash sluiceway along the upper face of the powerhouse in 1995.
- Bypass Channel—Fish are directed through a bypass pipe or flume to the fish collection/handling facilities or bypassed back to the river.
- Fish Collection/Handling—Fish arriving at the juvenile fish facilities by pipe or flume are separated from adult fish and debris by a separator. They are then passed to holding ponds or raceways where they may be held until being loaded into a truck or barge. At Ice Harbor Dam, with the exception of period sampling for fish condition, all juvenile fish are bypassed directly to the river.

Juvenile fish are transported from Lower Granite, Little Goose, Lower Monumental, and McNary dams under criteria and guidelines outlined in the Fish Passage Plan (juvenile fish are not transported at Ice Harbor Dam). Juvenile fish that go through the bypass systems can be routed either directly back into the river below the dam, or to holding and loading facilities for loading into barges or trucks for transport. The transport barges and trucks carry the fish past the remaining projects in the Columbia-Snake River System for release below Bonneville Dam. The juvenile fish are released in high velocity waters at night to reduce predation. River water circulates through the barges, allowing the fish to imprint the chemicals and smells of the water during the trip downriver. During the transport, biological technicians are assigned to each fish barge to monitor equipment operation and fish condition. Similarly, trucks are specially equipped to maintain proper conditions during transport (e.g., operation and maintenance of water temperatures).

Prior to 2006, the dates of operation were based on changing conditions (the timing of the fish run for transport is managed by water supply forecasts), discussions in the Technical Management Team (TMT), and legal discussions. In recent years, transport operations have been adaptively managed to optimize system survival, resulting in changes to the start of transport on the Snake River. Collection of juvenile fish generally starts in late March at Lower Granite and a few days later at Little Goose and Lower Monumental. In years with expected spring average river flows above 70 thousand cubic feet per second (kcfs), juvenile fish collected prior to mid-April are bypassed to the river. After mid-to-late April, juvenile fish collected are transported. Juvenile fish are generally transported by barge through about mid-August and by truck after that. Transportation at Lower Granite and Little Goose goes through late October and through late September at Lower Monumental. There are currently eight barges in the Corps' fish passage fleet. Early in the season, a barge leaves Lower Granite every other day. As numbers of fish increase, barges leave every day. After the beginning of June, barging returns to every other day until fish numbers drop in mid-August, after which juvenile fish collected are trucked every other day.

The four lower Snake River dams spill for juvenile fish passage from approximately April 3 through August 31, depending on Adaptive Management decisions. The amount of water spilled at each project and spill patterns utilized are coordinated with the region, and special spill patterns may be used as part of research projects. Final spill patterns for each project are incorporated into the Fish Passage Plan.

In an effort to improve spill passage for juvenile fish, RSWs were constructed at Lower Granite and Ice Harbor dams in 2001 and 2005, respectively. An RSW is a near-surface overflow weir installed in a spillbay, shaped to transition from the raised weir crest to the normal spillway ogee. The structure takes water from the top 10 feet of the reservoir, and passes it down the transition shape to the normal spillway chute. In operation, the normal spillway gate is raised until it is above the water surface, providing a free (nonpressurized) flow over the RSW and down the spillway ogee. The RSWs provide spillway passage through a more behaviorally-accepted route for juvenile fish, reducing forebay delay, and providing a more efficient passage route for migrating juvenile fish. During extreme high river flows, RSWs can be lowered to the bottom of the river (removable) to maintain full spillway capacity. An RSW is presently being constructed for Lower Monumental Dam, and is scheduled to be installed for the spring of 2008. A similar structure is under design for Little Goose Dam.

4.4.1.2 Fish Passage Maintenance

Both adult and juvenile fish passage facilities have established winter maintenance seasons outlined in the Fish Passage Plan. Adult fish facility maintenance is conducted in January and February of each year, and juvenile facility maintenance is conducted from December 16 through March 31. All routine maintenance activities or facility modifications that require the dewatering of facilities or that may impact the operation of facilities are scheduled for these periods. The Fish Passage Plan contains criteria on how to operate fish passage facilities during the normal operating season in the event that a facility component fails and there may be an impact on facility operations or fish passage. The Fish Passage Plan also contains criteria for coordinating facility operations or fish passage issues with regional parties.

All adult fish ladders are dewatered for a brief time period each winter. During the outages, project personnel inspect the fish passageways, remove any debris, and maintain all ladder and fish counting equipment. Annual maintenance on auxiliary water supply pumps is also conducted during the winter maintenance period. Project personnel inspect diffuser gratings each year either by dewatering the collection channels, using an underwater camera, or by employing divers. Any deficiencies found during winter maintenance periods are repaired or corrected.

Periodic maintenance of adult fishway equipment that does not seriously impact facility operations or fish passage may also be performed during the fish passage season. Some fishway equipment requires periodic lubrication, adjustment, or other preventative maintenance type of work that must be done during the fish passage season for continued operations. Other maintenance activities (e.g., cleaning debris off of fish ladder exit trashracks or fish counting station picketed leads) is done on an as needed basis to maintain the facilities within established operating criteria.

Annual maintenance of juvenile bypass systems requires the removal of fish screens from turbine intakes and the dewatering of juvenile fish collection channels, dewatering structures, and various fish transportation and/or sampling facilities. After the facilities are removed from service, they are inspected and repairs and annual maintenance performed. Overhauls and or modification of facilities take place during the annual maintenance period also. At juvenile fish transportation facilities, fish holding, loading, and transportation vessels/vehicles are also maintained. The fish passage equipment is all placed back in service prior to the beginning of the next operating season.

Juvenile bypass systems require almost continual oversight and maintenance during the operating season. Juvenile fish transportation facilities are manned 24 hours per day when transporting fish to make sure they operate according to established operating criteria. Fishway passages (gatewell orifices, flumes, separators, and piping) must be checked for debris and other obstacles that may injure juvenile fish. Fish screens (STSs and ESBSs) have annunciation systems connected to them to ensure that they are operating as programmed. The annunciation systems ensure that mesh rotates as planned on STSs or cleaning brushed cycle on ESBSs to keep screens debris free. When annunciation systems indicate screen failures, the turbine units are operated according to criteria in the Fish Passage Plan and the screens are repaired as soon as possible. Fish screens are also inspected by maintenance personnel utilizing underwater cameras on a monthly basis to ensure they are operating correctly.

4.4.2 Wildlife Program

The Lower Snake River Fish and Wildlife Compensation Plan (Comp Plan) was authorized by the Water Resources Development Act of 1976 to mitigate for fish and wildlife losses caused by construction and operation of the four lower Snake River dams. The Comp Plan includes managing project lands to meet wildlife mitigation goals. Project lands include 62 HMUs managed for these purposes (see Section 3).

Most wildlife operations focus around the intensively managed (irrigated) HMUs. These HMUs contain areas of trees and shrub plantings to replace lost riparian habitat (cover) and food plots and pastures for wildlife feed sources. The HMUs are open to the public for recreational uses. Operation and maintenance of HMUs include irrigation systems and management of vegetation for habitat improvement or control purposes.

4.5 IRRIGATION

The Lower Snake River Project provides irrigation water by having stabilized reservoir levels that enable the installation and operation of pumping stations. Ice Harbor is the only project with agricultural pumping stations. Fourteen pumping stations currently use water from Ice Harbor to irrigate approximately 37,000 acres of land. The pumping stations are all privately owned, and their owners operation and maintain the stations. Pumping stations are required to have screened intakes.

Ten surface water pumping plants are located on the four lower Snake River projects and are used for providing irrigation water to HMUs. The irrigation water is used to promote growth for wildlife cover and feeding. These pumping plants are operated and maintained by the Corps or its contractors. The Lower Granite reservoir has eight pumping stations that provide water for municipal and industrial purposes, including drinking water for the City of Lewiston.

5. REFERENCES

Corps (U.S. Army Corps of Engineers). 1999. Lower Snake River Juvenile Salmon Migration Feasibility Report/Environmental Impact Statement.

Corps and NMFS (U.S. Army Corps and Engineers and National Marine Fisheries Service). 1994. Lower Snake River Biological Drawdown Test Environmental Impact Statement. April.

Appendix B—Description of the Proposed Reasonable and Prudent Alternative
Section B.1—Operations for Flood Control, Irrigation, Navigation, and Power Generation and Transmission

Attachment B.1-3
U.S. Army Corps of Engineers Middle Columbia River Run-of-River Project

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ACRONYMS AND ABBREVIATIONS

BLM	U.S. Bureau of Land Management
BPA	Bonneville Power Administration
CCT	Colville Confederated Tribes
Corps	U.S. Army Corps of Engineers
HEP	Habitat Evaluation Procedure
MCHCA	Mid Columbia Hourly Coordination Agreement
MW	megawatt
NMFS	National Marine Fisheries Service
NWPP	Northwest Power Pool
PNCA	Pacific Northwest Coordinating Agreement
RCC	Reservoir Control Center
Reclamation	U.S. Bureau of Reclamation
USFWS	U.S. Fish and Wildlife Service
WDFW	Washington Department of Fish and Wildlife

1. GENERAL PROJECT DESCRIPTION

The U.S. Army Corps of Engineers (Corps) operates one run-of-river project on the middle Columbia River. Chief Joseph Dam is located at River Mile (RM) 545, approximately 1.5 miles upstream from Bridgeport, Washington and 51 miles downstream from Grand Coulee Dam. The reservoir created by Chief Joseph Dam is called Rufus Woods Lake. It extends 51 miles upstream (to Grand Coulee Dam) and has a shoreline length of 106 miles. Rufus Woods Lake is classified as a navigable waterway and commercial tour and fishing guide boats offer trips on Rufus Woods Lake. Recreation on the lake is an important component of the traffic along the waterway.

2. AUTHORIZATION

The River and Harbor Act of 1946 authorized the construction, repair, and preservation of certain public works on rivers and harbors for navigation, flood control, and other purposes. Chief Joseph Dam was initially authorized as Foster Creek Dam and powerhouse under this Act dated July 24, 1946 (H. Doc 693; PL 79-525, 79th Congress, 2nd Session), and in accordance with the survey report dated April 9, 1946 submitted by the Chief of Engineers in House Document 693 (79th Congress, 2nd Session July 3, 1946). Recreation is authorized under the Flood Control Act of 1944 (PL 78-534).

On July 11, 1969, eleven additional generating units were recommended along with a 10-foot pool raise to a maximum pool elevation of 956 feet. Authorization for this expansion was provided in House Document 693 (PL 94-587 and PL 95-26). Phase I construction of the dam and units 1 through 16 began in 1949 and was completed in 1958. Phase II construction for units 17 through 27 began in 1973 and was completed in 1979.

Authorizations for fish and wildlife enhancements and water quality were granted under Public Laws 85-624 and 92-500, respectively.

3. AUTHORIZED PURPOSES

Congressional authorization was provided to allow Chief Joseph Dam to operate for the purposes of hydropower and recreation. Subsequent legislation has augmented the missions of the Corps and Chief Joseph Dam currently also operates in the interest of navigation, fish, and a variety of other purposes.

Chief Joseph Dam is a run-of-river project and while flood damage reduction was not an initial objective, the dam and Rufus Woods Lake have been, and continue to be, regulated to help provide flood damage reduction, though on a very limited scale. Summary information for Chief Joseph Dam is presented in Table 1.

Table 1. Chief Joseph Dam Summary Information

Dam	Type of Dam	Year Completed[1/]	River Mile	Reservoir Name	Useable Capacity (acre-feet)
Chief Joseph	Run-of-River	1979	545	Rufus Woods Lake	116,000

1/Chief Joseph Dam was constructed in two phases. Phase I was completed in 1958; Phase II was completed in 1979.

Chief Joseph Dam and Rufus Woods Lake lie in a steep-sided canyon of the Columbia River Valley, which ranges in width from 2 to 4 miles. The north side of the valley rises sharply to the Okanogan Highlands, 1,000 feet or more above the Columbia River. The south side of the valley rises in a series of terraces and benches climbing to the Columbia Plateau.

The dam consists of a 19-bay gated concrete gravity spillway that abuts the right bank and connects to a curved non-overflow concrete section founded on a rock outcropping. The intake structure and powerhouse follow a downstream alignment and connect with the left abutment by means of a curved concrete gravity non-overflow dam. The 2,047-foot-long powerhouse encloses 27 main generators, two station service generators, maintenance shops and control room, and the visitor center. The area of Rufus Woods Lake at full pool is 8,400 acres, and it's gross capacity at full pool is 593,000 acre-feet. The reservoir is 51 miles long and has a shoreline length of 106 miles.

Total project real estate interest administered by the Corps is 16,123 acres of which 12,006 acres are easement lands. The balance is primarily designated wildlife mitigation lands and public domain lands; 318.18 acres of Corps fee and easement lands are managed for recreation. The Colville Confederated Tribes (CCT) exercise control over portions of the north shoreline in Okanogan County which lies within Colville Indian Reservation boundaries. The U.S. Bureau of Reclamation (Reclamation) has jurisdiction over lands upstream from RM 590.4. In addition, the U.S. Bureau of Land Management (BLM) administers substantial areas of public land adjoining the lake in Douglas County on the south bank. Several State managed parcels of land also exist in Douglas County.

4. PROJECT ACTIVITIES

4.1 FLOOD CONTROL

Chief Joseph Dam is a run-of-the-river project, with virtually no flood storage. However, limited flood control storage may be provided in the event of an extreme flood by drafting Rufus Woods Lake below its minimum normal operating level, elevation 950 feet, immediately prior to a flood peak, then refilling as the flood crest moves through the project. This type of operation would be under the direction of the Northwestern Division Corps' Reservoir Control Center (RCC). However, it should be noted that there is no flood control responsibility given to Chief Joseph Dam, either locally or for the Columbia River system. Use of the spillway may occur during flood events or during routine operation.

4.2 HYDROPOWER

Chief Joseph Dam was primarily constructed to provide hydroelectric power. The powerhouse at the Chief Joseph project is located immediately downstream from the intake structure along the left bank of the river. The present 27-unit powerhouse is 2,039 feet long and 68 feet wide, with a height of 136 feet above bedrock. Based on historical information, the minimum gross hydropower head is 162 feet. Assuming all 27 units are operating at their highest output, the maximum output is estimated to be 2,440 megawatts (MW). This estimate is based on recent index tests and historical model tests. Maximum powerhouse discharge is estimated to be approximately 215,000 cubic feet per second.

4.2.1 Hydropower Operations

The hydropower operation at Chief Joseph is a daily-weekly type with maximum generation during the weekdays and limited generation during the nighttime and weekends. Generation varies seasonally with the highest generation during the winter and the lowest during summer and early fall. Water supply from headwater storage plants provide the extra water supply for the winter generation. The Corps works with the following agencies and under the following Agreements regarding hydropower operations at Chief Joseph Dam, these include Bonneville Power Administration (BPA), Northwest Power Pool (NWPP), Mid Columbia Hourly Coordination Agreement (MCHCA), and the Pacific Northwest Coordinating Agreement (PNCA).

4.2.2 Hydropower Maintenance

Drafting of the reservoir below elevation 950 feet is done annually for inspection and possible maintenance, typically in late summer to minimize impacts to fish and wildlife and their habitats. If drafting occurs below elevation 950 feet due to emergencies or inadvertent conditions, adverse impacts on lake-shore pumping, damage to boat ramps, and hazards to recreational boating may occur.

If drafting is required below elevation 950 feet during the summer recreational season, the Project Resource Manager must be notified to alert the public to exposed hazards caused by the drawdown and to alert farmers to protect their irrigation pumps.

If drafting is required below elevation 950 feet for maintenance or other special conditions during the goose nesting period (February 15 to May 15), appropriate offices must be notified at least 15 days prior to the drawdown to coordinate protective action for the nesting geese with State and Federal natural resource agencies.

4.3 RECREATION

The dam's visitor center and overlooks receive approximately 140,000 recreating visitors annually. One campground (Bridgeport State Park) provides overnight camping in the vicinity of the project. Most of the lands along the reservoir shoreline are privately owned and public access is not allowed. However, a few sites were purchased by the Corps as potential recreation sites. These sites have not been developed, but are available to the public for day use. Minimal or no facilities are provided in these areas.

4.4 FISH AND WILDLIFE

4.4.1 Fish Management

Anadromous fish have no access to Rufus Woods Lake from below Chief Joseph Dam because the dam has no upstream fish passage facilities and is the upstream limit of migration for anadromous fish in the Columbia River. The CCT has expressed strong interest in seeing development of anadromous fish passage facilities at Chief Joseph Dam, and later, Grand Coulee Dam. This issue is a matter of regional public policy as well as a significant technical challenge, and is being discussed under other forums.

Opportunities for fish habitat management are limited on Rufus Woods Lake due to the fluctuating pool level and limited Corps fee land along the shoreline. Many of the densely vegetated wildlife mitigation habitat sites provide a direct benefit to fish by minimizing or eliminating overland erosion into the Columbia River. The riparian corridor along Foster Creek by the dam is managed for fish habitat. Trees have been planted to shade the creek, thus reducing the water temperature, and large rocks have been placed within the creek to provide resting and hiding areas for fish.

4.4.2 Wildlife Management

In 1981, the Corps raised the normal full pool level of Rufus Woods Lake 10 feet, from 946 to 956 feet above mean sea level, to increase the hydropower production of Chief Joseph Dam. Under the authority of The Fish and Wildlife Coordination Act of 1958 (Public Law 85-624), the Corps worked with the Washington Department of Fish and Wildlife (WDFW), CCT, and U.S. Fish and Wildlife Service (USFWS), to develop a comprehensive wildlife mitigation plan to preserve existing habitat for all wildlife species and mitigate wildlife habitat losses caused by the 10-foot raise. The plan of action, *Design Memorandum 52: Wildlife and Threatened Species Mitigation, Chief Joseph Dam Additional Units*

(1980) describes the Habitat Evaluation Procedure (HEP) for developing lands to mitigate for this habitat loss.

Sixteen wildlife mitigation sites have a total acreage of 2,672; 985 in fee land; and 1,687 in wildlife easement lands. Of this total, approximately 1,550 acres are above the normal full pool of 956 feet. The lands are located in Okanogan and Douglas counties from RM 547 through RM 589.

Goose nesting on Rufus Woods Lake is of regional importance. In the Okanogan Highlands area of Washington (the general region surrounding Rufus Woods Lake), goose nesting is relatively rare. Known goose-nesting activities on Rufus Woods Lake increased from 33 nests to 99 nests during the time period from 1981 through 2001. A 25-year monitoring and evaluation program was recently completed and the future direction of the mitigation program is currently being evaluated by the Corps, CCT, WDFW, and USFWS.

4.4.3 Threatened and Endangered Species

Salmon, steelhead trout and char stocks have been listed under the Endangered Species Act of 1973 (PL 93-205) in the Columbia River from the Pacific Ocean to Chief Joseph Dam; however, because there is no fish passage provided at Chief Joseph Dam, none of these listed fish are found in the project area above the dam. Operation of Chief Joseph Dam may affect these listed fish. Spill, in particular, may raise total dissolved gas above safe levels. Therefore, the National Marine Fisheries Service (NMFS) required in its 2000 Biological Opinion that the Corps construct flow deflectors on the Chief Joseph Dam spillway. This construction work is ongoing.

Appendix B—Description of the Proposed Reasonable and Prudent Alternative
Section B.1—Operations for Flood Control, Irrigation, Navigation, and Power Generation and Transmission

Attachment B.1-4
U.S. Bureau of Reclamation Storage Projects

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ACRONYMS AND ABBREVIATIONS

AIP	Agreement In Principle
BiOp	Biological Opinion
BPA	Bonneville Power Administration
cfs	cubic feet per second
Corps	U.S. Army Corps of Engineers
CRWMP	Columbia River Water Management Program
Ecology	Washington State Department of Ecology
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FCRPS	Federal Columbia River Power System
FEIS	Final Environmental Impact Statement
FELCC	Firm Energy Load Carrying Capacity
M&I	municipal and industrial
MOU	Memorandum of Understanding
MW	megawatt
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NPPC	Northwest Power and Conservation Council
NWQA	National Water Quality Assessment
PUD	Public Utility District
Reclamation	U.S. Bureau of Reclamation
ROD	Record of Decision
RPA	Reasonable and Prudent Alternative
SEPA	State Environmental Policy Act
TMT	Technical Management Team
URC	upper rule curve
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VDL	Variable Draft Limit

1. GENERAL DESCRIPTION

The Bureau of Reclamation (Reclamation) operates two storage projects that function as part of the Federal Columbia River Power System (FCRPS). These two projects are the Columbia Basin Project and the Hungry Horse Project.

The Columbia Basin Project is a multipurpose development on the Upper Columbia River in central Washington. The major facilities of the Columbia Basin Project are Grand Coulee Dam and its impoundment, Lake Roosevelt, the Grand Coulee Powerplant complex, the pump/generating plant, Banks Lake, and Potholes Reservoir. In addition, the project includes a well-developed system of canals, dams, reservoirs, drains, wasteways, laterals, and other structures.

The Hungry Horse Project, on the South Fork of the Flathead River in northwestern Montana, is operated primarily for flood control and power generation as part of the FCRPS. The dam is situated in a deep, narrow canyon, approximately 5 miles southeast of the South Fork's confluence with the mainstem Flathead River. The project includes a dam, reservoir, powerplant, and switchyard. The project plays an important role in meeting the need for power in the Pacific Northwest and in providing a storage system for flood control.

2. AUTHORIZATION

Congress allocated funds for construction of Grand Coulee Dam under the National Industrial Recovery Act of June 16, 1933. The Columbia Basin Project was authorized by Congress through Public Law 74-409 on August 30, 1935, and reauthorized through Public Law 78-8, which brought the project under the provisions of the Reclamation Project Act of 1939. Units 7, 8, and 9 of the Right Powerplant were approved by the Secretary on January 5, 1949. Congress authorized the Third Powerplant through Public Law 89-448 on June 14, 1966, and Public Law 89-561 on September 7, 1966. The authorized project purposes include flood control, navigation, hydroelectric generation, irrigation, and other beneficial uses including fish and wildlife.

Congress authorized the construction of Hungry Horse Dam through Public Law 78-329 on June 5, 1944. The authorized purposes of the Hungry Horse Project are irrigation, flood control, navigation, streamflow regulation, hydroelectric generation, and other beneficial uses. The project's irrigation component has not been developed.

The projects described here are authorized, funded, or carried out by Reclamation by virtue of Congressional or Secretarial authorizations, Congressional appropriations, and contracts with Reclamation. Reclamation received authorization for each of its projects from either Congress or the Secretary of the Interior, who had authority under the 1902 Reclamation Act to approve construction after a finding of feasibility. The Congressional and Secretarial authorizations state the purposes to be served by each project. Congress has directed in the Reclamation laws that Reclamation enter into contracts with project water users. These contracts set out, among other things, Reclamation's obligations to store and deliver project water to irrigation districts, municipalities, and other entities. Additionally, the 1902 Reclamation Act requires that Reclamation comply with State law with regard to control, appropriation, use, and distribution of waters. Water can only be stored and delivered by a project for authorized purposes for which Reclamation has asserted or obtained a State water right in accordance with Section 8 of the Reclamation Act of 1902 and applicable Federal law. Reclamation must honor senior or prior water rights in storing and diverting project water. Conversely, project water is protected from diversion by junior appropriators by State watermasters. The active cooperation of the State water rights administrators is essential in ensuring that any water Reclamation delivers for flow augmentation or any other purpose reaches the targeted points of delivery.

3. AUTHORIZED PURPOSES

Congress authorized Reclamation to operate Grand Coulee Dam for the multiple purposes of flood control, navigation, generation of electricity, storage and delivery of water for irrigation, and other beneficial uses including fish and wildlife.

Grand Coulee Dam, the primary storage and diversion structure for the Columbia Basin Project, was constructed from 1933 to 1941 and modified from 1967 to 1974 and 1982 to 1988. Hydroelectric generating units were installed to supply electric power for the war effort. After the war, construction centered on the associated pumping plant and irrigation facilities.

The first irrigation water was delivered to about 5,400 acres in 1948 from the Pasco Pumping Plant on the Columbia River. In 1950, the Burbank Pumping Plant began delivering water to about 1,200 acres on the Snake River south of Pasco. In 1952, the Grand Coulee Pumping Plant began delivering irrigation water to about 66,000 acres. The original plans anticipated about 1.1 million irrigated acres. Current contract acreage is about 671,500 acres. These lands produce potatoes, sweet corn, onions, seed and other specialty crops, grapes, fruit, sugar beets, dry beans, grain, alfalfa hay, and ensilage crops.

The Grand Coulee Dam Powerplant complex consists of three powerhouses and 27 generating units, with a total generating capacity of 6,495 megawatts (MW). The average net generation of the Grand Coulee Powerplants from 2001 to 2006 was about 20 billion kilowatts, which is a large share of the power requirements of the Pacific Northwest. The third powerplant alone can produce enough energy to meet the needs of Portland, Oregon, and Seattle, Washington.

Hungry Horse Dam and Powerplant were constructed between 1948 and 1953. The dam creates a large reservoir by withholding water in times of heavy runoff to minimize downstream flooding. This stored water is released for power generation when the natural flow of the river is low. Downstream power benefits are of major importance since more than five times as much power can be produced from water releases downstream than is produced at Hungry Horse Powerplant.

The Hungry Horse Powerplant consists of four 107-MW generators with a total installed capacity of 428 MW. Current transmission limitations restrict generation to around 350 MW when Libby Dam on the Kootenai River is operating to full powerplant capacity and could potentially restrict generation even further in the future.

Summary information is presented for the two projects in Table 1.

Table 1. Reclamation Storage Projects Summary Information

Facility	Type of Facility	Year Completed	River	River Mile	Reservoir Name	Total Reservoir Capacity (million acre-feet)
Grand Coulee	Storage	1941[1/]	Columbia	596.6	Franklin D. Roosevelt Lake (Lake Roosevelt)	10.1[2/]
Hungry Horse	Storage	1953	South Fork of the Flathead River	5	Hungry Horse Reservoir	3.46

1/Grand Coulee Dam was constructed from 1933 to 1941 and modified from 1967 to 1974 and 1982 to 1988.
2/This total includes both Lake Roosevelt (9.4 million acre feet) and Banks Lake (0.7 million acre feet). Banks Lake is a re-regulating reservoir. Water is pumped from Lake Roosevelt to Banks Lake for irrigation delivery.

3.1 COLUMBIA BASIN PROJECT

Grand Coulee Dam is the primary storage and diversion structure for the Columbia Basin Project. The dam, the largest concrete structure ever constructed, is 550 feet high and 5,673 feet long. The dam was constructed from 1933 to 1941 and was modified from 1967 to 1975 by constructing a 1,170-foot-long and 210-foot-high forebay dam along the right abutment as part of the construction for the Third Powerplant. The lake elevation at minimum pool is 1208.0 feet; lake elevation at full pool is 1290.0 feet. Lake Roosevelt has a total storage capacity of 9.4 million acre-feet (5.2 million acre-feet of active space) and extends more than 150 miles upstream to the Canadian border. Reclamation operates Grand Coulee Dam in coordination with other projects in the Columbia River basin to provide system flood control space in Lake Roosevelt to control the flow of the Columbia River at The Dalles.

The Grand Coulee Powerplant complex consists of powerplants on the right and left sides of the spillway and the Third Powerplant on the right bank of the dam. The right and left powerplants have a total of 18 units of 125-MW capacity plus 3 units of 10-MW capacity for a total capacity of 2,280 MW. The third powerplant contains 3 units of 600-MW capacity and three units of 805-MW capacity for a total capacity of 4,215 MW.

The pump/generating plant on the left bank was designed to accommodate 12 pumping units to pump water from Lake Roosevelt to Banks Lake for irrigation delivery. Six pumps, each with a capacity of 1,600 cfs, were installed by 1951, 2 pump/generators with a pumping capacity of 1,605 cfs each and a generating capacity of 50 MW were installed in 1973, and 4 pump/generators units with a pumping capacity of 1,700 cfs each and a generating capacity of 53.5 MW were installed between 1983 and 1994. The pumping/generating plant lifts water to the 1.6-mile-long feeder canal that leads to Banks Lake. Elevation 1240 is an elevation of note because below it, Reclamation cannot meet the full pumping demand at the pumping plant.

Banks Lake, located in an old ice-age channel called the Grand Coulee, is a re-regulating reservoir. This 27-mile-long reservoir is formed by the North Dam, located about 2 miles southwest of Grand Coulee Dam, and the Dry Falls Dam, located about 29 miles south of Grand Coulee Dam. Banks Lake has an active storage capacity of 715,000 acre-feet, feeds water to the Main Canal, and provides water to operate the pump/generators in generation mode.

The irrigation season extends from about mid-March to November 1. About 2.7 million acre-feet are diverted annually for the irrigation of about 671,500 acres of land.

3.2 HUNGRY HORSE DAM

Facilities at the Hungry Horse Project include the dam, reservoir, and powerplant. The 564-foot-high dam is a variable-thickness concrete arch structure with a 2,115-foot-long crest. The hydraulic capacity of the powerplant is about 12,000 cfs if generating at full capacity. There are three hollow jet valves with a combined capacity of 13,980 cfs at elevation 3560.0 feet and a “glory hole” spillway with a capacity of 50,000 cfs at elevation 3565.0 feet. The total storage capacity of the reservoir is 3.5 million acre-feet.

The Hungry Horse Powerplant originally included four 71.25-MW generators (a total of 285 MW installed capacity). The capacity of the generators was up-rated from 70.25 MW each to 107 MW each in the 1990s, which increased the installed capacity from 285 MW to 428 MW. However, current transmission limitations restrict generation to around 350 MW when Libby Dam on the Kootenai River is operating to full powerplant capacity and could potentially restrict generation even further in the future. Columbia Falls Aluminum Company, when operating to full capacity, uses 350 MW of power. In 2001, the plant reduced operations to 20 percent capacity[1]. The transmission system was built with the assumption that power generated at Hungry Horse would be used locally so there is a limit on how much power can be transmitted out of the valley. When the aluminum plant was fully operational, little of the energy generated at Hungry Horse Dam had to be transmitted out of the valley. Now, with little of the power used locally and a limitation on what can be transmitted out of the valley, there could be a restriction on power generation.

In 1995, Reclamation installed a selective withdrawal system on all four unit penstock intakes. This system is used from June 1 to the end of October to increase the water discharge temperature to reduce the thermal shock for downstream fisheries and to increase aquatic insect communities for bull trout growth and reproduction.

4. PROJECT ACTIVITIES

4.1 COLUMBIA BASIN PROJECT

4.1.1 Operation and Maintenance

Reclamation operates and maintains all of the Columbia Basin Project's major facilities. The Quincy-Columbia Basin Irrigation District, East Columbia Basin Irrigation District, and South Columbia Basin Irrigation District operate and maintain all of the irrigation distribution facilities within their geographic areas.

Operations for the Columbia Basin Project primarily include:

- Storage in and release of water from Lake Roosevelt, Banks Lake, Billy Clapp Lake, Potholes Reservoir, Scooteney Reservoir, and Soda Lake
- Diversion of water at the Grand Coulee Pump/Generating Plant and subsequent diversions into the Main, West, East Low, and Potholes Canals
- Power generation at the Grand Coulee Left, Right, and Third Powerplants and the Pump/Generation Plant, and the provision of surplus power to Bonneville Power Administration (BPA) for marketing
- Routine maintenance of project facilities.

The section below on Grand Coulee Dam's multiple-purpose operations more fully describes the operations of Grand Coulee Dam and its associated facilities. Aside from operations of Grand Coulee Dam and flow augmentation from Banks Lake, Reclamation does not further coordinate the operation of the Columbia Basin Project with the FCRPS. Reclamation also incorporates by reference the standing operating procedures for Dry Falls, Grand Coulee, O'Sullivan, North, and Pinto dams; Soda Lake Dike; and the Grand Coulee powerplants, which more fully describe the physical facilities, operational criteria, and operating thresholds.

Operation and maintenance of the Columbia Basin Project outside of the FCRPS includes parts of four water management programs: the Quincy Groundwater Subarea Program, the use of conserved project surface water to replace existing deep well pumping from the Odessa aquifer, the 508-14 program, and a small part of the Columbia River Water Management Program.

[1] There is a temporary contract for 2007 that increases Columbia Falls Aluminum Company to 60 percent capacity, which raises the restriction at Hungry Horse to 400 MW. This contract may or may not be extended beyond 2007.

Quincy Groundwater Subarea Program – This ongoing program involves the use of groundwater artificially stored in the Quincy subarea as a result of project irrigation development and operation. Reclamation issues licenses for the use of this project groundwater. It does not involve any additional diversions from the Columbia River and does not impact return flows to the Columbia River since groundwater in the subarea flows to Potholes Reservoir.

East District Conserved Water Program – This program involves the use of a portion of conserved project water (through facility improvements) within the East Columbia Basin Irrigation District. The conserved water is allocated to replace deep well pumping in the Odessa subarea. The program does not involve any additional diversions from the Columbia River.

508-14 Program – This program involves Reclamation issuing licenses for groundwater pumping from project water supplies in the Franklin County portion of the groundwater area (as designated in Washington Administrative Code 508-14). This program does not involve any additional diversions of water from the Columbia River. The U.S. Geological Survey estimates the Columbia River flow reduction associated with this program to be equal to or less than 0.1 cfs.

Washington State's Columbia River Water Management Program (CRWMP): Early Actions - Lake Roosevelt Drawdown - The 2006 Washington State Legislature passed the Columbia River Water Resource Management Act (HB 2860) directing the Washington Department of Ecology (Ecology) to pursue development of new water supplies in the mainstem Columbia River, over the next 20 years, for both instream and out-of-stream uses. The new water supplies are to be developed through storage, conservation, improved management of existing facilities, voluntary regional water management agreements, water rights transfers and exchanges, and potentially increased access to Canadian storage. Consistent with advice provided by the National Academies of Science, Water Science and Technology Board, the intent of the statute and the program is to bind state allocation of new economic uses of water to concurrent actions that result in positive contributions to streamflows and salmon recovery during critical periods.

Ecology describes how it intends to implement the new legislation in a Final Programmatic Environmental Impact Statement (FEIS) for the CRWMP dated February 15, 2007 (2007 FEIS) that was prepared pursuant to the State Environmental Policy Act (SEPA). Three early implementation actions are also evaluated, two of which, a new Lake Roosevelt Drawdown and Potholes Reservoir Supplemental Feed Route, involve Reclamation cooperation.

In 2004, Reclamation entered into a Memorandum of Understanding (MOU) with the State of Washington and the Columbia Basin Project irrigation districts (the South Columbia Basin Irrigation District, the East Columbia Basin Irrigation District, and the Quincy-Columbia Basin Irrigation District). The MOU describes roles and expectations of those parties during conduct of the then anticipated CRWMP (known then as the Columbia River Initiative), and specifically contemplates the new Lake Roosevelt Drawdown. The MOU and subsequently the 2007 FEIS specifically describe the allocated use of the stored water as follows:

In non-drought years (wettest 96 percent of water years), 82,500 acre-feet will be provided as follows:

- 25,000 acre-feet of municipal/industrial (M&I) supply
- 30,000 acre-feet of irrigation water to replace ground water supply in the Odessa Subarea
- 27,500 acre-feet for streamflow enhancement downstream of Grand Coulee Dam

In drought years (driest 4 percent of water years when the March Final water supply forecast for April through September at The Dalles is less than 60 million acre-feet, statistically 1 in 26 years of record), an additional 50,000 acre-feet broken down as follows:

- 33,000 acre-feet for Columbia River mainstem interruptible water right holders
- 17,000 acre-feet for streamflow enhancement downstream of Grand Coulee Dam.

For any withdrawal from Lake Roosevelt, the CRWMP provides that one-third of the water would be available to supplement water for fish flows during the juvenile salmon migration periods (April through August period). This "no net loss plus 33 percent" formula delivers water below Grand Coulee Dam that would not be available under current operations to benefit ESA-listed fish anytime from April through August.

The current understanding of flow and survival is changing as is the evolutionarily significant unit (ESU) most in need of further flow management. Although past operations prioritized summer migrants, these priorities are changing. Ecology has indicated that in the driest 20 percent of water years, the water allocated for streamflow enhancement would be released in the April through June period. For the remainder of water years, the sovereigns' governance process would identify the best use of the water such that it provides the maximum biological benefit to the ESUs most in need of survival improvement to ensure their survival and opportunity for recovery. This process would also address overall cost-effectiveness, and include an analysis of impacts on tribal interests in resident fish and cultural resources in Lake Roosevelt.

When implemented as described, the new CRWMP drawdown would result in a net increase to instream flows from McNary Dam during the April through August flow augmentation period. When used in the summer months, the increase in instream flows would be roughly 225 cfs average (corresponding to the 27,500 acre-feet listed above) in non-drought years and roughly 360 cfs average (44,500 acre-feet, which represents the sum of the 27,500 acre-feet and 17,000 acre-feet listed above) in drought years [2]. However, the instream component of the new drawdown could also be utilized at any time from April through August. In the lowest 20 percent of water years, the fish flow enhancement will be provided in the April through June period to aid spring migrants, and in the rest of the years the water will be provided for the ESU most in need of survival improvements. This is a very small increase in stream flow; however, the purpose of the flow is to ensure that there is no flow reduction during the juvenile salmon migration period.

The proposed delivery would result in an additional drawdown of approximately 1-foot in non-drought years, and another 0.8 foot in drought years. Recent operations provided that during July-August, Lake Roosevelt may be drafted to elevation 1280 feet in the wettest 50 percent of water years, and to 1,278 feet in the driest 50 percent for flow augmentation. Therefore, when conjoined with recent operations, the new CRWMP drawdown would lower the end of August elevation to 1279 feet in the wettest 50 percent of water years, to elevation 1276.2 feet in the driest 4 percent of water years, and to elevation 1277 feet in the other years (between 4 percent driest and 50 percent wettest years). Computer models indicate that refill of Lake Roosevelt would not be affected by the implementation of this additional draft.

According to a 2005 Government-to-Government Agreement in Principle (AIP) between the State of Washington and the Confederated Tribes of the Colville Reservation, the reservoir space vacated by the new draft would be refilled by September 30th of each year to ensure access to spawning habitat for resident kokanee populations in Lake Roosevelt. This action would add to the reduction in September flow that occurs after the end of prescribed flow augmentation in August; however, this action is part of a

[2] Flow numbers may increase slightly due to return flows from M&I supply.

suite of actions in this Proposed Reasonable and Prudent Alternative (RPA), certain elements of which have the potential to offset this reduction.

In accordance with Section 24 of the 2004 MOU regarding ESA consultation, Reclamation proposes to implement the Lake Roosevelt drawdown as described above. This consultation is intended to cover only the Early Action - Lake Roosevelt Drawdown component of the CRWMP. Implementation of any non Lake Roosevelt drawdown program components will require separate ESA compliance at the appropriate time. Fundamental commitments made in the AIP, indicate that for the duration of the CRWMP, the State will not seek further drawdowns from Lake Roosevelt for use in meeting stream flow requirements or out-of-stream water supply needs along the mainstem of the Columbia River.

Section 23 of the 2004 MOU recognizes that the primary effects of the drawdown would be to Lake Roosevelt elevations and may affect the interests of the Confederated Tribes of the Colville Reservation and the Spokane Tribe of Indians (Tribes). Reclamation will not implement this drawdown unless the State of Washington has secured the concurrence of the Tribes and Reclamation has separately consulted with them on a Government-to-Government basis.

In addition, the State as well as Reclamation must comply with the State Environmental Policy Act (SEPA) and National Environmental Policy Act (NEPA). Finally, Reclamation would need to submit a water permit application for approval by and the State.

Actions Associated with the 2000 Biological Opinion Reasonable and Prudent Alternative (RPA) – Reclamation completed its investigation of listed salmon and steelhead use of project wasteways (RPA Action 37 from the 2000 Biological Opinion [BiOp]). A report was completed in April 2005, which concluded that there was only minimal use of the wasteways by spawning steelhead. The study goes on to say that, although steelhead did spawn in two of the wasteways, the systems do not offer abundant, suitable year-around habitat conditions that favor successful production of juvenile steelhead. Reclamation concluded that a barrier should be constructed to prevent steelhead from entering either DCCI or RB4C wasteways to force steelhead to spawn in more suitable habitat.

Reclamation will also continue its water quality monitoring of surface return flows through 2007 (RPA Action 39). A final report will follow. Although not part of RPA Action 39, Reclamation contracted with the U.S. Geological Survey (USGS) to conduct additional water quality monitoring in coordination with their ongoing National Water Quality Assessment (NWQA) program. Between July 2002 and October 2004, the USGS collected and analyzed water quality samples for pesticides from four irrigation return-flow drainage basins in the Columbia Basin Project. Of the 107 analytes of concern, 42 pesticides and 5 pesticide metabolites were detected. Of the 47 total detections, three insecticides and one herbicide exceeded benchmarks for the protection of aquatic life. A final report was completed in January 2006. Reclamation does not use any of the four analytes detected and does not have regulatory authority over the irrigation districts or irrigators, but will make the report available to those who do.

Drum Gate Maintenance – The standing operations program requires annual inspections and dam safety maintenance for the 11 Grand Coulee Dam 135-foot-long and 30-foot-high drum gates. Inspection and maintenance activities can only occur when the lake is operated at or below elevation 1255 feet for at least 6 weeks (but preferably 60 days) to provide safe working conditions. During extended droughts when flood control operations do not require the reservoir to draft below elevation 1255 feet for 6 weeks, a forced draft may be required to perform maintenance. This forced draft can reduce the chance of reaching the upper rule curve (URC) elevation by April 10 and reduce downstream flows during refill.

Maintenance on Facilities on and around Banks Lake – Banks Lake Equalizing Reservoir is located in the upper Grand Coulee and was built to store and supply irrigation water to the Columbia Basin Project.

Banks Lake is formed by the construction of two dams: North Dam, which is near Grand Coulee Dam; and Dry Falls Dam, which is at the south end of the reservoir. Water is pumped from Lake Roosevelt through a set of pumps and pump/generators up to the Feeder Canal, which then discharges into Banks Lake. Water is released for irrigation to the Columbia Basin Project from Banks Lake through a set of gates at the headworks of the Main Canal at Dry Falls Dam.

Historically, Banks Lake has been operated with water surface fluctuation of as much as 27 feet on an annual basis. Routine maintenance was generally coordinated within this annual cycle. Reclamation voluntarily changed this operation during the 1980s when facilities such as the Second Bacon Siphon and Tunnel and the third powerplant were completed. This increased the opportunity for recreation but reduced the opportunity to perform routine maintenance on project-reserved works. Now special operations have to be performed to do routine maintenance. Every 12 to 15 years or so Banks Lake will need to be drafted up to 35 feet to perform routine maintenance.

Reclamation would coordinate with other agencies, facilities etc. with interest around Banks Lake so that all could take advantage of the drawdown to perform any necessary maintenance activities. The full hydrologic effects of the maintenance operations would span two different water years with drawdown starting in August of the first water year, by shutting off the pumps from Lake Roosevelt and allowing irrigation withdrawals to draft the lake. This would result in a slight increase in flows at McNary during drawdown as water typically pumped to Banks Lake would be released from Lake Roosevelt during August. Banks Lake would be down by the end of irrigation season, around the end of October. Maintenance would be performed during the winter and would be completed by March 1. Refill would occur during the second water year and would be coordinated with BPA to take advantage of high flows and low power demand to refill Banks Lake by April 15. In most years, there would be no effect to the Columbia River flow objectives during refill of Banks Lake.

During low water years, refill of Banks Lake would occur based on in-season water management decisions. For modeling purposes, minimum flows through Hanford Reach were maintained causing a deeper draft of Lake Roosevelt from March 1 through April 30. This deeper draft (in 24 percent of the water years) resulted in a decrease of up to 4,800 cfs in the spring flow objectives during refill of Lake Roosevelt.

At this time there are no procedures developed that would forecast water supply prior to the first of January. As drawdown would need to be done from August through October it would need to be scheduled without prior knowledge of what the water supply forecast might be during refill. Every effort will be made to complete maintenance in a timely manner to allow time to refill with minimal effects on spring flows.

4.1.2 Grand Coulee Dam Multiple-Purpose Operations

Congress has authorized Reclamation to operate Grand Coulee Dam for the multiple purposes of flood control, navigation, generation of electricity, storage and delivery of water for irrigation, and other beneficial uses including fish and wildlife. Reclamation also operates the dam in coordination with the Mid-Columbia Public Utility District (PUD) projects and other FCRPS facilities. Not only does Grand Coulee Dam's operation reflect multiple factors, such as water supply conditions, hydroelectric power generation requirements, and flow needs for fish, but the specific operating purposes also change from month to month and season to season. Reclamation seeks to balance the needs of the multiple purposes. This section discusses the general operating scheme for the project, by month and season.

4.1.2.1 Fall Operations, September through December

During the fall season, Reclamation's operating priorities are power generation and minimum flows for anadromous fish. Reclamation will attempt to refill Lake Roosevelt to a minimum elevation of 1283 by the end of September to support resident fish in the reservoir. A significant start to refill typically occurs during Labor Day weekend as it is one of the lowest load periods of the year.

By the beginning of October, Reclamation will have refilled Lake Roosevelt to elevation 1283 or higher. Reclamation then operates Lake Roosevelt for two purposes: to augment flows for fish, if necessary, and to meet hydropower operational targets for these months (its portion of the Firm Energy Load Carrying Capacity, or FELCC). Reclamation limits any drafts for power to elevation 1283 in October, elevation 1275 in November, and elevation 1270 in December. The release of these flows provides spawning and incubation flows for lower Columbia River chum salmon and also spawning and protection flows for Hanford Reach fall Chinook salmon. Banks Lake is drafted to elevation 1565 during the month of August, which is 5 feet from full pool. During the fall months, Reclamation will coordinate with BPA to refill Banks Lake to its normal operating range between elevation 1568 and elevation 1570. The refill is done in a manner that avoids impacts to power generation or minimum flows for fish.

4.1.2.2 Winter Operations, January through March

During the winter season, Reclamation's operating priorities are flood control, power generation, and minimum flows for fish. Reclamation generally drafts Lake Roosevelt below the required flood control elevations to generate power. The limits to this winter power flexibility are set to provide an 85 percent probability of refilling to the URC on April 10, to increase stream flows for juvenile migration in the spring. The draft of Lake Roosevelt can help provide protection flows for Hanford Reach fall Chinook salmon redds and also augment flows below Bonneville Dam to provide protection to chum salmon redds. The U.S. Army Corps of Engineers (Corps) has established the Lake Roosevelt flood control rule curves, which include an adjustment that is based on the runoff forecast minus the space available upstream of The Dalles.

During these 3 months, Reclamation releases water while maintaining the reservoir elevation at or above the higher of two figures: the winter draft limits (elevation 1260 at the end of January, elevation 1250 at the end of February, and elevation 1240 at the end of March) or the Variable Draft Limit (VDL)[3] for winter power flexibility. The VDL is set based an assumed inflow volume that has an 85 percent probability of occurrence while still providing the required flows at Vernita Bar. The VDL is calculated each month after the official water supply forecasts and flood control elevations are issued. This winter power flexibility is an important tool that is used to meet the winter power demands in the northwest without affecting minimum fish flows or Reclamation's ability to be at the URC on April 10.[4]

Reclamation schedules drum gate maintenance during March, April, or May when the water surface elevation is typically well below elevation 1255 for at least 45 days and preferably 60 days (typical flood control operations usually provide this opportunity). In dry years with low water supply forecasts,

[3] A VDL is a computed end-of-month elevation limit for drafting Grand Coulee Dam for the periods January, February, and March. The VDLs are used to provide winter power flexibility while maintaining an 85 percent probability of achieving refill of the project to its April 10 URC elevations (see April 10 URC definition). The VDLs have lower limits and are set at elevations 1,260 for January, 1,250 for February, and 1,240 for March. The only variables in the computation of the VDLs are the flood control elevation computed by the Corps, which is based on the water supply forecast and the space available in storage reservoirs upstream from The Dalles. The basic computation assumes an inflow that has an 85 percent probability of occurrence from which both the volume of upstream storage that must be filled and the volume needed to meet minimum flows at Vernita Bar are subtracted. The remainder is the volume available for winter power flexibility.

[4] The flood control elevation is based on water supply forecasts. It is a common misconception that maintaining reservoirs at their flood control elevations from January through March would provide 100 percent probability of achieving refill to the April 10 URC. Modeling has shown that there is very little difference in the likelihood of achieving refill to April 10 URC between an operation that only drafts the project to URC or to meet the minimum flow requirements downstream and an operation that allows a measured draft for winter power flexibility.

Reclamation would typically not vacate as much flood control space, which would necessitate a forced draft to lower the water surface elevation to allow for the maintenance. Maintenance could be deferred in dry years based on the March final water supply forecast and criteria developed for in-season management, but would have to occur at least once in a 3-year period, twice in a 5-year period, and three times in a 7-year period. Maintenance would be done in emergency situations regardless of water conditions, and if during maintenance inspection, critical damage is discovered then the project may be drawn down for maintenance in the following water year regardless of water conditions. If critical damage is discovered then the draw down would extend until the damage is repair which could exceed 60 days. Criteria developed for in-season management decision making will be included in the Technical Management Team (TMT) Water Management Plan. Based on the above listed constraints forced drawdowns would occur in about 5 percent of years, deferred maintenance about 23 percent of years, and routine maintenance operations in about 72 percent of years.

4.1.2.3 Spring Operations, April through June

During the spring season, most of Grand Coulee Dam's authorized purposes come into play as Reclamation operates the facilities for flood control, power generation, spring flow augmentation for fish, and irrigation storage and delivery. During early and mid-spring, Reclamation operates Grand Coulee Dam primarily for flood control, flow augmentation for juvenile salmon and steelhead migration, and power generation; Reclamation then adds irrigation storage and delivery in mid-April. On April 30, Lake Roosevelt is typically at its lowest elevation to maintain adequate space to capture high flows to reduce downstream flooding. The reservoir's minimum pool is at elevation 1208.

If Lake Roosevelt is drafted below elevation 1240, numerous inundated cultural resource sites become exposed and susceptible to damage from wave action, vandalism, and looting. At this elevation, the Keller Ferry dock site must be moved, which adds 12 to 15 minutes travel each way. Also at elevations below 1240 feet, four of the pump/generators are out of service and cannot pump full irrigation demand to Banks Lake. At elevations below 1225 feet, the Inchelium Ferry, an important transportation connection for medical services, can no longer be operated. In the last 10 years, flood control operations have caused this to occur in 2 years (39 days in 1997 and 33 days in 1999), and power emergencies caused this to occur in 1 year (60 days in 2001). When the reservoir elevation approaches elevation 1226, Reclamation tries to avoid drops in elevation during the day that would put the ferry out of service and strand travelers.

As spring flows increase, Reclamation captures some of these flows to help refill the reservoir, and also releases flows to provide flow augmentation to help juvenile salmon and steelhead travel downstream. From April 30 through the end of May, Reclamation may draft Lake Roosevelt to the lower of flood control or elevation 1280 to support Priest Rapids and McNary flow augmentation targets.

Reclamation holds Columbia River water rights for about 2.7 million acre-feet to irrigate over 670,000 acres within the Columbia Basin Project. Reclamation pumps water from the Lake Roosevelt forebay to Banks Lake though six pumps and six pump/generators to supply the project's irrigation water. Lake Roosevelt must be at elevation 1240 by the end of May for the pumping plant to deliver full irrigation demand to Banks Lake. When Lake Roosevelt is below elevation 1240, four of the pump/generators are unavailable to deliver water to Banks Lake; when the lake is below elevation 1233, none of the pump/generators is able to deliver water. In years when the water surface elevation is not high enough to allow sufficient irrigation water delivery from Lake Roosevelt, Reclamation must draft Banks Lake water to meet irrigation demands and then replace this water when Lake Roosevelt is above elevation 1240.

By June 1, Reclamation attempts to have Lake Roosevelt at or about elevation 1265 to benefit the net pen program for rainbow trout, which must be released by this date to avoid diseases associated with warmer water. During the month of June, Reclamation will make releases to support the Priest Rapids and

McNary flow targets for salmon and steelhead. The reservoir is generally refilled by the end of the July 4 holiday weekend. The refill in May and June is generally accomplished to best provide the required flows in the mid-Columbia River.

During spring or early summer in higher water years when required releases exceed the power demand, water has to be spilled (bypass the turbines) at some of the Columbia and Snake River powerplants. A spill priority list has been established to guide operators on how to operate during high flows. Grand Coulee Dam is low on the spill priority list. Above elevation 1260 at Lake Roosevelt, water can be spilled over the spillway, below elevation 1260 water must be spilled through the low-level outlet works. Reclamation tries to avoid spilling water when the reservoir is below elevation 1260 because spilling through the low-level outlet works causes significant gas problems. The Corps is installing flow deflectors at Chief Joseph Dam (to be completed in 2008), the next dam downstream from Grand Coulee, to further reduce the generation of gas at the dam. When this work is completed, Reclamation will transfer as much spill as possible to Chief Joseph Dam when Lake Roosevelt falls below elevation 1260, and Chief Joseph Dam will transfer generation to Grand Coulee. If water must be released through the outlets, then it is released evenly through the upper and lower gates. If only two gates are required, then an upper gate and the lower gate immediately below it will be used (and not two side-by-side gates). Involuntary spill operations typically only occur during flood control operations in the spring and early summer from about April into early July.

When Lake Roosevelt is above elevation 1260, Grand Coulee will spill water evenly across the 11 spillway gates, which can reduce gas up to a certain point.

4.1.2.4 Summer Operations, July through August

During the summer season, Reclamation's operating priorities are irrigation, augmentation for fish, and power generation. In July and August, Reclamation continues to supply irrigation water to Banks Lake for the Columbia Basin Project. In August, Reclamation will reduce pumping to Banks Lake and allow the reservoir to sag 5 feet to elevation 1265.

Reclamation will draft Lake Roosevelt to as low as elevation 1278 to support Priest Rapids and McNary flow augmentation targets. If the July final forecasted runoff volume for the April through August period at The Dalles is less than 92 million acre-feet, the draft limit is elevation 1278; otherwise, the draft limit is elevation 1280. During the summer flow augmentation period, Reclamation will release no more water from Lake Roosevelt than necessary to meet the McNary flow objective.

4.1.2.5 Daily Operations

The above sections describe how Reclamation operates Grand Coulee Dam across months and seasons to meet a variety of authorized purposes. Reclamation's daily operations also show how Reclamation meets the multiple purposes of power generation, safety, and resource protection while shaping flows to benefit anadromous fish.

Reclamation's hourly coordination on regional power generation can cause releases from Grand Coulee to vary widely during the day. The Mid-Columbia projects, Chief Joseph Dam, and Grand Coulee Dam are operated as one system to provide the reliability required to meet the regional power demand. Reclamation also operates Grand Coulee Dam to meet peaking operations so it runs high during heavy load hours and could be shut back to almost no flow during light load hours.

Reclamation limits the draft of Lake Roosevelt to 1.5 feet measured on a rolling 24-hour period to preserve reservoir bank stability. During BPA-declared emergencies, draft rates can be as high as 2 feet per day but only after BPA has clearly demonstrated that all other reasonable actions have been taken to meet the emergency. During these situations, Reclamation requires aerial or ground inspections of the shoreline to determine the potential for landslides.

Grand Coulee Dam also has limits to the minimum tailbay elevation and hourly tailbay drawdown rates to maintain the river banks' stability. The allowable minimum tailbay elevation is the higher of the average tailbay elevation for the previous 24 hours minus 11 feet; the average tailbay elevation for the previous 5 days minus 11 feet; or elevation 951. If either the 24-hour average or the 5-day average exceeds elevation 966 for 5 consecutive days, then 10 feet will be subtracted rather than 11 feet. The tailbay hourly drawdown limit is 5 feet per hour above elevation 962; 4 feet per hour between elevation 957 and 962; 3 feet per hour between elevation 953 and 957, and 2 feet per hour between elevation 951 and 953.

Although there are no flow restrictions at Grand Coulee Dam to reduce gas levels, there are priorities for how the water is released. The first priority is to generate power. If no power is needed, then the second priority is to operate units at speed-no-load. If releases are in excess of the powerplant capacity, then the water is released in the following order:

1. If the water elevation is above 1260 feet, Reclamation releases the water evenly across the 11 spillway gates.
2. If the water surface elevation is below elevation 1260, Reclamation seeks a generation swap with Chief Joseph Dam (as described above). This allows additional generation at Grand Coulee and addition spill from Chief Joseph Dam. This is advantageous because spilling at Chief Joseph Dam generates much less total dissolved gas than spilling through the low-level outlets at Grand Coulee Dam. The Corps is working to install flow deflectors at Chief Joseph Dam (to be completed in 2008) that would further reduce the generation of gas at the dam; when this work is completed, Reclamation will transfer as much spill as possible to Chief Joseph Dam when Lake Roosevelt falls below elevation 1260.
3. If water is to be released through the outlets, then it is released evenly through the upper and lower gates. If only two gates are required, then an upper gate and the lower gate immediately below will be used (and not two side-by-side gates).

4.1.3 Related ESA Consultations

In 2000, the U.S. Fish and Wildlife Service (USFWS) provided a BiOp for FCRPS effects to Columbia Basin bull trout and Kootenai River white sturgeon. The preceding discussion includes measures from this consultation that Reclamation implements to benefit resident listed species.

4.2 HUNGRY HORSE PROJECT

4.2.1 Operation and Maintenance

Reclamation operates and maintains all of the project's major facilities. Operations for the Hungry Horse Project primarily include:

- Storage in and release of water from Hungry Horse Reservoir
- Power generation at the Hungry Horse Powerplant
- Routine maintenance of project facilities.

The following discussion more fully describes the operations of Hungry Horse Dam and its associated facilities. Reclamation also incorporates by reference the standing operating procedures for Hungry

Horse Dam, which more fully describes the physical facilities, operational criteria, and operating thresholds.

4.2.2 Hungry Horse Dam Multiple-Purpose Operations

Congress has authorized Reclamation to operate Hungry Horse Dam for the multiple purposes of irrigation, flood control, navigation, streamflow regulation, hydroelectric generation, and other beneficial uses. Reclamation also operates the dam in coordination with other FCRPS facilities. Not only does Hungry Horse Dam's operating range reflect variability in multiple affecting factors, such as water supply condition, hydroelectric power generation requirements, and flow needs for downstream anadromous and resident fish, but the specific operating purposes also change from month to month and season to season. This section discusses the general operating scheme for the project, by month and season.

4.2.2.1 Fall Operations, September through December

During the fall season, Reclamation has two operating priorities: minimum flows at Columbia Falls for fish and flood control. The Action Agencies propose to implement the Northwest Power and Conservation Council's (NPPC) 2003 mainstem amendments on an interim basis to analyze impacts to both resident and anadromous fish from this operation. After a 3-year study, a decision will be made concerning long-term implementation of the mainstem amendments. Under the mainstem amendments Hungry Horse will be drafted to elevation 3550 feet by the end of September in all but the lowest 20 percent of years; in those 20 percent of years, the reservoir will be drafted to elevation 3540 feet by the end of September. Since implementation of the 2000 USFWS and National Marine Fisheries Service (NMFS) FCRPS BiOps, ramping rates, minimum flows and the need to meet refill dates have limited the power operations at Hungry Horse Dam. In many years, Hungry Horse Reservoir continues to draft throughout the fall to meet minimum flows at Columbia Falls and can be an additional 15 to 20 feet down by the end of December.

To provide local flood protection in wetter falls, the Corps has established flood control criteria for Hungry Horse Reservoir. The reservoir is required not to exceed elevation 3555.7 from October 31 through November 30 and elevation 3549.2 by December 31. Also in wetter years, Hungry Horse can be operated to help meet hydropower operational targets (its portion of the FELCC); however, Reclamation limits any drafts for power to the flood control elevation of 3549.2 by the end of December to maintain a 75 percent probability of being at the URC on April 10.

4.2.2.2 Winter Operations, January through March

During the winter season, Reclamation's operating priorities are flood control, minimum flows for resident listed fish, and power generation. Reclamation generally drafts Hungry Horse Reservoir below the required flood control elevations to meet minimum flow requirements at Columbia Falls for resident listed fish. In water years when minimum flows do not draft the reservoir below the required flood control elevations, there is some flexibility to operate for power generation. The limits to this winter power flexibility are set to provide a 75 percent probability of refilling to the URC on April 10. Hungry Horse operates to the VARQ (which is short for variable flow) flood control rule curves.[5]

During these 3 months, Reclamation releases water while maintaining the reservoir elevation at or between the VDL[6] and the URC. The VDL is set based an assumed inflow volume that has a 75 percent

[5] A FEIS has been completed for the Upper Columbia Alternative Flood Control and Fish Operations, which selected the VARQ operations as the preferred alternative; however, as a Record of Decision (ROD) has not been completed at this time, VARQ will continue to be implemented on an interim basis until such time as a ROD has been signed.

[6] The variable draft limit is a computed end-of-month elevation limit for drafting Hungry Horse Dam for the periods January, February, and March. The VDLs are used to provide winter power flexibility while maintaining a 75 percent probability of achieving refill of the project to its April 10 URC elevation (see April 10 URC definition).

probability of occurrence while still providing the required flows at Columbia Falls. The VDL is calculated each month after the official water supply forecasts and flood control elevations are issued. This winter power flexibility is an important tool that is used to meet the winter power demands in the northwest without affecting minimum fish flows or Reclamation's ability to be at the URC on April 10.

4.2.2.3 Spring Operations, April through June

During early and mid-spring, Reclamation typically operates Hungry Horse Dam for flood control, power operations, and minimum flow requirements. On April 30, Hungry Horse Reservoir is typically at its lowest seasonal elevation in order to capture the high flows from spring runoff and to reduce downstream flooding.

Hungry Horse flood control rule curves are designed for both local and system flood control. For the system flood protection, Reclamation coordinates with the Corps of Engineers on when Hungry Horse Reservoir can begin refill in the spring. The Corps computes the initial control flow at The Dalles and estimates the day that control flow is expected to be reached. When unregulated flows at The Dalles are equal to the initial control flow, the reservoirs can start refill. Hungry Horse Reservoir can actually start refill 10 days prior to the date that the initial control flow is expected to be met.

As spring flows increase, Reclamation no longer needs to make releases to meet minimum flows at Columbia Falls but does have a minimum flow requirement below the project on the South Fork Flathead River. As flows in the mainstem Flathead River increase, Reclamation must balance refill of Hungry Horse while attempting to control flows at Columbia Falls at or below the flood stage of 14 feet (52,000 cfs). At the same time, Reclamation must limit spill (flows that bypass the power plant) from the project in order to maintain total dissolved gas below the State of Montana standard of 110 percent. With the current transmission limit in the valley, this sometimes requires delaying refill to the first week in July when inflows drop below what can be put through the generators either due to unit availability or transmission limitations. Hungry Horse may also be operated to be below the April 30 flood control point so that it can reduce the outflows during refill to prevent spills that would result in total dissolved gas above the limit.

Reclamation typically tries to refill Hungry Horse reservoir by June 30.

4.2.2.3 Summer Operations, July through August

During the summer season, Reclamation's operating priorities are augmentation for fish, and refill for resident fish.

In accordance with the mainstem amendments, Reclamation will draft Hungry Horse Reservoir to as low as elevation 3550 in the top 80 percent of water years and to elevation 3540 feet in the lowest 20 percent of water years to support Priest Rapids and McNary flow augmentation targets. Hungry Horse releases are calculated to either operate at a constant release from July through September or for gradually reduced outflows in an attempt to prevent "double peaking" below the project. As the natural flows recede on the

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The only variable in the computation of the VDLs is the flood control elevations. The basic computation assumes an inflow that has a 75 percent probability of occurring. The volumes needed to meet minimum flows at the project and at Columbia Falls are subtracted from the assumed inflow. The remainder is the volume available for winter power flexibility. The minimum flow required at Columbia Falls is computed based on flows in the Middle and North Forks of the Flathead River that have a 75 percent probability of occurring.

The flood control elevations are computed based on water supply forecasts; however, minimum flow requirements often draft the reservoir below the computed flood control elevation. It is a common misconception that maintaining reservoirs at their flood control elevations in January through March would provide 100 percent probability of achieving refill to the April 10 URC. Modeling has show that there is very little difference in the likelihood of achieving refill to April 10 URC between an operation that limits drafts to URC or minimum flow and an operation that allows a measured draft for winter power flexibility.

mainstem Flathead River, Hungry Horse outflows are set to fill in the recession. Occasionally, Reclamation will not "fill" Hungry Horse but will transition from flood control releases to flow augmentation releases; this prevents dropping outflows to a minimum (900 cfs) to fill then increasing at the start of flow augmentation.

4.2.2.4 Daily Operations

The above sections describe how Reclamation operates Hungry Horse Dam across months and seasons to meet a variety of authorized purposes. Reclamation's daily operations also show how Reclamation meets the multiple purposes of power generation, resident fish operations, and local flood protection.

First, changes in Hungry Horse discharges are limited by ramping rates, as described in the 2000 USFWS FCRPS BiOp and Table 2. These ramping rates are based on flows in the Flathead River at Columbia Falls. These ramping rates protect bull trout and other fish from stranding.

Second, minimum releases set at Hungry Horse are determined by either the flow requirement below Hungry Horse or the flow requirement at Columbia Falls, depending on whichever one is greater. The minimum flows are calculated using the Hungry Horse inflow forecast and guidelines as set forth in the USFWS FCRPS BiOp and Table 3. The minimum flows at Hungry Horse and Columbia Falls are updated every month between January and March after the final inflow volume forecast for the month is issued. The March final forecast sets the minimum flows for the rest of the calendar year.

Table 2. Ramping Rate Guidelines at Hungry Horse Dam

Ramp Up Rates – Hungry Horse dam		
Flow Range (measured at Columbia Falls)	**Ramp Up Unit (Daily Max)**	**Ramp Up Unit (Hourly Max)**
3,500-6,000 cfs	Limit ramp up 1,800 cfs per day	1,000 cfs/hour
>6,000-8,000 cfs	Limit ramp up 1,800 cfs per day	1,000 cfs/hour
>8,000-10,000 cfs	Limit ramp up 3,600 cfs per day	1,800 cfs/hour
>10,000 cfs	No limit	1,800 cfs/hour
Ramp Down Rates		
Flow Range (measured at Columbia Falls)	**Ramp Up Unit (Daily Max)**	**Ramp Up Unit (Hourly Max)**
3,500-6,000 cfs	Limit ramp down to 600 cfs per day	600 cfs/hour
>6,000-8,000cfs	Limit ramp down to 1,000 cfs per day	600 cfs/hour
>8,000-12,000 cfs	Limit ramp down to 2,000 cfs per day	1,000 cfs/hour
>12,000 cfs	Limit ramp down to 5,000 cfs per day	1,800 cfs/hour

Table 3. Minimum Flows

At Hungry Horse Dam	
April through August Forecast	Minimum flow
>1,790 thousand acre feet (KAF)	900 cfs
<1,190 KAF	400 cfs
Between 1,190 KAF and 1,790 KAF	Linearly interpolated between 400 and 900 cfs
At Columbia Falls	
April through August Forecast	Minimum flow
>1,790 thousand acre feet (KAF)	3,500 cfs
<1,190 KAF	3,200 cfs
Between 1,190 KAF and 1,790 KAF	Linearly interpolated between 3,200 and 3,500 cfs.

Third, local flood control affects the daily operations at Hungry Horse. When flood control is required in the Flathead River above Flathead Lake, Hungry Horse Dam releases will be reduced to prevent the Flathead River at Columbia Falls from exceeding a stage of 14.0 feet (the official flood stage from the National Weather Service). Also, the zero damage level (level at which flood damages begin to occur) is listed at 14.0 feet in the Hungry Horse Dam Water Control Manual (Corps 2005). The outflow from Hungry Horse Reservoir should not exceed 300 cfs when the river stage is at or above 14.0 feet, or when a greater outflow would cause the river to rise above 14.0 feet at Columbia Falls.

There may be instances when Hungry Horse Dam has enough space to control the stage at Columbia Falls to below 14.0 feet. In those cases, reservoir operators will adjust outflows from Hungry Horse Dam as necessary (to a minimum discharge of 300 cfs) in order to maintain the Flathead River at Columbia Falls to a lower stage (generally starting at around 13.0 feet). The ability to control flows at Columbia Falls between 13 and 14 feet is dependent upon volume of runoff remaining, timing of flows, space remaining in the reservoir, and flows in the North and Middle Forks of the Flathead River.

4.2.3 Related ESA Consultations

In 2000, the USFWS provided a BiOp for FCRPS effects to Columbia Basin bull trout and Kootenai River white sturgeon. This action includes measures from this consultation (which include the minimum flows and ramp rates listed above) that Reclamation implements to benefit resident listed species.

REFERENCES

Corps (U.S. Army Corps of Engineers). 2005. Hungry Horse Dam and Reservoir Water Control Manual (Table 4-10 and Chart 4-6). Seattle District. June.

Appendix B—Description of the Proposed Reasonable and Prudent Alternative
Section B.1—Operations for Flood Control, Irrigation, Navigation, and Power Generation and Transmission

Attachment B.1-5
U.S. Army Corps of Engineers Storage Projects

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ACRONYMS AND ABBREVIATIONS

BiOp	biological opinion
BPA	Bonneville Power Administration
Cfs	cubic feet per second
Corps	U.S. Army Corps of Engineers
CRT	Columbia River Treaty
FCRPS	Federal Columbia River Power System
ICF	Initial Control Flow
IDFG	Idaho Department of Fish and Game
IJC	International Joint Commission
Kcfs	thousand cubic feet per second
MCE	minimum control elevation
MFWP	Montana Department of Fish, Wildlife, and Parks
MOA	Memorandum of Understanding
Msl	mean sea level
MW	megawatt
NGVD	National Geodetic Vertical Datum
NMFS	National Marine Fisheries Service
RCC	Reservoir Control Center
RM	river mile
TMT	Technical Management Team
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
VARQ	variable discharge

1. GENERAL DESCRIPTION

The U.S. Army Corps of Engineers (Corps) operates three storage projects that function as part of the Federal Columbia River Power System (FCRPS). These three projects are Libby Dam, Dworshak Dam, and Albeni Falls Dam.

Libby Dam is located on the Kootenai River at river mile (RM) 221.9 in Lincoln County in northwestern Montana. The project is about 15 miles northeast of Libby, Montana. Lake Koocanusa, Libby Dam's reservoir, is about 90 miles long and extends about 42 miles into Canada. The dam regulates stream flow for 17 downstream hydroelectric projects in the United States and Canada.

Dworshak Dam is located at RM 1.9 on the North Fork Clearwater River, near Ashaka in Clearwater County, Idaho. The Dworshak project has a watershed of approximately 2,440 square miles and provides flood damage reduction for the Snake and Columbia River basins. The reservoir formed by the dam (Dworshak Reservoir) extends 53.6 miles upstream.

Albeni Falls Dam is located within the Pend Oreille Subbasin, Pend Oreille Basin, tributary to Columbia River, in Bonner County, Idaho, 2.5 miles east of Newport, Washington, and 50 miles northeast of Spokane, Washington. The dam is located at stream mile 90, above the mouth of the Pend Oreille River. Lake Pend Oreille, the lake formed by the dam, is 68 miles long and one of the largest and deepest lakes in the western United States. The dam regulates stream flow for 15 downstream Federal and non-Federal hydroelectric projects

2. AUTHORIZATION

Construction of the Libby Dam Project for hydroelectric power, flood control, navigation, and recreation was authorized by the Flood Control Act of 1950 (Public Law 81-516, 81st Congress, 2nd Session) in accordance with a plan set forth in House Doc 531, 81st Congress, 2nd Session. The dam was constructed in accordance with the Columbia River Treaty between the United States and Canada. Recreation was authorized in the Flood Control Act of 1944, Section 4 (Public Law 78-534). Fish and wildlife enhancement was authorized by Public Law 85-624, and water quality was authorized by Public Law 92-500.

Construction of Dworshak Dam for the purposes of flood control was authorized under Public Law 85-500, Public Law 87-874, and Public Law 78-534. Hydroelectric power, recreation, and navigation were authorized under Public Law 87-874. The additional purpose of fish and wildlife enhancement was authorized under Public Law 87-874 and Public Law 85-624, and water quality was authorized under Public Law 92-500.

Construction of the Albeni Falls multipurpose dam and powerhouse was authorized by the Flood Control Act of 1950 (Public Law 81-516, 81st Congress, 2nd Session). Flood control, hydroelectric power, and navigation are authorized under Public Law 81-516. Recreation was authorized in the Flood Control Act of 1944, Section 4 (Public Law 78-534). Water quality and fish and wildlife enhancement were authorized under Public Law 92-500 and Public Law 85-624, respectively.

3. AUTHORIZED PURPOSES

The Libby Dam Project has multiple purposes. Operating purposes include flood control, hydroelectric power generation, recreation, and navigation, as well as enhancement for fish and wildlife. Libby Dam also provides flood control storage for 17 downstream hydroelectric projects in the United States and Canada.

The authorized uses of Dworshak Project are flood damage reduction, power generation, navigation, fish and wildlife, and recreation. The project operates as a storage project to protect downstream areas from flood damage.

Albeni Falls Dam is operated for the multiple purposes of power generation, navigation, recreation, flood control, and fish and wildlife conservation. Its operation primarily benefits flood control of Lake Pend Oreille, power generation, and regulation of streamflow for 15 downstream Federal and non-Federal hydroelectric projects.

Summary information is presented for the three projects in Table 1.

Table 1. Corps Storage Projects Summary Information

Facility	Type of Facility	Year Completed	River	River Mile	Reservoir Name	Useable Reservoir Capacity (million acre feet)
Libby	Storage	1977[1/]	Kootenai	221.9	Lake Koocanusa	4.9
Dworshak	Storage	1973	North Fork Clearwater	1.9	Dworshak Reservoir	2.0
Albeni Falls	Storage	1955	Pend Oreille	90	Lake Pend Oreille	1.2

[1/] Flood control operations were initiated in 1972, power generation came online in 1975. Four generators were completed in 1977, with a fifth unit completed in 1984.

3.1 LIBBY DAM

Construction of Libby Dam began in 1966 and flood control operations began in 1972. Power generation came on line in 1975 and initial powerhouse construction with four generators (with Francis-type turbines) was completed in 1977. A fifth unit was completed and put on line in 1984. The powerhouse was built to accept eight units and the remaining three units are partially installed but not currently operational.

Libby Dam is a concrete gravity dam with 47 monoliths, a total length of 2,887 feet, and a maximum height of 432 feet from bedrock to the roadway deck at the top of the dam. The elevation of the roadway deck is 2472 feet elevation above mean sea level (msl).

The powerhouse contains eight unit bays, with operable units in the five bays closest to the right bank. Each generator unit has a 120-megawatt (MW) capacity. The routine electrical generating capacity at Libby Dam is 600 MW, under optimal head conditions. A multiple-bulkhead intake system permits selective withdrawal of water from the reservoir above elevation 2222 feet above msl. The selective withdrawal system helps regulate water temperature of powerhouse releases. The system consists of a concrete housing for bulkheads and guides attached to the upstream side of the dam over the penstock intakes. Each guide accommodates up to 22 10-foot-high steel bulkheads, which allows withdrawal of water from the reservoir as high as elevation 2442 feet above msl.

The dam includes a spillway with two bays and two spillway tainter gates; the spillway crest elevation is 2405 feet above msl. A sluice outlet system includes three sluices individually regulated by separate tainter gates. The sluices have an intake invert at elevation 2201.5 feet above msl and empty into the spillway stilling basin. The stilling basin is a conventional hydraulic-jump type which provides energy dissipation for both sluice and spillway flow. The stilling basin is defined by training walls leading from the spillway and has a width of 116 feet, a length of 275 feet, and a floor elevation of 2073 feet above msl.

Lake Koocanusa, Libby Dam's reservoir, is about 90 miles long and extends about 42 miles into Canada. Normal full pool and minimum reservoir elevations are 2459 feet above msl and 2287 feet above msl, respectively. The maximum water surface elevation of Lake Koocanusa permitted by the Columbia River Treaty is 2459 feet above msl. Lake Koocanusa has 4.9 million acre-feet of usable storage for local (i.e. primarily along the Kootenai River near Bonners Ferry, Idaho) and system flood control (i.e. primarily along the lower Columbia River near Portland, Oregon). At full pool, the reservoir area is 46,456 acres (with about 62 percent of the acreage in the United States).

The majority of public recreation facilities associated with the Libby Dam Project are administered by the U.S. Department of Agriculture Forest Service (USFS) under a Memorandum of Agreement. The Corps and USFS operate and maintain 11 campgrounds and 13 boat launches on the U.S. side of the lake. The Corps administers the recreation area on Lake Koocanusa by Libby Dam, as well as some small recreation areas downstream from the dam on the Kootenai River. The Canadian portion of Lake Koocanusa is administered by British Columbia Parks, Ministry of Forestry, and private Canadian citizens.

The Libby Dam Project also includes the Murray Springs Fish Hatchery, built in 1978, which mitigates project-related fishery losses in the Kootenai River. The Montana Department of Fish, Wildlife, and Parks (MFWP) operates and maintains the hatchery under contract with the Corps.

3.2 DWORSHAK DAM AND RESERVOIR

The Dworshak Project was placed into service in March 1973. It has a watershed of approximately 2,440 square miles and provides flood damage reduction for the Snake and Columbia River basins. The hydraulic height of the dam is 632 feet at full pool. The dam has a crest length of 3,287 feet, and a maximum base width of 574 feet. The spillway is located on the left side of the dam, extends down the front of the dam and consists of a concrete chute with two tainter gates. Two low-level regulating outlets provide spill discharge at lower lake levels. The reservoir elevations range from 1,600 feet National Geodetic Vertical Datum 29 (NGVD29) at full pool and 1445 feet NGVD29 at minimum pool elevation.

Dworshak Dam is equipped with a turbine water intake structure that has selector gates for selective withdrawal of water from various levels of the lake to provide temperature control of released water. The powerhouse encloses two 90-MW generating units and one 220-MW generating unit. Vacant generator spaces and penstocks adjacent to the powerhouse are provided for the possible installation of three additional generating units.

The reservoir at Dworshak, known as Dworshak Reservoir, extends 53.6 miles upstream to RM 55.5 when the reservoir is at full pool at elevation 1600 feet NGVD29. The water surface area is 16,417 acres at full pool elevation of 1600 feet NGVD29 and 9,050 at minimum pool elevation of 1,445 NGVD29. The reservoir has a shoreline length of 175 miles at full pool. When full, the reservoir contains 3,453,000 acre-feet of water. The difference between full and minimum operating pool levels provide 2,000,000 acre-feet of usable water storage for flood damage reduction and/or power generation.

There are no fish passage facilities at Dworshak Dam and migrations of anadromous fish are blocked by the dam. Dworshak National Fish Hatchery was constructed as mitigation for the dam and is located downstream of the dam on the left bank at the confluence of the North Fork Clearwater River and the Clearwater River. The water supply for the hatchery is provided by pumps on the North Fork Clearwater River and water temperatures for the hatchery are set by using the selector gates on the turbine intakes to control the temperature of water released from the dam.

There are 29,318 acres of fee-owned project lands surrounding Dworshak Reservoir. The majority of the Corps-managed lands are used for public recreation, wildlife habitat, wildlife mitigation, and project structures. There are 14 developed recreation areas and 121 boat access mini-camps around Dworshak Reservoir. Two camping areas are licensed to the Idaho Department of Parks and Recreation and operated as Dworshak State Park. A total of 5,033 acres are managed for mitigation for elk wintering habitat and an additional 4,541 acres are managed specifically for wildlife. Other project acreages are managed under environmental stewardship principles for wildlife habitat and other environmental concerns.

3.3 ALBENI FALLS DAM

Albeni Falls Dam is constructed on the granite rock outcropping that formed the original Albeni Falls. The dam and spillway are embedded and tied into the granite rock and the surface rock is cut and shaped to provide an improved natural tailrace for the spillway and powerhouse discharge.

Albeni Falls Dam was placed in operation in 1955. Albeni Falls Dam is a concrete gravity, gate-controlled structure with a submerged spillway 472 feet long, and a net opening of 400 feet. The overall length, including the non-overflow abutment section, is 755 feet. The height is 90 feet, with a crest elevation of 2033 feet above msl. The elevation at the top of the gates is 2065 feet above msl, while the elevation at the top of the operating deck is 2097 feet above msl. The spillway has 10 caterpillar two-leaf vertical lift gates with dimensions of 40 by 32 feet. Ten spillway gates are the vertical lift roller-chain type.

Lake Pend Oreille is one of the largest (94,600 acres) and deepest (1,237 feet) lakes in the western United States. The reservoir is 68 miles long, with a maximum width of 6.5 miles and an average depth of 545 feet. The Clark Fork River, emptying into the northeast corner of the lake, is the largest tributary, contributing about 85 percent of the input. The drainage area above the dam site is 24,200 square miles. Two other major tributaries, the Pack River and Priest River, enter from the north.

The powerhouse is 206 feet wide and 301 feet long, with three Kaplan turbines, each with a rated capacity of 19,600 horsepower at 22-foot head. Total powerplant rated nameplate capacity is 42.6 MW, with an annual production of approximately 200,000 megawatt-hours. In case of a commercial power outage, a 350-kilowatt (kW) diesel-electric generator provides emergency power for operating the spillway crane, operation of pumps to prevent flooding in the powerhouse, and other critical loads.

The spillway structure contains 10 bays and 10 roller train, vertical lift, span type gates. The spillway crest elevation is 2033 feet (msl). The project can safely pass 350,000 cubic feet per second (cfs) with the spillway gates in their fully open position. At higher flows (flows above 350,000 cfs) the spillway gates are generally removed from the spillway to minimize flow restriction, and reduce pressure against the spillway structure. Spillway capacity is 420,000 cfs at elevation 2097 feet, the top-of-dam elevation. The structurally safe spillway discharge is estimated to be about 500,000 cfs at a forebay elevation of 2106 feet. There are no sluiceways.

The Corps has real estate interests in approximately 18,627 acres surrounding Lake Pend Oreille, of which approximately 14,390 acres are in the form of flowage easements and withdrawn lands from other Federal agencies. The remaining 4,237 acres are held in fee for authorized purposes including recreation, project operations, and wildlife conservation (approximately 4,000 acres are in wildlife license).

4. PROJECT ACTIVITIES

Project activities for each authorized purpose at the Corps storage projects are described in the following subsections.

4.1 FLOOD DAMAGE REDUCTION

4.1.1 Libby Dam

Libby Dam operations provide local and system flood damage reduction through regulation of spring flows in the Kootenai River valley and the mainstem Columbia River. Currently, Libby Dam is operated consistent with variable discharge (or VARQ) flood control procedures. Libby Dam operations also follow a variable end of December flood control rule curve based on the runoff forecast. Libby Dam operations for flood damage reduction are consistent with the requirements of the Columbia River Treaty (CRT) and the International Joint Commission (IJC) Order of 1938 on Kootenay Lake.

During flood season, Corps reservoir regulators operate Libby Dam for system flood damage reduction and to minimize flood impacts by trying not to exceed river stages in excess of elevation 1764 feet at Bonners Ferry, Idaho. Control of runoff during wet years relies on a combination of storage space in Canadian and U.S. storage reservoirs that is provided under the CRT together with the protection afforded by levees.

During the winter, the water level in the reservoir is drawn down or drafted based on the April-August seasonal water supply forecast. The higher the water supply forecast, the deeper the reservoir draft. The amount of draft is determined by the storage reservation diagram that is developed for the specific flood control strategy, in this case VARQ flood control.

In practice, there may be some occasions where the actual reservoir elevations may be higher than the flood control rule curve. For example, high runoff events during the winter due to rainfall or warm periods may require a dam to reduce outflows to moderate downstream river flows, resulting in an increase in reservoir elevation. After the end of the runoff event, the water that was stored during the runoff event would be released in an attempt to bring the reservoir back to the elevation defined by the flood control rule curve.

Refill of Libby Dam commences in the spring 10 days before unregulated flow of Initial Control Flow (ICF) on the Columbia River at The Dalles, Oregon, is forecasted to reach that year's initial controlled flow.[1] Once refill begins, outflows during the refill period under VARQ flood control procedures are

[1] The controlled flow is the target flow for lower Columbia River flood control as measured at The Dalles, Oregon, and is a function of the projected volume of the Columbia River spring runoff as measured at The Dalles, Oregon, and the amount of upstream storage space that is available for system flood control. Storage in reservoirs to meet the controlled flow will generally result in adequate control at other flood damage areas in Canada and the United States. Refill of upstream reservoir storage is regulated in a manner that provides the desired controlled flow at The Dalles. The initial controlled flow is the first controlled flow determined for the runoff season. The initial controlled flow is used in conjunction with unregulated streamflow forecasts to guide the determination of when to begin refill of reservoirs (Corps 2003).

calculated using the April to August water supply forecast and the duration of the refill period. The level of the reservoir in relation to the flood control rule curve on the refill start date is factored into the outflow calculation. In subsequent calculations, the outflow calculation also considers adjustments to compensate for previous dam outflows that may have been higher or lower than the flow that should have been released, based on the most recent information (e.g., revised forecasts or different than anticipated flows). Flow releases for Kootenai River white sturgeon typically occur during the refill period, as discussed in Section 4.5.1.1. The target is to refill the reservoir by around early July each year, but outflows may be increased during the final stages of refill, potentially delaying refill, in order to reduce the risk of overfilling and unwanted spill.

Managing this large river system has many complexities and uncertainties, requiring the Corps to exercise its best professional judgment in making flood control decisions. Each day, the Corps examines the available information and develops management strategies to meet the multi-purpose uses of the system and individual reservoirs. The strategies must take into account the near-term (3 days) conditions, but must also be consistent with longer-range objectives of the next several months. Adjustment by water managers of operations made in response to changing conditions and new information is called “adaptive management.”

4.1.2 Dworshak Dam

Dworshak Dam and Reservoir provide flood damage reduction for the Snake and Columbia River basins. Dworshak Reservoir has a water surface area of 16,417 acres when the reservoir is at full pool and 9,050 acres at minimum pool. The difference between full and minimum operating pool levels provide 2,000,000 acre-feet of usable water storage for local and regional flood control.

The fixed (same every year) end-of-December flood control elevation at Dworshak Dam is 1,558 feet above msl. In January, February, March, and April monthly volume forecasts dictate end-of-month flood control elevations. Starting 1 day before The Dalles is estimated to reach the unregulated Initial Control Flow, the project starts to refill. Refill continues in a controlled manner and reaches full about the end of June. Refill considers requests from the Technical Management Team (TMT) for fish, including shifting flood control from Dworshak to Grand Coulee and releasing water for fish in May and June to facilitate fish movement.

4.1.3 Albeni Falls Dam

Flood damage reduction benefits of the Albeni Falls project are realized by lowering the maximum stage of Lake Pend Oreille for peak floods between the 80,000 cfs to 220,000 cfs range. During major spring floods, the lake may exceed normal full pool (2062.5 feet) because of the flood volume and limited lake outlet capacity.

The normal full pool of 2062.5 feet is occasionally exceeded during large floods. This has resulted in Federal purchase of flowage easements loosely tied to the 2067.5 above msl contour to reduce flood impacts to the railroad causeway skirting the lake’s north shore and residential, recreation, and commercial facilities along the lakeshore.

The channel reach downstream from Albeni Falls Dam to Box Canyon Dam serves as the reservoir for Box Canyon Dam and reservoir depths in the reservoir reach are primarily due to operations at Box Canyon Dam.

Maximum hourly change in discharge at Albeni Falls Dam is 5,000 cfs. Maximum change in average daily discharge at Albeni Falls Dam in any 24-hour period is 10,000 cfs. Changes in discharge exceeding

10,000 cfs during the 24-hour period are permitted provided subsequent discharge reductions reduce the average 24-hour change to the maximum specified rate, and the maximum hourly discharge limit and maximum tailwater criteria are observed.

Maximum discharge and tailwater reduction rates are used during a flood recession to limit downstream bank sloughing and erosion. The Pend Oreille River below Albeni Falls Dam can accommodate minor floods with incidental erosion and bank sloughing. During major floods, channel banks saturated by weeks of high runoff are susceptible to significant erosion and sloughing if the recession is too abrupt. During the spring runoff, the Corps' Northwestern Division Reservoir Control Center (RCC) will coordinate frequently with Albeni Falls Dam and projects on the upper Clark Fork River to assure that the lake is refilled in a controlled manner that precludes sudden streamflow decreases below the lake (as much as possible). If the lake begins to recede too rapidly to comply with the required project stage-discharge criteria, Albeni Falls Dam will immediately coordinate and take corrective measures to help stabilize the lake level and discharge.

4.2 HYDROPOWER

4.2.1 Libby Dam

Libby Dam has five generating units. Each generating unit has a 120-MW capacity and Libby Dam has a routine electrical generating capacity of 600 MW, under optimal head conditions. A multiple-bulkhead intake system permits selective withdrawal of water from the reservoir above elevation 2222 feet above msl.

4.2.1.1 Hydropower Operations

Turbine units are operated to meet the electrical needs of the region, depending on river flows. Over the last several years, peak generation has occurred in May/June during sturgeon flows and August during salmon flows. Additionally, peak generation can occur in December as the project drafts to target elevation 2411 feet above msl or the end of December target established for the year, and during cold snap periods in January and February. Normally all turbine units are made available for spring operations to pass high flows and winter periods when very cold weather may result emergency generation requirements. To the extent possible, hydropower operations would avoid drafting Lake Koocanusa below the flood control rule curve during the drawdown season.

4.2.1.2 Hydropower Maintenance

For the last 10 years, Libby Dam annual unit maintenance and outages for equipment upgrades and change-outs usually occurred during the low load periods. Those periods have been the low load months of September, October, November, and sometimes March and April. Scheduling around these low load months helps meet flow and generation needs during cold snaps in the winter as well as for sturgeon and salmon flows in May, June, July, and August.

4.2.2 Dworshak Dam

Dworshak Dam has three generating units, two smaller units at 90 MW and one large unit at 220 MW. Water is supplied to the turbine units via penstocks. The top of the penstock inlets in the dam are at elevation 1,421 feet NGVD29, 179 feet below full pool. The penstocks have an intake structure with adjustable gates for selective withdrawal of water from various levels of the reservoir to provide control of outlet water temperatures. The selector gates are attached to hoists and can be operated remotely from the powerhouse control room.

4.2.2.1 Hydropower Operations

Turbine units are operated to meet the electrical needs of the region and to meet project discharge requirements. Peak electrical use in the region typically occurs in the winter months (December to February). However, peak hydropower generation typically occurs in the spring (May and June) during the snowmelt freshet. Discharges from Dworshak, however, are regulated to meet Snake River flow augmentation and flood damage reduction requirements for the project and may differ from regional power requirements. Dworshak consequently has long periods of time when the powerhouse is operated at minimum discharge to retain water for these other uses.

Due to the great depth of Dworshak Reservoir, water temperatures vary greatly depending on the time of the year. In summer, the surface water is much warmer than water at depth. Selector gates on the penstock intakes are used to control the temperature of water released through the powerhouse.

4.2.2.2 Hydropower Maintenance

Annual outages for maintenance and testing of turbine units and related equipment are normally scheduled for seasonal time periods when the project is not expected to increase flows to meet flow augmentation, flood damage reduction operations, or emergency winter power needs. Annual outage schedules are prepared each winter and coordinated with the region. Schedules detail outages for each turbine unit for testing and maintenance of turbine units and/or related equipment. Schedules are updated throughout the year as required to reflect maintenance requirements and are provided to the RCC for regional coordination through the TMT.

4.2.3 Albeni Falls Dam

Albeni Falls Dam has three generating units. Each generating unit has a 14.2-MW capacity and total powerplant capacity is 42.6 MW, with an annual production of approximately 200,000 megawatt-hours.

4.2.3.1 Hydropower Operations

Maximum powerloads occur during the winter while maximum unregulated hydroelectric potential occurs during the spring snowmelt runoff. Albeni Falls Dam is operated to meet the maximum electric demand in spring and store excess spring runoff to augment flows during the fall to help protect kokanee spawning. This is managed with regional planning, coordination, and scheduling to assure that all water is used for on-site and downstream hydropower except in very rare instances.

Albeni Falls Dam hydraulic capacity ranges from 4,000 cfs up to the maximum powerhouse capacity of 35,000 cfs. Except during flood periods, the powerhouse discharge is normally used to maintain the Lake elevations, discharge, and rate-of-change requirements. During the spring runoff forebay drawdown and high tailwater may reduce the powerplant hydraulic head below 8 feet, the minimum head for power generation. The powerhouse generation is then curtailed, often for days or weeks, until the runoff has receded.

Powerhouse generation is normally scheduled by the Albeni Falls Dam powerhouse operator based on actual or coordinated outflow conditions. The powerhouse status is reported hourly to the Bonneville Power Administration (BPA).

4.2.3.2 Hydropower Maintenance

Routine maintenance activities are scheduled around management of flows for flood control and kokanee spawning.

4.3 NAVIGATION

Navigation is an authorized purpose for Libby Dam.

Dworshak was authorized for navigation primarily for commercial floating and downstream transportation of logs. Log dump facilities were constructed for these activities at several locations around the reservoir and log storage and handling facilities were constructed near the dam. Due to increased costs for transporting logs via water and lack of interest by the logging community, log handling facilities have been removed.

Albeni Falls Dam does not have a navigation lock, so there is no traditional navigation. However, water levels on the lake are generally controlled for navigation purposes.

4.4 RECREATION

4.4.1 Libby Dam

Recreation facilities provide both water-based and land-based recreational opportunities. Water-based recreation opportunities include primarily boating, fishing, swimming, and sightseeing. Boat launching ramps, swim beaches, marinas, and other facilities have been developed to support these activities. The Corps, the USFS, and private enterprises operate a mix of recreational facilities associated with the reservoir and river. Land-based activities such as picnicking, camping, hunting, and hiking take place at facilities along the reservoir. Park and campground areas contain lawns with irrigation and domestic water supplied by wells. Camping and utilities are provided for fee at some facilities during the spring and summer.

4.4.2 Dworshak Dam

There are 14 developed recreation sites and 121 boat access only mini-camp sites adjacent to Dworshak Dam and the reservoir. The mini-camp sites are scattered along both sides of the lake for its entire length. Nearly all of these recreation sites provide recreational opportunities that either depend on water or are enhanced by the proximity of water.

Recreation facilities provide both water-based and land-based recreational opportunities. Water-based recreation opportunities include primarily boating, water skiing, fishing, sightseeing, and swimming. Boat launching ramps, swim beaches, a marina, destination docks, floating restrooms and other facilities have been developed to support these activities. Land-based activities such as picnicking, camping, hunting, and hiking take place at facilities along the reservoir. Park and campground areas contain lawns with irrigation and domestic water supplied by wells. In general, project lands and some facilities are open for these activities year round. Some parks may close during the winter. Full-service camping and utilities are provided for fee at some facilities during the spring and summer. Mini-camps provide boat access camping areas around the reservoir. These sites are usable by the public when the reservoir is within 30 feet of full pool, from elevation 1,570 to 1,600 feet NGVD29.

4.4.3 Albeni Falls Dam

The Corps administers four campgrounds on Lake Pend Oreille. The Corps also administers two day-use recreation areas along the Pend Oreille River and Lake Pend Oreille. Four access areas on Corps lands are administered under license by Idaho Department of Fish and Game (IDFG). Other facilities along the reservoir are operated by the USFS, IDFG, city and county agencies, and the private sector. Recreation facilities provide both water-based and land-based recreational opportunities. Water-based recreation opportunities include primarily boating, fishing, swimming, and sightseeing. Boat launching ramps, swim beaches, marinas, and other facilities have been developed to support these activities. The Corps, the USFS, and private enterprises operate a mix of recreational facilities associated with the reservoir and river. Land-based activities such as picnicking, camping, hunting, and hiking take place at facilities along the reservoir.

4.5 FISH AND WILDLIFE

4.5.1 Fish Management

4.5.1.1 Libby Dam

Libby Dam provides benefits for fish through flow augmentation and specified ramping rates. Flow regulation for fish is consistent with recommendations in the current the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) Biological Opinions (BiOps).

Libby Dam maintains a year-round instantaneous minimum flow of 4,000 cfs whenever possible. From May 15 through September 30, minimum releases range from 6,000 to 9,000 cfs, based on the April through August seasonal water supply forecast (Table 2).

Table 2. Tiered Bull Trout Minimum Flows at Libby Dam

April to August Water Supply Forecast (million acre-feet)	Minimum Bull Trout Flows From May 15 to September 30 (kcfs)
0 < forecast < 4.8	6
4.8< forecast < 6.0	7
6.0 < forecast < 6.7	8
6.7 < forecast	9

In the spring, the Corps operates Libby Dam to augment flows for benefit of listed Kootenai River white sturgeon. Each year the Corps stores and is prepared to supply, at minimum, water volumes based upon water availability or a “tiered” approach as defined in Figure 1. This water is available for use in May, June, and July, and is measured as a volume out of Libby Dam above a minimum flow of 4,000 cfs. Accounting of the total tiered volumes occurs according to the experimental hydrograph plan outline

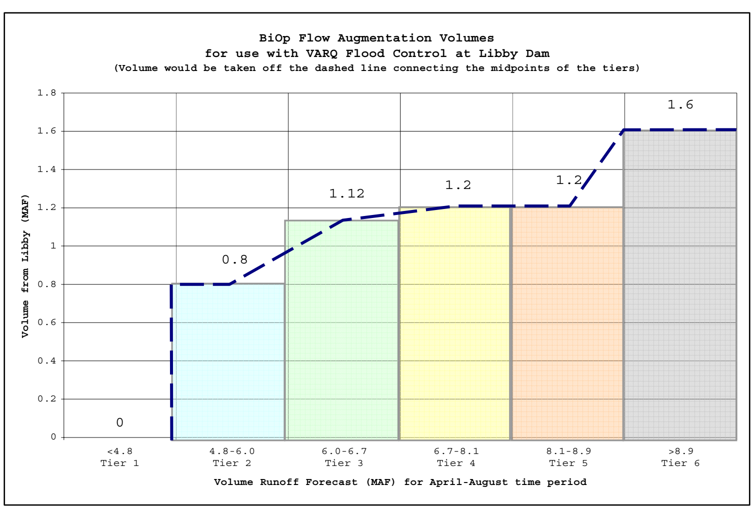

Figure 1. Minimum Sturgeon Flow Augmentation Volumes from Libby Dam

(MFWP et al. 2006). Actual flow releases are shaped based on seasonal requests from the USFWS and in coordination with the TMT. Use of this water is subject to flood control constraints, including the Bonners Ferry 1,764 feet flood stage, the requirements of the IJC 1938 Order on Kootenay Lake, and water quality, specifically total dissolved gas supersaturation.

During July and August, the Corps operates Libby Dam to provide flows for salmon and steelhead in the Columbia River. The Corps manages Libby Dam to refill Lake Koocanusa to elevation 2459 feet above msl (full pool) by early July. Refill later than June 30 may be necessary to avoid filling the reservoir before reservoir inflows drop below powerhouse capacity releases. Currently, after refill, the Corps releases water from Libby to augment Columbia River flows for salmon from Libby Dam, with a draft limit elevation of 2439 feet above msl (20 feet from full pool) by August 31. A draft of 20 feet from full pool provides up to 891,000 acre-feet of additional water from Lake Koocanusa.[2] In any given year, the timing and magnitude of the summer drafts for salmon at Hungry Horse and Libby dams are coordinated through the in-season management process (TMT). This Proposed RPA includes adjustments based on the Northwest Power and Conservation Council's 2003 Mainstem Amendments as described in Section B.2.1.

In addition to the summer flow augmentation, Libby Dam operates using a variable end-of-December draft point that is intended to allow Lake Koocanusa to remain fuller at the end of December in order to provide an increased likelihood of having augmentation water available the following spring and summer for sturgeon and salmon flows. The end-of-December elevation will vary between elevation 2411 and 2426.7 feet above msl depending on the December water supply forecast for the April to August runoff. Targeting a December 31 reservoir elevation higher than 2411 feet above msl would occur in years where the December forecast for seasonal water supply is less than 5.9 million acre-feet.

In recent years, Libby Dam operations in November, December, and January have also considered requests to maintain low flows, release water temperatures as low as possible, or both, for benefit of burbot migration and spawning in the lower Kootenai River in Idaho. Requests for burbot operations are coordinated through the TMT process.

Year-round, Libby Dam operations follow ramping rate guidelines[3] to minimize adverse effects of rapid flow fluctuations on aquatic biota and river shorelines.

Table 3 contains the current ramping rate guidelines at Libby Dam. Daily or weekly load shaping at Libby Dam would be avoided during the more biologically productive late spring, summer, and early fall but may occur in the late fall or winter.

[2] In some years, the salmon draft at Lake Koocanusa may be reduced, with the Lake Koocanusa water exchanged with water from Canadian reservoirs under the Libby Coordination Agreement.

[3] The recommended ramp rates are followed except if the recommended ramp rate causes the unit(s) to operate in the rough zone, a zone of chaotic flow in which all parts of a unit are subject to increased vibration and cavitation that could result in premature wear or failure of the units. In this case the project will utilize a ramp rate that allows all units to operate outside the rough zone. Ramping rates are followed to the extent possible with possible exceptions during flood control operations, power emergencies, and fish flow operations.

Table 3. Ramping Rate Guidelines at Libby Dam

	Dam Outflow Interval	Max. Hourly Rate (cfs)	Max. Daily Rate
October 1 - April 30			
Ramp Up	4-6 kcfs	2,000	1 unit
	6-9 kcfs	2,000	1 unit
	9-16 kcfs	3,500	2 units
	>16 kcfs	7,000	2 units
Ramp Down	4-6 kcfs	500	1,000 cfs
	6-9 kcfs	500	2,500 cfs
	9-16 kcfs	1,000	1 unit
	>16 kcfs	3,500	1 unit
May 1 - September 30			
	Dam Outflow Interval	Max. Hourly Rate (cfs)	Max. Daily Rate
Ramp Up	4-6 kcfs	2,500	1 unit
	6-9 kcfs	2,500	1 unit
	9-16 kcfs	2,500	2 units
	>16 kcfs	5,000	2 units
Ramp Down	4-6 kcfs	500	500 cfs
	6-9 kcfs	500	1,000 cfs
	9-16 kcfs	1,000	2,000 cfs
	>16 kcfs	3,500	1 unit

4.5.1.2 Dworshak Dam

Dworshak Dam blocked anadromous fish passage (steelhead) in the North Fork Clearwater River. The Corps constructed Dworshak National Fish Hatchery as mitigation for the anadromous and resident fisheries. The hatchery is operated and maintained by the USFWS with funding provided by the Corps. The water for operating the hatchery is pumped from the North Fork Clearwater River at the hatchery site. The Dworshak Project tries to regulate the temperature of released water for optimum hatchery operations. Releasing optimum water temperatures for the hatchery is impacted during the summer as the primary emphasis on dam releases are for Snake River flow and temperature augmentation to meet biological opinion requirements. Each spring juvenile steelhead are released directly from the hatchery and from selected locations in the Clearwater River Basin. The Corps trucks the outplanted fish to these other locations each spring. The resident sport fishery in the reservoir is provided primarily by self sustaining kokanee and smallmouth bass fisheries. Some rainbow trout are stocked in the reservoir annually.

4.5.1.3 Albeni Falls Dam

Kokanee (a small, land-locked variety of sockeye salmon) exist in Lake Pend Oreille, and spawn in lakeshore gravels as well as in tributary streams. There is evidence they constitute an important forage species for bull trout, which is listed as threatened in the Columbia River Basin. According to the IDFG, kokanee have declined since the 1960s, as a result of autumn drafting below the elevations where most of the clean gravels exist.

Clean spawning gravel is key to rebuilding the kokanee population in Lake Pend Oreille, which, in turn, is an important food source to bull trout listed under the Endangered Species Act (USFWS 2000 BiOp).

Because of the potential impact of kokanee populations on ESA-listed bull trout, IDFG has called for continuation of the studies, and the USFWS and NMFS have supported that in their 2000 BiOps, which call for elevations of 2051 and 2055 feet above msl in alternating years as an experimental protocol.

There has been considerable discussion and some litigation over these lake operations in recent years, and there were court settlement stipulations for operations during the winters of 1999-2000 and 2000-2001. There are currently no active legal actions, but the Corps remains sensitive to the many interests around the lake and the Pend Oreille River when coordinating annual operations.

To protect fish and their habitats downstream from Albeni Falls Dam, the normal minimum instantaneous discharge of 4,000 cfs is provided to maintain acceptable streamflows in the Pend Oreille River. In case of emergency or powerplant outage, Albeni Falls Dam discharge may be reduced below 4,000 cfs. If conditions indicate the discharge will remain below 4,000 cfs beyond 1 hour, Albeni Falls Dam must immediately notify RCC, BPA, Seattle City Light, Box Canyon Dam, and the Pend Oreille Public Utility District about the problem and the increase discharge above 4,000 cfs as quickly as possible, using spillway releases if necessary.

4.5.2 Wildlife Management

4.5.2.1 Libby Dam

Libby Dam Project lands managed for wildlife are among the lowest elevation lands in Montana and, as such, provide winter habitat to big game animals, particularly during winters of heavy snowfall. Operation of Libby Dam results in warmer water in the Kootenai River below the dam during winter months, preventing the formation of ice. This warmer water improves the availability of prey for bald eagles and, when combined with readily available perch sites, makes the project area important for the eagles, a threatened species. The backwaters and islands of the Kootenai River are also especially suited to waterfowl breeding and feeding.

The resource objective for the wildlife management areas is to maintain and protect wildlife habitats for the benefit of existing resident and migratory game and non-game wildlife species, including big game, Canada geese, wood ducks, mallards, common mergansers, goldeneyes, ospreys, bald eagles, and other raptors.

Although big game animals are the most visible animals in the project area and are traditionally given the highest priority for habitat management, many other species of animals live on project lands and each species is important to ensure the continued health of an ecosystem. Management of project lands, therefore, strives to maintain each habitat to improve species richness. Improving diversity of vegetation species and structure creates more opportunities for foraging and breeding, thus allowing a greater number of wildlife species to inhabit the area. This is accomplished by creating openings in forests, thinning of trees, and planting of native shrubs and forbs in areas lacking diversity.

4.5.2.2 Dworshak Dam

Dworshak project lands include 5,033 acres that were purchased specifically for elk mitigation. These lands are managed to provide winter browse for elk in hard winters. Brush fields were developed and they are periodically renovated when the brush becomes too tall for elk to browse on. Another 4,541 acres of project lands are managed for general wildlife management and additional project lands are managed for wildlife under environmental stewardship principles. This may include removing diseased trees, promoting growth of climax forest species, and other management activities.

4.5.2.3 Albeni Falls Dam

Mallard, pintail, blue-winged teal, American wigeon, and coots nest along the shores of Pend Oreille Lake. Canada geese in limited numbers also rear their young there. Areas most used by migratory birds are Oden Bay, Pack River flats, Clark Fork delta and Denton Slough. Shallow water and abundant feed make these areas inviting to waterfowl as summer breeding grounds and as resting and feeding places for thousands of ducks and geese during the annual migratory flights.

Mitigation for construction of Albeni Falls Dam was not authorized; nevertheless, in 1955 the Corps licensed 3,780 acres of wetlands to the IDFG for wildlife management. Administration of these lands by the IDFG was authorized and licensed in 1956, granting IDFG the authority to use and occupy for the purpose of development, conservation, and management of all wildlife resources, approximately 3,780 acres of land and water area. The license was reviewed in 1983 to be in effect for 25 years from that date, thus ending in November 2008 (*General Plan for Use of Project Land and Water Areas for Wildlife Conservation and Management, Albeni Falls Dam, Idaho*).

4.6 RESERVOIR REGULATION

4.6.1 Libby Dam

4.6.1.1 Fall

The project is constrained year-round by a minimum outflow requirement of 3,000 cfs. The preferred daily flow of 4,000 cfs is maintained when practical. The project maintains a minimum bull trout flow of 6 kcfs in September.

The project drafts to a variable end of December target based on the December Corps April to August water supply forecast. If the forecast is greater than or equal to 5,900 KAF, the end of December flood control elevation at Libby is 2411 feet. For forecasts less than or equal to 5,500 KAF, the end of December draft target is 2426.7 feet. For forecasts in between the two, the end of December target is linearly interpolated.

The Corps is a party to the Burbot Conservation Strategy Memorandum of Understanding (July 2005). Requests for burbot operations are submitted to the TMT.

4.6.1.2 Winter

From January through the start of refill, the project operates to end of month flood control elevations based on the VARQ[4] storage reservation diagram. These elevations are based on forecast volumes using the most recent Corps water supply forecast. In the event of a power emergency, more water can be released from the project. Specific criteria must be met for BPA to proclaim a power emergency. These criteria are written in the TMT Water Management Plan Emergency Protocols.

During the winter drawdown, Libby will be operated consistent with any order of approval which may be in force relating to the levels of Kootenay Lake made by the International Joint Commission under the Boundary Waters Treaty, 1909. Namely, the project may not be allowed to draft if Kootenay Lake is

[4] The project has implemented the VARQ Flood Control Procedure on an interim basis pursuant to an Environmental Assessment/Finding of Non-Significant Impact (2002). The Upper Columbia Alternative Flood Control and Fish Flows Environmental Impact Statement was finalized in April 2006, and a decision concerning long-term implementation is under consideration.

above its rule curve elevation and the "commencement of the spring rise" has not yet occurred on Kootenay Lake.

4.6.1.3 Spring

The minimum outflow during the refill season is generally the maximum of the following flows:

- VARQ flows from the project during refill season are calculated using the eight VARQ operating rules. They vary based on water supply forecast, reservoir elevation on refill start date, and previous outflows during refill. Flows are re-calculated at least monthly with each new issuance of the Corps April to August water supply forecast.

- The 2006 USFWS BiOp also designates an annual volume of water to be provided for sturgeon flow augmentation. This volume varies based on the Corps May forecast for the April through August period. The accumulated volume does not include the minimum flow of 4,000 cfs. A request with specific flow shape and date recommendations is submitted annually to TMT prior to initiating a flow operation for sturgeon.

- Per the 2006 USFWS BiOp, the project initiates bull trout flows of 6 kcfs on May 15 and maintains these minimum flow criteria until the sturgeon pulse begins. After the sturgeon pulse, the bull trout minimum varies from 6 kcfs to 9 kcfs based on the May forecast for the April through August forecast.

Flows may also be adjusted upwards to slow the rate of refill, or may be reduced for flood damage reduction purposes in the Kootenai Valley.

4.6.1.4 Summer

The project is operated to balance flood damage reduction, reservoir refill and flow augmentation for fish and other uses. During the summer (July and August) the project is operated to help meet the flow objectives for juvenile salmon out-migration in the lower Columbia River. The current standard summer reservoir draft limit is 2439 feet by the end of August. Retention of July/August water in Lake Koocanusa has occurred in some years under a Libby-Canadian storage water exchange, but is not guaranteed. This exchange agreement also reduces the second flow peak created by July/August salmon flow through Kootenay Lake July and August. (Note: This type of exchange is allowed under the current Libby Coordination Agreement, which was signed February 16, 2000. Because the operation must be mutually beneficial and the magnitude of the water year is not known earlier, the operation, if any, for a given water year is not finalized until June or July of that year.) Revisions to project summer operations are usually considered each year by the TMT.

The Northwest Power and Conservation Council Fish and Wildlife Program Mainstem Amendments and this Proposed RPA call for an evaluation of the benefits to resident fish by drafting the reservoir to 2439 feet by September 30 in the lowest 20 percent of volume runoff years and to elevation 2449 feet by September 30 in all other years.

4.6.2 Dworshak Dam

4.6.2.1 Fall

The project is operated to draft 80 feet from full by the end of September. On 1 September, the project releases water for augmentation and temperature control as specified by the Water Management Plan for the use of up to 200,000 acre-feet of water stored in the reservoir. Use of the water is based on the

Agreement between the United States, through the Corps, and the Nez Perce Tribe (Tribe) for water use in Dworshak Reservoir (Agreement), and that Agreement's underlying Memorandum of Agreement (MOA) (see Actions on Natural Hydrograph in Hydro Actions B.2.1).

After the project reaches elevation 1520 the project reduces to minimum flow (about 1,300 cfs), which is the lowest flow release possible without exceeding the State standard of 110 percent total dissolved gas (TDG). The Dworshak Fish Hatchery, which is operated by the USFWS, requests releases to provide the preferred water temperature. There is a limited ability to maintain target temperature, especially with minimum flows, using the water temperature control structure.

4.6.2.2 Winter

The project operates to end of month flood control elevations from January through April. These elevations are based on the most recent water supply forecast. If adequate water is available, the project will shape outflows to optimize for power generation. In the event of a power emergency, more water can be released from the project. Criteria for this type of action are found in the TMT Emergency Protocols. If requested through the TMT, the project will attempt to shift flood control from Dworshak to Grand Coulee to provide a increased chance of refill.

4.6.2.3 Spring

As mentioned in the Winter description, the project operates to end of month flood control elevations from January through April. After April 30, the project operates to refill while also providing salmon flow augmentation, if possible. Augmentation requests are coordinated by the TMT. Dworshak releases are used to help meet flow objectives in the lower Snake River. Until water temperatures go up dramatically, the project operates the water temperature control structure for the Dworshak Hatchery, which is operated by the USFWS.

4.6.2.4 Summer

The project is operated to balance flood damage reduction, refill, and flow augmentation while targeting a June 30 refill date. Although the project drafts approximately 80 feet during the summer, one of the goals is to maintain the lake full through the Fourth of July for recreation. This may not be possible if Lower Granite water temperatures are high prior to the Fourth of July. The amount and temperature of water released from Dworshak help moderate Lower Granite water temperatures. This is especially important as Hells Canyon Dam and Orifino (the other two main sources of Snake River water) do not provide water temperature control. Water temperatures and volume releases are coordinated through the TMT often throughout the summer. The Lower Granite water temperatures and the Dworshak Hatchery water temperature needs must be balanced in decision making. The maximum project discharge for flow augmentation is managed to maintain TDG no higher than 110 percent, the State of Idaho's TDG water quality standard.

4.6.3 Albeni Falls Dam

Regulation of the elevation of Lake Pend Oreille follows an annual schedule that provides a stable summer shoreline and a predictable minimum pool in the winter. This maximizes water resource benefits while minimizing negative effects. Albeni Falls is authorized to maintain lake levels between elevation 2049.7 and 2062.5 feet above msl. However, normal minimum pool elevation is 2051.0 feet above msl. The exception is during flood periods, when the project is on free flow or when operating at 2055 feet for fish operations, depending on the operation coordinated for Kokanee management at TMT. Lake Pend Oreille is stabilized for a significant period of time each year at lower-than-flood levels, but at higher levels than occurred during dry years.

Regulation of Pend Oreille Lake occurs only within limits that were experienced under natural conditions. As it occurred pre-dam, the annual spring rise usually begins in April and reaches its peak by early June. The dam releases freshet in-flows so that the reservoir does not exceed 2062.5 feet above msl to the extent possible. Large floods may occasionally cause the lake to fill above 2062.5 feet msl due to the large runoff and limited lake outlet capacity. The present plan for normal operation of the project provides for drawdown, starting about September and ending on November 20. The lake will then be held within narrow limits to the November 20 level for about 30 days, and thereafter allowed to fluctuate only above the November 20 elevation until the kokanee incubation period is complete, usually in April or early May. A minimum control elevation (MCE) is provided from December 1 to March 31 (control period) to provide a means of protecting kokanee spawning and egg incubation. Drafting of the lake below the MCE is restricted during the control period to provide the necessary kokanee protection. The lake may be filled above the MCE after January but the lake level must be at or below elevation 2056 feet above msl by April 1 to provide flood control storage space in case of spring flood runoff from the Clark Fork River.

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Appendix B—Description of the Proposed Reasonable and Prudent Alternative
Section B.1—Operations for Flood Control, Irrigation, Navigation, and Power Generation and Transmission

Attachment B.1-6
Bonneville Power Administration Transmission Operations

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ACRONYMS AND ABBREVIATIONS

AGC	automatic generation control
BPA	Bonneville Power Administration
ERO	Electric Reliability Organization
FERC	Federal Energy Regulatory Commission
FCRPS	Federal Columbia River Power System
MORC	minimum operating reliability criteria
NERC	North American Electric Reliability Corporation
Northwest Power Act	Pacific Northwest Electric Power Planning and Conservation Act
WECC	Western Electricity Coordinating Council

1. GENERAL DESCRIPTION

The Bonneville Power Administration (BPA) owns, operates, and maintains over 15,000 miles of transmission lines that serve Oregon, Washington, Idaho, western Montana, and small portions of Wyoming, Nevada, Utah, California, and eastern Montana. The transmission system requires continual monitoring and maintenance to meet applicable reliability standards. The North American Electric Reliability Corporation (NERC) has been certified by the Federal Energy Regulatory Commission (FERC) as the Electric Reliability Organization (ERO) under Section 215 of the Federal Power Act with authority to enforce mandatory reliability standards on all users, owners, and operators of the Bulk-Power System, including the BPA.

2. AUTHORIZATION

The BPA is authorized by the Bonneville Project Act, the Federal Columbia River Transmission System Act, and the Pacific Northwest Electric Power Planning and Conservation Act (Northwest Power Act) to operate the federal transmission system in the Pacific Northwest. The Bonneville Project Act authorized BPA to construct, operate and maintain transmission facilities to deliver federal energy and to interconnect the BPA hydroelectric project with other federal projects and publicly owned power systems. The 1974 Transmission System Act granted broad authority to the BPA to construct and operate a federal transmission system in the Pacific Northwest to transmit both federal and nonfederal power within the region. Both the Transmission System Act and the 1964 Regional Preference Act directed BPA to make available to others any transmission capacity that is not required for the transmission of federal energy. The 1980 Northwest Power Act directed BPA to furnish transmission and other services to its customers unless such services would interfere with the agency's power marketing program, operating limitations, or existing contractual obligations.

3. PROJECT ACTIVITIES

One of the fundamental necessities of operating any power system is that generation must match load. To help prevent events where energy does not match load, the Western Electricity Coordinating Council (WECC), the organization that establishes system reliability criteria for most of the Western United States and British Columbia, Canada, created guidelines that require utilities to maintain generation reserves. These guidelines, known as minimum operating reliability criteria (MORC), require utilities to carry reserves to meet unanticipated power demands and replace power in response to scheduled or unscheduled generation outages. Having these reserves available is vital to maintain system reliability. These reserves “bridge the gap” when small, short-term energy demands on the system increase beyond the level planned for. Without such reserves, blackouts or power curtailments would be more common.

Generation must match load on a second-by-second basis. This is accomplished through automatic generation control (AGC). AGC is a computerized management system that allows hydroelectric generators to instantaneously follow load requirements on the federal system by increasing or decreasing the amount of water passing through the turbines, thereby keeping generation levels matched with load requirements. To maintain the reliability of the transmission system, BPA carries AGC and MORC reserves at the Federal Columbia River Power System (FCRPS) projects, including those projects on the lower Snake and Columbia Rivers.

The Action Agencies have long-term and short-term planning procedures in place to avoid planned transmission outages during the mitigation operations identified in applicable biological opinions. For the purpose of scheduled maintenance, the Action Agencies plan all transmission commitments to fully comply with all fish operations.

In order to maintain the reliability of the grid, transmission lines are inspected and maintained at regular intervals. Some requirements are set by NERC (North American Electricity Reliability Council) standards while others derive from good utility practice. When damaged equipment is found, the transmission line is taken out of service. A planned outage is called to repair or replace equipment before it fails. Unplanned outages occur when automatic devices detect a problem, such as a short circuit due to a fallen tree, and remove the line from service for safety purposes and for the protection of the grid.

The ability of the transmission system to reliably carry power to meet the ever-changing load demand is limited. The transmission system is particularly constrained on certain transmission paths, where special care must be given to avoid unplanned transmission outages and to manage sensitive operating conditions. Moreover, the ability to work on some transmission lines is often constrained by adverse weather conditions. For example, lines that are accessed by mountain roads are routinely closed during winter months and when the ground is wet in the spring. In other instances, scheduled maintenance at certain times of the year is impractical due to the high demand for electricity and a lack of alternative energy supplies.

The loss of transmission capacity due to unplanned outages such as acts of nature and vandalism may create conditions that necessitate the alteration of reservoir operations to ensure that adequate energy is provided to the system at the right locations to meet demand without overloading the transmission system or violating NERC standards. Due to the size and complexity of the power and transmission systems, unforeseen power emergencies may render the initial set of actions in the Action Agencies' planning procedures inadequate to resolve the power emergency at hand. If an emergency transmission requirement dictates a change in dam operations affecting fish, the Action Agencies will work to minimize the impacts to fish to the full extent possible.

Generally, planned transmission outages can be scheduled to avoid affecting fish operations during the migration period. If during a planned outage, circumstances arise that threaten system reliability, necessitating an interruption of fish operations at projects passing migrating ESA-listed fish, the planned outage can be suspended within 1 working day unless doing so would pose an unacceptable risk to the reliability of the power system. In such a case, the Action Agencies would declare a power emergency, and the Technical Management Team Emergency Protocols would be followed. Reasonable mitigation will be provided when appropriate.

Often, completing a maintenance operation in a timely manner reduces the risk of an unplanned transmission outage in the future, thereby avoiding interruptions to fish operations. Unplanned interruptions can take longer to restore than planned outages because of the time necessary to respond.

Appendix B—Description of the Proposed Reasonable and Prudent Alternative
Section B.1—Operations for Flood Control, Irrigation, Navigation, and Power Generation and Transmission

Attachment B.1-7
U.S. Bureau of Reclamation Tributary Projects[1]

[1] The Dalles and Chief Joseph Dam projects are small mainstem projects that are included here because they are not part of the Federal Columbia River Power System.

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ACRONYMS AND ABBREVIATIONS

BA	Biological Assessment
BiOp	Biological Opinion
cfs	cubic feet per second
Corps	U.S. Army Corps of Engineers
ESA	Endangered Species Act
FCRPS	Federal Columbia River Power System
NMFS	National Marine Fisheries Service
O&M	operations and maintenance
Reclamation	U.S. Bureau of Reclamation
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

1. GENERAL DESCRIPTION

This attachment describes the operation and maintenance (O&M) activities for tributary projects in the Columbia River Basin that are included in this consultation. This attachment includes four general sections:

- Section 1 – General description and a discussion of the hydrologic effects from Reclamation's tributary projects, with an emphasis on irrigation development in the Columbia River Basin, and the volume of water diverted for irrigation and other project purposes. The net hydrologic impacts at various points on the mainstem Columbia River are available in the Comprehensive Analysis of the Federal Columbia River Power System (FCRPS) and Upper Snake River, Appendix B
- Section 2 – Future operations of the Federal U.S. Bureau of Reclamation (Reclamation) projects
- Section 3 – An overview of each project (organized alphabetically), its authorizations, relevant facilities and water supplies, the operations and maintenance activities, and the status of separate consultations on the tributary effects of project operations
- Section 4 – A summary description of routine maintenance activities at project facilities. Though routine maintenance at these projects does not affect mainstem flows; this description is included here to more fully describe the overall action.

Table 1 describes the status of consultations that address the effects of each action on listed salmon and steelhead within each tributary. The individual sections following also provide detail for consultations on effects within the tributaries on species within the jurisdiction of the U.S. Fish and Wildlife Service (USFWS).

Table 1. Summary of the Status of Endangered Species Act (ESA) Compliance for Tributary Effects on Species within the Jurisdiction of National Marine Fisheries Service (NMFS)

Project	Status of ESA Compliance
Chief Joseph Dam	Completed consultation for screen modifications in 2001. No tributary effects.
Crooked River, Deschutes, and Wapinitia	Completed consultation in 2005.
Okanogan	In progress.
The Dalles	Completed informal consultation in 1992. No tributary effects.
Tualatin	In progress.
Umatilla	Completed consultation in 2004.
Yakima	In progress.

1.1 IRRIGATED ACRES AND DIVERSIONS ASSOCIATED WITH RECLAMATION PROJECTS

The Columbia River drains about 219,000 square miles in the United States and 39,500 square miles in Canada. Observed outflow of the Columbia River averages about 198 million acre-feet per year. Irrigation accounts for most surface water withdrawals in the Columbia River Basin. Total irrigation withdrawals are about 33 million acre-feet of water each year; about 19 million acre-feet of this withdrawn water return to the river as return flows and are available for reuse (BPA et al. 1995). Irrigation depletions are less than 7 percent of the Columbia River's observed outflow.

Total irrigated acreage in the United States portion of the basin in 1990 was between 6.9 and 7.1 million acres (BPA et al. 1995). Table 2 shows the number of irrigated acres and the volume of water diverted; it also separates the acres and acre-feet associated with Reclamation's projects that are within the action area of this consultation (1,330,690 acres) and the acres and acre-feet that are not within the action area (5,632,900 acres). The area of land irrigated in any single year varies from 10 to 20 percent with water supply and the general economy, and different methods are used to estimate non-Federal irrigated acreage; therefore, these data are only intended to be a general guide.

Nearly 33 million acre-feet are diverted from streams and pumped from groundwater for irrigation (BPA et al. 1995). Of this total, about 13.7 million acre-feet are consumptively used and lost from the system; the remaining 18.9 million acre-feet return to surface and ground water systems. Irrigation diversions are more susceptible to annual variation than the amount of irrigated land. During drought years, irrigation diversions from a storage reservoir may be much greater than in wet years, whereas those dependent entirely on natural flow rights will likely be less as the streamflow falls. Because the methods of determining diversions for Reclamation and non-Reclamation projects differ, irrigation diversions are only intended to be a general guide. (Reclamation data use actual diversions, while U.S. Geological Survey (USGS) data are generally an estimate based on irrigated acres, climate, crops needs, and expected conveyance and other losses.)

Table 2. Irrigated Acres and Diversions in the Columbia River Basin [1/]

Location and Type	Acres	Acre-Feet
Upper Columbia River (Upstream from the Snake River Confluence)		
Reclamation in Action Area	1,170,690	4,844,000
Non-Reclamation	926,000	2,576,000
Total	**2,096,690**	**7,420,000**
Lower Columbia River (Downstream from the Snake River Confluence)		
Reclamation in Action Area	171,700	764,000
Non-Reclamation	915,900	2,186,000
Total	**1,087,600**	**2,950,000**
Snake River		
Reclamation in Action Area	3,900	6,000
Non-Reclamation	271,900	717,000
Total	**275,800**	**723,000**
Total Reclamation in Action Area	1,346,290	5,614,000
Total Non-Reclamation	2,113,800	5,479,000
Grand Total within Basin	**3,460,090**	**11,093,000**

1/ These numbers represent diversions from the river, not hydrologic depletions and includes small Reclamation projects that are not part of this consultation. Sources: Reclamation 1990 and 1992 with 2006 updates as contained in their respective descriptions; non-Reclamation diversions use 1990 USGS data.

2/ Reclamation projects in the Snake River Basin above Hells Canyon Dam are outside the Federal Columbia River Power System (FCRPS) Action Area. They are included in the Upper Snake River Biological Opinion (BiOp) and the Comprehensive Analysis, which looks at the combined effects of both the FCRPS and the Upper Snake River projects.

Table 3 provides a breakdown of irrigated acres and diversions by project to show which projects account for the bulk of irrigation associated with Reclamation's operations in the Action Area. The Columbia Basin and Yakima projects account for over 84 percent of irrigated acres and almost 84 percent of diversions.

This attachment does not present specific information on return flows for individual Reclamation projects. Based on the data for the total Columbia River Basin, slightly more than 40 percent of irrigation diversions could be expected to be consumptively used. However, data on some Reclamation projects indicate that the volume of return flow versus total diversion is highly variable and depends on many factors, including the available water supply, type of application, application rate, and efficiency of the carriage system.

Table 3. Irrigated Acres and Diversions for Reclamation Projects in the Action Area 1/

Project	Acres	Acre-Feet
Upper Columbia River (Upstream from the Snake River Confluence)		
Avondale 2/	240	1,000
Chief Joseph Dam 3/	19,300 4/	69,000
Columbia Basin	671,500	2,700,000
Dalton Gardens 2/	700	2,000
Frenchtown 2/	3,800	29,000
Hungry Horse	0	0
Missoula Valley 2/	150	3,000
Okanogan	5,000	14,000
Rathdrum Prairie 2/	4,000	10,000
Spokane Valley 2/	4,000	16,000
Yakima 5/	462,000	2,000,000
Lower Columbia (Downstream from the Snake River Confluence)		
Crooked River	20,000	50,000
Deschutes	85,000	500,000
The Dalles 3/	5,600	11,000
Tualatin	15,800	37,000
Umatilla	43,300	161,000
Wapinitia	2,000	5,000
Snake River		
Lewiston Orchards 2/	3,900	6,000
Reclamation Total	1,336,790	5,614,000

1/ These numbers represent diversions from the river, not hydrologic depletions and includes small Reclamation projects that are not part of this consultation. Source: Reclamation 1990 and 1992, with 2006 updates as contained in their respective descriptions. The diversion data include both storage and natural flows.
2/ Projects not included in the FCRPS consultation because they had unmeasureable effect on the mainstem Columbia River.
3/ The Dalles and Chief Joseph Dam projects do not have tributary effects. They are included here because they are included in this consultation but are not part of the FCRPS.
4/ Includes irrigable lands, not only irrigated lands.
5/ Includes the U.S. Bureau of Indian Affairs Wapato Irrigation Project.

2. FUTURE OPERATIONS FOR RECLAMATION'S TRIBUTARY PROJECTS

Reclamation proposes to undertake separate Federal actions in Columbia River tributaries involving the future operations for Federal Reclamation projects. For each of these projects, Reclamation has ongoing or completed consultations with National Marine Fisheries Service (NMFS, also called National Oceanic and Atmospheric Administration [NOAA] Fisheries) and the USFWS to address effects to listed species within the tributaries. Reclamation is consulting on the mainstem impacts resulting from its O&M of the projects as part of this FCRPS consultation. The cumulative impacts of the projects' irrigation operations are part of the FCRPS flow record through Bonneville Dam.

The projects described here are authorized, funded, or carried out by Reclamation by virtue of Congressional or Secretarial authorizations, Congressional appropriations, and contracts with Reclamation. Reclamation received authorization for each of its projects from either Congress or the Secretary of the Interior, who had authority under the 1902 Reclamation Act to approve construction after a finding of feasibility. The Congressional and Secretarial authorizations state the purposes to be served by each project. Congress has directed in the Reclamation laws that Reclamation enter into contracts with project water users. These contracts set out, among other things, Reclamation's obligations to store and deliver project water to irrigation districts, municipalities, and other entities. Additionally, the 1902 Reclamation Act requires that Reclamation comply with State law with regard to control, appropriation, use, and distribution of waters. Water can only be stored and delivered by a project for authorized purposes for which Reclamation has asserted or obtained a State water right in accordance with Section 8 of the Reclamation Act of 1902 and applicable Federal law. Reclamation must honor senior or prior water rights in storing and diverting project water. Conversely, project water is protected by State watermasters from diversion by junior appropriators.

3. PROJECT DESCRIPTIONS

This section includes an overview of each project (organized alphabetically), its authorizations, relevant facilities and water supplies, the operations and maintenance activities, and the status of separate consultations on the tributary effects of project operations. This information has been obtained from a variety of sources (see Reclamation 1990, 1992, and Reclamation's DataWeb site at http://www.usbr.gov/dataweb). Several of the sections incorporate by reference other documents that more fully describe operations, water right ownerships, previous consultations, and other project details.

3.1 CHIEF JOSEPH DAM PROJECT

3.1.1 General Project Description

The Chief Joseph Dam Project occupies lands along the Columbia and Okanogan rivers in north-central Washington and is not part of Chief Joseph Dam, which the U.S. Army Corps of Engineers (Corps) operates. There are four divisions and a total of seven units currently in operation. Additional units authorized for construction have been deferred and are not discussed here. All of the units are separate land areas with independent irrigation systems. Settlement in the general area of north-central Washington began early in the 1800s but was relatively slow until after 1900 when large-scale private irrigation began. Most of Reclamation's studies of irrigation potential were made in the late 1940s and in the 1950s. The project serves about 19,300 irrigable acres. Primary crops produced on project lands include apples, pears, cherries, and alfalfa hay.

The Chelan Division and its single unit, the Manson Unit, borders the north shore at the lower end of Lake Chelan and has about 6,300 irrigable acres.

The Foster Creek Division and its two units, Bridgeport Bar and Brewster Flat, are near the confluence of the Okanogan River with the Columbia River. The Bridgeport Bar Unit has about 500 irrigable acres, and the Brewster Flat Unit has about 2,400 irrigable acres.

The Greater Wenatchee Division and its three units, Brays Landing, East, and Howard Flat, is in three separate areas along the Columbia River between Wells Dam and Rock Island Dam. The Brays Landing Unit has about 1,700 irrigable acres, the East Unit has about 4,500 irrigable acres, and the Howard Flat Unit has about 900 irrigable acres.

The Okanogan-Similkameen Division currently has only one unit, Whitestone Coulee, and includes about 3,000 irrigable acres in the Spectacle Lake area, west of the Okanogan River near Loomis between Oroville and Tonasket, Washington. Until recently, the division also included the Oroville-Tonasket Unit, which supplied irrigation water to about 10,000 irrigable acres along the Okanogan River near Oroville and Tonasket, Washington. A settlement with the Oroville-Tonasket Irrigation District (Public Law 105-9 dated April 14, 1997) transferred title of all Reclamation-constructed facilities to the district and relieved the district of all contractual obligations. The unit is effectively dissolved and is no longer a part of a Federal Reclamation Project.

3.1.2 Authorization

Congress authorized all of the divisions and units within the Chief Joseph Dam Project, as specified in Table 4.

Table 4. Chief Joseph Dam Project Authorizations and Purposes

Division and Unit	Authorization
Chelan Division, Manson Unit	Public Law 89-557 dated September 7, 1966, for irrigation, conservation and development of fish and wildlife, and enhancement of recreation.
Foster Creek Division, all units	Public Law 83-540 dated July 27, 1954, for irrigation.
Greater Wenatchee Division, all units,	Public Law 85-393 dated May 5, 1958, for irrigation.
Okanogan -Similkameen Division, Whitestone Coulee Unit	Public Law 88-599 dated September 18, 1964, for irrigation, conservation and development of fish and wildlife, and improvement of public recreation.

3.1.3 Facilities and Water Supply

Chelan Division – The Manson Unit facilities include a pumping plant on Lake Chelan, relift and booster pumping plants, regulating steel-tank reservoirs, and a pressure pipe distribution system. Lake Chelan Pumping Plant has eight units with a total capacity of 106.7 cfs. The pumping plant on Lake Chelan replaced the water supply obtained from the privately owned Antilon Reservoir.

Foster Creek Division – The Brewster Flat Unit facilities include a pumping plant with four 11.7-cfs pumps on the right bank of the Columbia River, pumping plant intake fish screens, booster and relift pumping plants, two steel-tank reservoirs, and a pressure-pipe distribution system.

Bridgeport Bar Unit facilities include a well pumping plant with two 4.45-cfs pumps on the Columbia River, a booster pumping plant, an equalizing steel-tank reservoir, and a pressure-pipe distribution system.

Greater Wenatchee Division – East Unit facilities include a pumping plant with four units and a total capacity of 76 cfs on the left bank of the Columbia River, pumping plant intake fish screens, a booster and relift pumping plants, and a closed pipe pressure delivery system.

Brays Landing Unit facilities include a well pumping plant near the Columbia River, a regulating reservoir, four small pumping plants and reservoirs, and a pressure-pipe system. The pumping plant, about 25 miles north of Wenatchee, Washington, has five units with a total capacity of 32.25 cfs.

Howard Flat Unit facilities include a well pumping plant near the Columbia River, booster and relift pumping plants, and a pressure-pipe distribution system. The pumping plant, located northeast of Chelan, Washington, has three units with a total capacity of 16.7 cfs.

Okanogan-Similkameen Division – Whitestone Coulee Unit facilities include Toats Coulee Creek Diversion Dam, the Sinlahekin siphon, an open carriage system and distribution system, a steel storage tank, Spectacle Lake (6,250 acre-feet), and three pumping plants on Spectacle Lake. The unit's water supply is Toats Coulee Creek.

3.1.4 Operation and Maintenance

The independent entities that operate and maintain project facilities are identified in Table 5. Facility operation is generally limited to the irrigation season, which begins from about mid-April to mid-May and ends from mid-September to October 1. The average annual diversions are 19,000 acre-feet for the Manson Unit, 8,700 acre-feet for the Brewster Flat Unit, 1,400 acre-feet for the Bridgeport Bar Unit, 29,000 acre-feet for the Greater Wenatchee Division (Brays Landing, East, and Howard Flat Units), and 10,900 acre-feet for the Whitestone Coulee Unit.

Table 5. Operating Entities of the Chief Joseph Dam Project

Division and Unit	Operating Entity
Chelan Division, Manson Unit	Lake Chelan Reclamation District
Foster Creek Division, Brewster Flat Unit	Brewster Flat Irrigation District
Foster Creek Division, Bridgeport Bar Unit	Bridgeport Bar Irrigation District
Greater Wenatchee Division, Brays Landing, East, and Howard Flat Units	Greater Wenatchee Irrigation District
Okanogan-Similkameen Division, Whitestone Coulee Unit	Whitestone Reclamation District

Reclamation incorporates by reference the standing operating procedures for Spectacle Lake Dike, which more fully describes the physical facilities, operational criteria, and operating thresholds.

These O&M actions also include routine maintenance of the associated project facilities; Section 5 describes the types of activities typically included in routine maintenance.

3.1.5 Status of Tributary Consultations

The project has no tributary effects to species within the jurisdiction of the USFWS. Reclamation initiated and concluded consultation on modifications to screens at two facilities in 2001, which constitutes the whole of the tributary effects to species within the jurisdiction of NMFS. The project's mainstem impacts are part of this FCRPS consultation.

3.2 CROOKED RIVER PROJECT

3.2.1 General Project Description

The Crooked River Project is located near Prineville, Oregon in the Crooked River Basin. Private irrigation began in the late 1800s. Reclamation and the State of Oregon made cooperative irrigation surveys and proposed several irrigation plans for the Crooked River basin in 1915. During 1918-1921, private interests constructed the Ochoco Project in cooperation with the State of Oregon. Reclamation conducted a basinwide survey in the 1940s and secured the Prineville dam site (now Arthur R. Bowman Dam) for flood control and irrigation purposes. Deterioration of Ochoco Dam and the need for more reliable water resources led to reconstruction of Ochoco Dam in 1950 and authorization of the Crooked River Project as a Federal Reclamation Project in 1956. Prineville Dam was completed in 1961 and work on the Crooked River Extension was completed in 1970.

Within the Crooked River Project, there are about 20,000 irrigated acres producing grain, hay and pasture, mint, and seed-type crops for garlic, carrots, and various grasses. The farm units range in size from small suburban residential tracts to large livestock ranches. Prineville and Ochoco Reservoirs provide flood control on Ochoco Creek and the Crooked River as well as providing considerable recreation and fish and wildlife preservation and propagation.

Reclamation prepared an operations report (2003b) and biological assessment (2003a) that describe in detail the authorizations, facilities, operations, and maintenance activities associated with the Crooked River Project. These documents are incorporated by reference.

3.2.2 Authorization

Congress authorized reconstruction of Ochoco Dam through Public Law 80-841 dated June 29, 1948, and Public Law 81-350 dated October 12, 1949. The Crooked River Project was authorized by Congress through Public Law 84-992 dated August 6, 1956. This legislation incorporated Ochoco Dam and included Arthur R. Bowman Dam (Prineville Reservoir) along with carriage facilities. Congress, through Public Law 86-271 dated September 14, 1959, authorized extra capacity in the canal and pumping plants for future irrigation and authorized the Crooked River Project Extension by Public Law 88-598 dated

September 18, 1964. Rehabilitation of the drains and lateral system of the Extension in 1982 was accomplished under Public Laws 81-335 and 81-451 dated October 7, 1949.

The authorized purposes of the Crooked River Project are irrigation and other beneficial purposes, including flood control and the preservation and propagation of fish and wildlife (the "preservation and propagation of fish and wildlife" authorized only the installation of a fish ladder and screen at the Crooked River Diversion Dam headworks and a minimum release of 10 cfs for fish life when there would otherwise be not discharge from Prineville Reservoir).

3.2.3 Facilities and Water Supply

Major facilities of the Crooked River Project include Arthur R. Bowman Dam and Prineville Reservoir on the Crooked River, Ochoco Dam and Reservoir on Ochoco Creek, Lytle Creek Diversion Dam and Wasteway, two major pumping plants, nine small pumping plants, Ochoco Main Canal, and a distribution system of canals.

Arthur R. Bowman Dam is an earthfill structure on the Crooked River about 20 miles upstream from Prineville. It was completed in 1961, called Prineville Dam at the time, with a height of 240 feet, a crest length of 790 feet, and an outlet capacity of 3,300 cfs. The impoundment, Prineville Reservoir, has a total capacity of 150,200 acre-feet and an active capacity of 148,600 feet based on a 1998 sedimentation survey.

Ochoco Dam, found about 6 miles east of Prineville on Ochoco Creek, was completed in 1919 as part of the Veterans Farm Settlement Program of the State of Oregon. Reclamation completed repair and reconstruction of the dam in 1950. The dam is 125 feet high and has a crest length of 1,350 feet. After a 1990 sedimentation survey and recent Safety of Dams construction, Ochoco Reservoir is currently considered to have a total capacity of 45,130 acre-feet and an active capacity of 39,370 acre-feet.

Water for project operations is obtained from storage in Ochoco Reservoir on Ochoco Creek and in Prineville Reservoir on the Crooked River.

3.2.4 Operation and Maintenance

Reclamation coordinates the operations and maintenance of the project with the Deschutes and Wapinitia projects. The Ochoco Irrigation District operates and maintains the facilities of the Crooked River Project and owns Ochoco Dam and Reservoir. Irrigation operations extend from April 1 to October 31 with an annual diversion of about 18,000 acre-feet.

Flood control operations for Ochoco Dam extend from November 15 to June 30. A total of 16,500 acre-feet of space are maintained in Ochoco Reservoir from November 15 to January 31. After January 31, space is maintained in Ochoco Reservoir on a forecast basis to control flow downstream of Ochoco Dam to no more than 500 cfs.

Flood control operation for Arthur R. Bowman begins with 60,000 acre-feet of space in Prineville Reservoir from November 15 through February 15 with space decreased in a straight line to zero on March 31. The flood control objective is control flows downstream of Arthur R. Bowman Dam to no more than 3,000 cfs. The reservoir has a large uncontracted component; Reclamation currently uses this space to maintain a minimum target release of 75 cfs from Arthur R. Bowman Dam to the extent possible for fish, but the release may drop lower under drought conditions.

Reclamation incorporates by reference the standing operating procedures for Arthur R. Bowman and Ochoco dams, which more fully describe the physical facilities, operational criteria, and operating thresholds.

These O&M actions also include routine maintenance of the associated project facilities; Section 5 describes the types of activities typically included in routine maintenance.

3.2.5 Status of Tributary Consultations

Reclamation (2003a) described its plans for future operations and maintenance of the Crooked River Project (along with the Deschutes and Wapinitia projects) in a biological assessment submitted to NMFS and the USFWS in 2003. The assessment evaluated the potential tributary effects on listed species, including bald eagle, bull trout, Canada lynx, northern spotted owl, and Middle Columbia River Steelhead. Reclamation found no adverse effects to any fish and wildlife species, and the USFWS sent a letter concurring with that determination. NMFS determined the planned O&M actions adversely affect Middle Columbia River Steelhead and provided a BiOp in 2005. The BiOp's incidental take statement requires Reclamation to minimize take when making operational releases. Reclamation is implementing this requirement. The project's mainstem impacts are part of this FCRPS consultation.

3.3 DESCHUTES PROJECT

3.3.1 General Project Description

The Deschutes Project is near Madras, Oregon. Private irrigation in the area began in the late 1800s, and, by 1900, the canals of the Central Oregon Irrigation District had been developed. Reclamation completed a comprehensive report on the Deschutes River basin in 1914. North Unit Irrigation District was formed in 1916, and bonds were issued to finance private investigations and construction of an irrigation project. Investigations of possibilities for the North Unit were completed and reported in 1921; however, private financing for construction never became available. Reclamation reviewed the plans in a brief study in 1921, made a study in 1924, and published a comprehensive study of all storage possibilities above the Crooked River in 1936. The report was the basis for Federal authorization.

The Deschutes Project provides a full water supply to about 50,000 irrigable acres within the North Unit Irrigation District and a supplemental water supply for about 48,000 irrigable acres within the Central Oregon Irrigation District and the Crook County Improvement District Number 1. In any year, about 500,000 acre-feet irrigate about 85,000 acres within the project to produce grain, hay, pasture, mint, and seeds.

Reclamation prepared an operations report (2003b) and biological assessment (2003a) that describe in detail the authorizations, facilities, operations, and maintenance activities associated with the Deschutes Project. These documents are incorporated by reference.

3.3.2 Authorization

The President authorized the Deschutes Project on November 1, 1937, pursuant to the Act of June 25, 1910, and the Act of December 5, 1924. Congress authorized construction of Haystack Dam in Public Law 83-573 dated August 10, 1954. Irrigation is the authorized purpose of the Deschutes Project.

3.3.3 Facilities and Water Supply

Major facilities of the Deschutes Project are Wickiup Dam and Reservoir, Haystack Dam and Reservoir, Crane Prairie Dam, North Unit Main Canal, Crooked River Pumping Plant, and a distribution system.

Crane Prairie Dam, located on the mainstem Deschutes River about 37 miles southwest of Bend, Oregon, was privately constructed as a rockfilled timber-crib structure but was rehabilitated by Reclamation in

1940. The dam is an earthfill structure about 36 feet high with a crest length of 284 feet. Crane Prairie Reservoir has a total capacity of 55,300 acre-feet and a surface area of about 4,900 acres at full pool.

Wickiup Dam, on the mainstem Deschutes River about 2 miles downstream from Crane Prairie Dam, was completed in 1949 and is an earthfill structure 100 feet high with a crest length of 342 feet. The reservoir has a total capacity of 200,000 acre-feet and a surface area of about 11,200 acres at full pool.

Haystack Dam, about 10 miles south of Madras, Oregon, is an off-stream regulatory facility completed in 1957. The earthfill structure has a height of 105 feet, and Haystack Reservoir has an active capacity of 5,600 acre-feet and a surface area of about 230 acres at full pool.

North Unit Main Canal heads at a diversion dam on the Deschutes River near Bend and extends about 65 miles to the vicinity of Madras. Its initial capacity is 1,000 cfs.

The Crooked River Pumping Plant is on the Crooked River where the North Unit Main Canal crosses the river. The plant consists of 9 pumps with a total capacity of 200 cfs. This pumping plant is not a Reclamation facility and is not included in Reclamation's screening program.

Water supply for the Deschutes Project consists of storage in Wickiup and Crane Prairie Reservoirs and water pumped from the Crooked River.

3.3.4 Operation and Maintenance

Reclamation coordinates the operations and maintenance of the project with the Crooked River and Wapinitia projects. North Unit Irrigation District operates and maintains the facilities of the Deschutes Project North Unit. The irrigation season extends from April 1 to October 31. About 500,000 acre-feet are diverted annually. Diversions include irrigation storage releases from Wickiup and Crane Prairie Reservoirs.

Reclamation incorporates by reference the standing operating procedures for Wickiup, Crane Prairie, and Haystack dams, which more fully describe the physical facilities, operational criteria, and operating thresholds.

These O&M actions also include routine maintenance of the associated project facilities; Section 5 describes the types of activities typically included in routine maintenance.

3.3.5 Status of Tributary Consultations

Reclamation (2003a) described its planned future operations and maintenance of the Deschutes Project (along with the Crooked River and Wapinitia projects) in a biological assessment submitted to NMFS and the USFWS in 2003. The assessment evaluated the potential tributary effects on listed species, including bald eagle, bull trout, Canada lynx, northern spotted owl, and Middle Columbia River Steelhead. Reclamation found no adverse effects to any fish and wildlife species, and the USFWS sent a letter concurring with that determination. NMFS determined the planned O&M actions adversely affect Middle Columbia River Steelhead and provided a BiOp in 2005. The opinion's incidental take statement requires Reclamation to minimize take when making operational releases. Reclamation is implementing this requirement. The project's mainstem impacts are part of this FCRPS consultation.

3.4 OKANOGAN PROJECT

3.4.1 General Project Description

The Okanogan Project, located along the west bank of the Okanogan River near Okanogan and Omak, Washington, was developed early in the century. Reclamation began investigations in 1902, the project was authorized in 1905, and construction began in 1907. The project includes about 5,000 contract acres. Apples are the principal crop; however, other fruits, grain, hay, and forage crops are produced.

3.4.2 Authorization

The Secretary of the Interior authorized the Okanogan Project on December 2, 1905, under the 1902 Reclamation Act, and the Shell Rock Point Pumping Plant was constructed under Public Law 95-18 dated April 7, 1977. The project's purpose is irrigation.

3.4.3 Facilities and Water Supply

Project facilities include Conconully Dam and Reservoir, Salmon Lake Dam and Conconully Lake, Shell Rock Point Pumping Plant, diversion dams, a feeder canal, a main canal, and a piped carriage and distribution system.

Conconully Dam, constructed on Salmon Creek near the town of Conconully, is an earthfill structure about 72.5 feet high; the structure was completed in 1910 and raised 2.5 feet to its present height in 1920. Conconully Reservoir's total volume is 13,000 acre-feet.

Salmon Lake Dam, completed in 1921, is an earthfill structure about 54 feet high constructed at the outlet of Conconully Lake, a natural lake. The dam provides an active storage capacity of 15,700 acre-feet.

Salmon Creek Diversion Dam was constructed in 1906 on Salmon Creek about 5 miles upstream from the town of Okanogan. The structure is a concrete diversion weir, about 6 feet high and 140 feet long, that diverts water from Salmon Creek to the Main Canal, which has a capacity of 100 cfs. Recently, a fish ladder was constructed, and the fish screens were replaced.

Shell Rock Point Pumping Plant was constructed on the Okanogan River in 1977-1978 to replace two smaller pumping plants. It has four pumps, each with a capacity of 8.3 cfs and is generally used only in drought years. Up to three pumps can be operated simultaneously for a maximum diversion of 24 cfs.

The principal water supply for the Okanogan Project is Salmon Creek, a tributary of the Okanogan River.

3.4.4 Operation and Maintenance

The Okanogan Irrigation District operates and maintains the project facilities. Operation of facilities is limited generally to the irrigation season that begins about April 1 and ends about mid-October. The annual diversion of water is about 14,000 acre-feet. Reclamation incorporates by reference the standing operating procedures for Conconully and Salmon Lake dams, which more fully describe the physical facilities, operational criteria, and operating thresholds.

These O&M actions also include routine maintenance of the associated project facilities; Section 5 describes the types of activities typically included in routine maintenance.

3.4.5 Status of Tributary Consultations

Reclamation has initiated consultation with NMFS on the operations and Maintenance of the Okanogan Project. Reclamation is preparing a Biological Assessment (BA), which will be provided in draft form to the Okanogan Irrigation District and Confederated Colville Tribes in August 2007. Following a coordinated review, the BA will be finalized and transmitted to NMFS for preparation of their BiOp. The project's mainstem hydrologic impacts are part of this FCRPS consultation.

3.5 THE DALLES PROJECT

3.5.1 General Project Description

The Dalles Project, Western Division, is on the south side of the Columbia River adjacent to The Dalles, Oregon, about 80 miles east of Portland, Oregon. The Dalles Project is not part of The Dalles Dam, which the Corps operates. The Dalles Project pumps directly from Bonneville Dam forebay. Due to a favorable location, the area became an important transportation hub in the early 1900s. Irrigated orchards were developed using pumped ground water, but a rapidly falling water table resulted in investigations and reports by Reclamation in 1947 and in 1959. The latter report was the basis for authorization of The Dalles Project.

Although the project includes about 6,000 irrigable acres, water from the Columbia River is supplied to an annual average of 5,600 acres which produce fruit, primarily sweet cherries.

3.5.2 Authorization

Congress authorized The Dalles Project in Public Law 86-745 dated September 13, 1960. Rehabilitation of facilities in 1999 was accomplished under the authority of Public Law 84984 dated August 6, 1956 (Small Reclamation projects Act). The authorized purpose of the project is irrigation.

3.5.3 Facilities and Water Supply

Facilities of The Dalles Project are Mill Creek Pumping Plant, a booster pumping plant, several relift pumping plants, three surface reservoirs, 1.6-million-gallon re-regulation tank, five smaller re-regulating tanks, and a pipe distribution system.

Mill Creek Pumping Plant, on the Columbia River about 4 miles downstream from The Dalles Dam, consisted of five pump units with a total capacity of 54.2 cfs as originally constructed. In 1999, The Dalles Irrigation District replaced several pumps with larger capacity units. Anadromous fish screens at the intakes of the pumps meet NMFS fish protective criteria. The water supply for The Dalles Project is the Columbia River.

3.5.4 Operation and Maintenance

The Dalles Irrigation District operates and maintains the facilities of The Dalles Project. About 11,000 acre-feet are pumped annually during the irrigation season, March 1 to October 31. These O&M actions also include routine maintenance of the associated project facilities; Section 5 describes the types of activities typically included in routine maintenance.

3.5.5 Status of Tributary Consultations

Reclamation initiated and concluded informal consultation for tributary effects in 1992 on project facilities. The project's mainstem impacts are part of this FCRPS consultation.

3.6 TUALATIN PROJECT

3.6.1 General Project Description

The Tualatin Project is located along the Tualatin River in northwest Oregon just west of Portland, Oregon. This area is the site of one of the first farming settlements in Oregon. By late 1950, about 6,000 acres were irrigated but with an inadequate water supply. Reclamation completed engineering and feasibility reports in 1956 and 1963. The latter report was the basis for development of a multipurpose project that includes irrigation, M&I water supply, flood control, fish and wildlife, recreation, and water quality.

The Tualatin Project includes about 17,000 irrigable acres, of which about 15,800 acres are irrigated annually to produce grain, strawberries, blueberries, nursery stock, orchard crops, seed crops, pasture, hay, and specialty crops such as beans and crimson clover. In addition, the project provides about 14,000 acre-feet of water for M&I purposes and another 16,900 acre-feet to improve water quality in the summer when natural flows are low.

Reclamation prepared an operations report (2002b) that describes in detail the authorizations, facilities, operations, and maintenance activities associated with the Tualatin Project. This document is incorporated by reference.

3.6.2 Authorization

Congress authorized the Tualatin Project in Public Law 89-596 dated September 20, 1966. The project's purposes include irrigation, M&I water supply, flood control, recreation, fish and wildlife, and water quality.

3.6.3 Facilities and Water Supply

Facilities of the Tualatin Project are Scoggins Dam and its impoundment, Henry Hagg Lake, Patton Valley Pumping Plant, Spring Hill Pumping Plant, several booster pumping plants, and piped lateral distribution systems. Construction of project facilities began in 1972 and was completed in 1978.

Scoggins Dam, an earthfill structures 151 feet high with a crest length of 2,700 feet, is located on Scoggins Creek, a tributary of the Tualatin River. Henry Hagg Lake, the impoundment, has a total capacity of 59,910 acre-feet (53,600 acre-feet active capacity) and a surface area of 1,132 acres at full pool. Scoggins Dam was completed in 1978.

Patton Valley Pumping Plant, on Scoggins Creek about 2.5 miles downstream from Scoggins Dam, consists of five pumps with a total capacity of less than 10 cfs. The pumping plant and associated distribution system provide supplemental water to about 1,900 acres.

Spring Hill Pumping Plant, on the Tualatin River about 9 miles downstream from Scoggins Dam, is a combined irrigation and M&I water pumping plant. There are nine pumps with a total capacity of 148.2 cfs for pumping irrigation water and 4 pumps with a total capacity of 127 cfs for pumping M&I water to the cities of Hillsboro, Beaverton, and Forest Grove. The pumping plant and associated distribution system provide water to about 10,300 acres.

In addition to the two pumping plants and distribution systems, numerous pumps along the river provide irrigation water directly to about 4,800 acres.

The source of the water for the project is Scoggins Creek and the Tualatin River. Storage is maintained in Henry Hagg Lake on Scoggins Creek, and all project water is pumped from Scoggins Creek and the Tualatin River.

3.6.4 Operation and Maintenance

The Tualatin Valley Irrigation District operates and maintains Scoggins Dam and all of the irrigation facilities of the project. The Joint Water Commission operates the three M&I water pumps of the Spring Hill Pumping Plant. Washington County operates and maintains recreation facilities at Henry Hagg Lake.

The irrigation season usually begins about May 1 and ends on September 30. During this period, water is released from Henry Hagg Lake and diverted by pumping from the Tualatin River as needed to meet irrigation demands. Average annual diversions for irrigation are about 37,000 acre-feet. Minimum flows of 10 cfs year-round and 20 cfs during October and November are maintained for fishery purposes in Scoggins Creek.

The flood control period for Scoggins Dam is from November 1 to May 1. Flood control space of 20,300 acre-feet in Henry Hagg Lake is sufficient to completely regulate a 50-year flood event at the dam and significantly reduce flooding downstream along the Tualatin River.

Reclamation incorporates by reference the standing operating procedures for Scoggins Dam, which more fully describes the physical facilities, operational criteria, and operating thresholds.

These O&M actions also include routine maintenance of the associated project facilities; Section 5 describes the types of activities typically included in routine maintenance.

3.6.5 Status of Tributary Consultations

Reclamation is currently preparing a biological assessment to analyze the tributary impacts of future O&M of the project. As of early 2006, Reclamation has completed preliminary hydrologic modeling and has met several times with NMFS and the USFWS to help frame the consultation process. In addition, Reclamation has coordinated with Project contractors and other stakeholders and will continue to do so as the consultation proceeds. Reclamation anticipates submitting a draft biological assessment by fall of 2007. The project's mainstem impacts are part of this FCRPS consultation.

3.7 UMATILLA PROJECT

3.7.1 General Project Description

The original Umatilla Project furnishes a full supply of irrigation water to over 17,000 acres and a supplemental supply to approximately 22,500 acres. These lands, located in north-central Oregon, are divided into three divisions.

In January 1903, the Reclamation began investigations to determine the possibility of irrigating lands on the lower Umatilla River by gravity flow from the Columbia and Snake rivers. During 1903-1904, Reclamation surveyed the Umatilla River and its tributaries and mapped the more feasible reservoir sites. Subsequent investigations were made to find a reservoir site on the irrigable lands east of the river. The studies resulted in construction of Cold Springs Reservoir and the establishment of the Umatilla Project. In 1923, construction was started on McKay Dam and Reservoir.

The East Division is the Hermiston Irrigation District, the West Division is the West Extension Irrigation District, and the South Division includes the Stanfield and Westland Irrigation Districts. In addition, there are approximately 3,800 acres not included in an irrigation district that are provided either a full or supplemental water supply from McKay Reservoir under individual storage contracts.

Reclamation prepared a biological assessment (2001) with an additional supplement (2003c) that more fully describes project operations. Consultation with NMFS was completed on the Umatilla Project with a BiOp dated April 23, 2004. These documents are incorporated by reference.

3.7.2 Authorization

The Secretary of the Interior authorized the East and West Divisions on December 4, 1905, under provisions of the Reclamation Act. The authorized project purpose of the original project was irrigation. The Act of March 11, 1976, reauthorized McKay Dam and Reservoir for the purposes of irrigation, flood control, fish and wildlife, recreation, and safety of dams. This act provided for the modification of the spillway as a safety of dams measure to handle the discharge of large flood inflows. It also reserved 6,000 acre-feet of storage space for exclusive flood control.

Phase I and Phase II water exchange facilities were authorized by the Act of October 28, 1988, for the purposes of mitigating losses to anadromous fishery resources and continuing water service to the irrigation districts.

3.7.3 Facilities and Water Supply

Project features of the East Division are Cold Springs Dam and Reservoir, A-Line Canal, Feed Canal and Diversion Dam, and Maxwell Diversion Dam, Canal, and associated canals and laterals. Three Mile Falls Diversion Dam and the West Extension Main Canal are the principal features of the West Division. McKay Dam and Reservoir are the only features in the South Division.

The original project plan provided for irrigation of lands in the lower Umatilla River Valley and along the south side of the Columbia River near Umatilla, Oregon, with water from the Umatilla River. Storage is provided by Cold Springs Dam, to which water from the Umatilla River is conveyed through the Feed Canal and by McKay Dam on McKay Creek. Three diversion dams on the Umatilla River divert project water. These are the Feed Canal Diversion Dam into the Feed Canal, which supplies Cold Springs Reservoir, Three Mile Falls Diversion into the West Extension Canal, and Maxwell Diversion Dam into Maxwell Canal.

Cold Springs Dam is located off stream about 6 miles northeast of Hermiston, Oregon. Water is diverted to the reservoir from the Umatilla River by the Feed Canal Diversion Dam and Canal. The reservoir's total active capacity is 44,600 acre-feet.

McKay Dam, located on McKay Creek about 6 miles south of Pendleton, Oregon, was constructed to furnish a supplementary supply of water to Stanfield and Westland Irrigation Districts. In 1993, a sedimentation survey estimated the total reservoir storage capacity at 71,500 acre-feet.

The West Extension Irrigation District installed the River Pumping Plant in 1968-69 to supply supplemental irrigation water to lands within the district and to serve an additional 2,000 acres outside the West Extension irrigable area. The plant is located on the Umatilla River 0.5 mile above its confluence with the Columbia River and discharges into the West Extension Main Canal 3 miles from Three Mile Falls Diversion Dam. Three vertical-turbine pumps, rated at 20 cfs each and driven by 600-horsepower motors, are installed in the plant.

Phase I water exchange facilities serve the West Extension Canal and consist of a new canal, pumping plant, and discharge line. The purpose of these facilities is to deliver up to 140 cfs of Columbia River water for irrigation of West Extension Irrigation District lands, in exchange for Umatilla River flows that are not diverted by the irrigation district at Three Mile Falls Diversion Dam, but left in the lower 3 miles of the Umatilla River.

Phase II water exchange facilities serve the Hermiston and Stanfield Irrigation Districts. The Hermiston Irrigation District historically diverted water from the Umatilla River in the non-irrigation season, conveyed it through the Feed Canal to Cold Springs Reservoir, and then drew it from the reservoir for summer irrigation. Stanfield Irrigation District historically diverted natural flow and irrigation releases from McKay Reservoir into their Furnish Ditch for direct delivery.

The Columbia River Pumping Plant is located on the south shore of the Columbia River just downstream of the Corps' Sand Station Recreation area about 10 miles northeast of Hermiston, Oregon. The pumping plant lifts water from Lake Wallula, created by McNary Dam, approximately 4,300 feet in a south direction through a 66-inch discharge line into the Columbia-Cold Springs Canal. The maximum pumping rate is 240 cfs with a total dynamic head of about 321 feet. Average annual pumping is estimated at about 30,000 acre-feet.

From 1987 through 1991, BPA funded the installation of fish ladder and fish screens through the Fish and Wildlife Program of the Northwest Power Planning Act. Reclamation and the Oregon Department of Fish and Wildlife installed these facilities: ladders and screens at Furnish Diversion Dam and Ditch; ladders and screens at Feed Canal Diversion Dam and Canal; ladders and screens at Westland Diversion Dam and Canal; screens at Maxwell Canal; and ladders and screens at Three Mile Falls Diversion Dam and West Extension Main Canal.

3.7.4 Operation and Maintenance

In the South Division, Reclamation operates McKay Reservoir and those Phase II facilities that deliver water to Stanfield Irrigation District. Stanfield and Westland Irrigation Districts operate their own facilities. The Hermiston Irrigation District operates the East Division, and the West Extension Irrigation District operates the West Division. BPA has contracted with Westland Irrigation District to operate and maintain the fish passage and protective facilities BPA funded, as described above.

Reclamation prepared an operations plan for the Umatilla Basin Project (2004) that describes the project facilities and operations. This document is incorporated by reference. Reclamation also incorporates by reference the standing operating procedures for Cold Springs, McKay, and Three Mile Falls Diversion dams, which more fully describe the physical facilities, operational criteria, and operating thresholds.

These O&M actions also include routine maintenance of the associated project facilities; Section 5 describes the types of activities typically included in routine maintenance.

3.7.5 Status of Tributary Consultations

Reclamation submitted a supplemental biological assessment (2003c) on the project's tributary effects to NMFS and the USFWS in 2003; this supplement addressed the associated districts' water operations and the district's use of exchange water from the Columbia River. In 2004, NMFS provided a BiOp with an incidental take statement that requires Reclamation to implement some operational changes and increase accessibility at a fish ladder. A BiOp was completed in April 2004. The project's mainstem impacts are part of this FCRPS consultation.

3.8 WAPINITIA PROJECT

3.8.1 General Project Description

The Wapinitia Project, at the junction of the White and Deschutes River near the town of Maupin in north-central Oregon, consists of the Juniper Division. Investigation of the irrigation potential in the area began in 1910. Reclamation made a preliminary investigation and published a report in 1916, prepared another report in 1945, and made a detailed investigation of stabilizing the water supply for lands under the Juniper Flat District Irrigation Company in 1952. The report on the 1952 investigation led to authorization of the Wapinitia Project, Juniper Division in 1956 and construction in l959.

Although about 2,100 irrigable acres are included in the project, a supplemental water supply is provided annually to about 2,000 acres of scattered irrigated lands that produce pasture, hay, and wheat.

Reclamation prepared an operations report (2003b) and biological assessment (2003a) that describe in detail the authorizations, facilities, operations, and maintenance activities associated with the Wapinitia Project. These documents are incorporated by reference.

3.8.2 Authorization

Congress authorized the Wapinitia Project, Juniper Division, in Public Law 84-559 dated June 4, 1956. The authorized purpose of the project is irrigation.

3.8.3 Facilities and Water Supply

The primary feature of the Wapinitia Project is Wasco Dam constructed at a natural lake, Clear Lake, to increase the storage capacity and a diversion dam 3 miles downstream from Wasco Dam. Wasco Dam is an earthfill structure about 59 feet high with a crest length of 415 feet. Clear Lake has a total storage capacity of 13,100 acre-feet (11,900 acre-feet of active storage) and a surface area of 557 acres at full pool.

Water supply for the Wapinitia Project is storage in Clear Lake on Clear Creek.

3.8.4 Operation and Maintenance

Reclamation coordinates the operations and maintenance of the project with the Crooked River and Deschutes projects. The Juniper Flat District Improvement Company operates and maintains facilities of the Wapinitia Project. Operation of facilities is limited generally to the irrigation season that begins about April 1 and ends about October 31. About 5,000 acre-feet are annually diverted for irrigation.

Reclamation incorporates by reference the standing operating procedures for Wasco Dam, which more fully describes the physical facilities, operational criteria, and operating thresholds.

These O&M actions also include routine maintenance of the associated project facilities; Section 5 describes the types of activities typically included in routine maintenance.

3.8.5 Status of Tributary Consultations

Reclamation (2003a) described its planned future operations and maintenance of the Wapinitia Project (along with the Crooked River and Deschutes projects) in a biological assessment submitted to NMFS and the USFWS in 2003. The assessment evaluated the potential tributary effects on listed species, including bald eagle, bull trout, Canada lynx, northern spotted owl, and Middle Columbia River Steelhead. Reclamation found no adverse effects to any fish and wildlife species, and the USFWS sent a letter concurring with that determination. NMFS determined the planned O&M actions adversely affect Middle Columbia River Steelhead and provided a BiOp in 2005. The opinion's incidental take statement requires Reclamation to minimize take when making operational releases. Reclamation is implementing this requirement. The project’s mainstem impacts are part of this FCRPS consultation.

3.9 YAKIMA PROJECT

3.9.1 General Project Description

The Yakima Project provides irrigation water for a comparatively narrow strip of fertile land that extends for 175 miles on both sides of the Yakima River in south-central Washington. The irrigable lands presently being served total approximately 462,000 acres. Yakima County ranks first among all counties of the United States in the production of apples, mint, and hops. Principal crops are fruit, vegetables, forage, hops, and mint.

In 1903, citizens petitioned the Secretary of the Interior to develop irrigation in the basin. Following Reclamation investigations, the Sunnyside and Tieton Units were approved for construction in 1905. Early in 1906, investigation of storage sites was initiated, including Bumping Lake, McAllister Meadows (Tieton Reservoir), and Cle Elum, Kachess, and Keechelus lakes.

There are seven divisions in the project: Storage, Kittitas, Tieton, Sunnyside, Roza, Kennewick, and Wapato. The Bureau of Indian Affairs operates the Wapato Division but receives most of its water supply from the Yakima Project for irrigation of 136,000 acres of land. Private interests irrigate over 45,000 acres not included in the seven divisions under water supply contracts with Reclamation. Storage dams and reservoirs on the project are Bumping Lake, Clear Creek, Tieton, Cle Elum, Kachess, and Keechelus. Other project features are five diversion dams, canals, laterals, pumping plants, drains, two powerplants, and transmission lines.

Irrigation water for the approximately 59,000 acres of land in the Kittitas Division is diverted from the Yakima River into the Main Canal by the Easton Diversion Dam near Easton, Washington. The Main Canal carries the water along the south side of the river to a point near Thorp, where it divides into the north and south branches. The North Branch Canal crosses the Yakima River through a siphon to irrigate land lying on the north side of the river, while the South Branch Canal continues generally southeast from the point of division to irrigate lands lying on the south side of the river.

The Tieton Division includes nearly 28,000 acres of land lying west of the city of Yakima between the Naches River and Ahtanum Creek. Irrigation water for the lands in this division is diverted from the Tieton River by the Tieton Diversion Dam, about 8 miles downstream from Rimrock Lake. The diversions flow through Tieton Main Canal and, after supplying the distribution system of the Tieton Division, drain into Ahtanum Creek about 14 miles west of Union Gap.

The Sunnyside Division consists of some 103,000 acres of land lying mostly north of the Yakima River, and extends from the Sunnyside Diversion Dam, on the Yakima River near Parker, to the vicinity of Benton City. Water is diverted from the Yakima River by the Sunnyside Diversion Dam and flows generally southeast through the Sunnyside Canal, which supplies the distribution system of the division. Four irrigation districts in the Sunnyside Division pump water to their lands by hydraulic turbine pumps at drops on the Sunnyside Canal.

The Roza Division, a unit containing approximately 72,500 acres of land north of the Yakima River, extends from the vicinity of Pomona to a point north of Benton City. The distribution system is supplied by the Roza Canal, which originates at the Roza Diversion Dam on the Yakima River about 10 miles north of Yakima. The Roza Powerplant is adjacent to the Roza Canal, 3 miles from Yakima.

The Kennewick Division is a combined irrigation and power development. It includes the 12,000-kilowatt Chandler Powerplant and over 19,000 acres of irrigable land, of which some 4,600 acres are in the Kennewick Highlands and have been irrigated for many years. All of the lands receive a full water supply.

The Storage Division has supervision over the entire Yakima River water supply, both natural riverflow and the stored water in six reservoirs. The reservoirs have a total active capacity of 1,070,700 acre-feet.

Reclamation prepared an interim operations report (2002a) that describes in detail the authorizations, facilities, operations, and maintenance activities associated with the Yakima Project. This document is incorporated by reference.

3.9.2 Authorization

Congress authorized all of divisions within the Yakima Project, as specified in Table 6.

The original purpose of the Tieton, Sunnyside, Wapato, Kittitas, and Roza Divisions, as well as the Storage Division, was irrigation. The Kennewick Division was authorized for irrigation, hydroelectric generation, and the preservation and propagation of fish and wildlife. The fish and wildlife purpose is associated with fish screens in the Chandler Canal and fish ladders at Prosser Diversion Dam. The Act of October 31, 1994, authorized fish, wildlife, and recreation as additional purposes of the Yakima Project. These purposes however, shall not impair the operation of the Yakima Project to provide water for irrigation purposes nor impact existing contracts.

Table 6. Yakima Project Authorizations and Purposes

Division and Unit	Authorization
Tieton and Sunnyside Divisions	Reclamation Act of 1902.
Benton Division, incorporated as a part of the Sunnyside Division, and the Kittitas and Wapato Divisions	Act of June 25, 1910.
Roza Division	Act of June 25, 1910, and Act of December 5, 1924.
Kennewick Highlands Division	Act of June 12, 1948.
Kennewick Division	Act of June 12, 1948.
Kennewick Division Extension	Act of August 25, 1969.
Yakima River Basin Fish Passage	Act of August 17, 1984, and the Act of August 22, 1984.
Yakima River Basin Water Enhancement Project	Act of October 31, 1994.

3.9.3 Facilities and Water Supply

Bumping Lake Dam is on the Bumping River about 29 miles northwest of Naches. The dam formed a reservoir with an active capacity of 33,970 acre-feet constructed over a natural lake having unknown dead storage capacity. Kachess Dam is an earthfill structure located on the Kachess River about 2 miles northwest of Easton. This dam also formed a reservoir with an active capacity of 239,000 acre-feet constructed over a natural lake having unknown dead storage capacity. Keechelus Dam was constructed at the lower end of a natural lake and is on the Yakima River 10 miles northwest of Easton. Keechelus Lake has an active capacity of 157,800 acre-feet constructed over a natural lake having unknown dead storage capacity. Clear Creek Dam, a concrete thin-arch structure on the North Fork of the Tieton River about 30 miles southwest of Naches and 48 miles west of Yakima, creates a reservoir with an active capacity of 5,300 acre-feet. Tieton Dam is on the Tieton River about 40 miles west of Yakima. The reservoir's active capacity is 198,000 acre-feet. Cle Elum Dam, on the Cle Elum River 10 miles northwest of Cle Elum, is an earthfill dam constructed at the end of a natural lake. The reservoir has an active capacity of 436,900 acre-feet constructed over a natural lake having unknown dead storage capacity.

3.9.4 Operation and Maintenance

Reclamation's interim operations report (2002a), incorporated by reference, describes project operations in detail. Reclamation also incorporates by reference the standing operating procedures for Bumping Lake, Clear Creek, Cle Elum, Easton Diversion, French Canyon, Kachess, Keechelus, Roza Diversion, and Tieton dams and Roza Powerplant, which more fully describe the physical facilities, operational criteria, and operating thresholds. Table 7 shows the entities that operate and maintain project facilities.

These O&M actions also include routine maintenance of the associated project facilities; Section 5 describes the types of activities typically included in routine maintenance.

Table 7. Operating Entities of the Yakima Project

Division	Operating Entity
Kittitas Division	Kittitas Reclamation District
Roza Division	Roza Irrigation District
Kennewick Division	Kennewick Irrigation District
Tieton Division	Tieton Irrigation District
Sunnyside Division	Sunnyside Valley Irrigation District and the Board of Control
Storage Division	Reclamation

3.9.5 Status of Tributary Consultations

Reclamation submitted a biological assessment in 2000 to NMFS and the USFWS to describe the tributary effects of project O&M to nine listed species of plants and animals. Reclamation operates five major dams and storage reservoirs in the basin for flood control, irrigation, and instream flows and maintains a number of fish ladders and screens at irrigation diversion facilities. Reclamation's assessment concluded that project operations could adversely affect bull trout and Middle Columbia River Steelhead. In February 2005, Reclamation sent the USFWS an addendum to the assessment to address effects to recently designated bull trout critical habitat. Reclamation has not yet received BiOps, and the consultation is still underway. The project's mainstem impacts are part of this FCRPS consultation.

4. ROUTINE MAINTENANCE ACTIVITIES

Water conveyance and control facilities require periodic inspection, maintenance, and repair. These O&M actions for Reclamation's projects all include routine maintenance, inspection, and repair activities that are limited to those actions' associated features and facilities. Reclamation (or the operating entity) prepares a yearly program for routine maintenance activities for review, approval, and execution. Reclamation (with the operating entity, where applicable) also inspects the major features described in this document every 3 to 6 years. Inspection reports are developed and recommendations are incorporated into the yearly routine maintenance programs where applicable. Some maintenance, inspection, and repair activities are not routine; these activities are not part of the planned O&M activities, and Reclamation would consult with the relevant regulatory agencies prior to conducting the activity.

Reclamation (or the operating entity) typically takes advantage of low river conditions or low reservoir elevations, when possible, to accomplish repairs or inspections to avoid or minimize impacts to normal operations. In some cases, however, these activities may require reducing or temporarily suspending river flows. This is avoided whenever possible and depends on the water conditions of that particular year.

Scheduled maintenance and inspections usually occur during lower flows in the late summer, fall, or winter. If possible, Reclamation (or the operating entity) reroutes river or waterway flows around the work area. Where this is not possible, river flows may be temporarily suspended for the duration of the work.

The following subsections summarize the categories of routine maintenance activities. These routine maintenance activities are part of the overall actions associated with each of the projects, but they do not affect the hydrology of the mainstem Columbia and Snake rivers. The effects of these activities on the tributary reaches was included within each tributary consultation. This discussion is included here to help fully describe the action, regardless of whether this facet of the action affects the mainstem reaches.

4.1 ROUTINE INSPECTION OF ALL DISCHARGE FEATURES

Reclamation inspects spillways, canal headworks, river outlet works, powerplant outlet works, pumping plant equipment, and associated equipment at least every 6 years. These inspections are typically performed under dewatered conditions but can be performed by divers, climbers, and other specially trained personnel. Whenever possible, inspections are scheduled to minimize impacts to water deliveries and environmental and other interests. The inspection of these features may require temporary suspension or diversion of flow via another discharge feature for minutes or hours to ensure the safety of inspection personnel.

4.2 PERIODIC TESTING OF ALL MECHANICAL EQUIPMENT

Reclamation strives to operate each gate and valve through at least one complete cycle each year. Gate and valve operation under both balanced (operation in dry conditions or equal head on both sides of the gate or valve) and unbalanced head is critical to ensure the reliability of the equipment. In many cases, spillway gate testing is limited to operation during dewatered conditions or a portion of the full operating cycle due to potential impacts downstream. The testing of gates and valves typically results in minor or no fluctuation in the downstream waterway.

Periodic testing of other mechanical equipment such as compressors for air bubbler ice prevention systems, emergency backup generators, and pumps, is required to ensure that the equipment is operating satisfactorily.

4.3 ROUTINE MAINTENANCE OF DISCHARGE FEATURES AND ASSOCIATED EQUIPMENT

This work includes concrete repairs, protective coating repairs, and maintenance of mechanical equipment. Whenever possible, Reclamation schedules maintenance such that impacts to streamflows, water deliveries, or environmental or other interests are minimal. Maintenance activities may require dewatering, temporary suspension or rerouting of flow via another discharge feature to allow access to the pertinent feature, curing of repair material such as concrete and protective coatings, or to ensure the safety of maintenance personnel. A reservoir may be temporarily surcharged to allow diversion of flow via a spillway to allow repair of river outlet works features.

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Section B.2
Operations to Benefit Listed Fish

B.2. OPERATIONS TO BENEFIT LISTED FISH

The U.S. Army Corps of Engineers, Bonneville Power Administration, and U.S. Bureau of Reclamation (Action Agencies) are committed to reversing the decline in Endangered Species Act (ESA)-listed salmon and steelhead in the Columbia River Basin. In this section, the Action Agencies describe their Proposed Reasonable and Prudent Alternative (RPA) to accomplish this. The RPA focuses on five primary objective areas (Figure B.2-1) where specific actions or measures are already ongoing or can be implemented to achieve improving trends and conditions for the listed anadromous salmonid species. These areas include hydropower, habitat, hatcheries (the All-Hs) and predator management. The sections and their supporting attachments are:

- **Section B.2.1—Hydropower Action**
  Attachment B.2.1-1 – Rationale for Transport Operation
  Attachment B.2.1-2 – Transport Permit

- **Section B.2.2—Habitat Action**
  Attachment B.2.2-1 – Estimated Habitat Quality Improvement for Actions to be Funded from 2007 to 2017
  Attachment B.2.2-2 – Tributary Habitat Action Tables
  Attachment B.2.2-3 – Lower Columbia River Estuary Partnership Criteria for Identifying and Prioritizing Habitat Protection and Restoration Projects

- **Section B.2.3—Hatcheries Action**
  Attachment B.2.3-1 – Action Agencies' Hatchery Mitigation Authorities/Obligations for the Federal Columbia River Power System
  Attachment B.2.3-2 – Current Basin-Wide Hatchery Reform Efforts
  Attachment B.2.3-3 – Action Agency-Funded Anadromous Artificial Production Programs in the Interior Columbia Region and the Lower Columbia River
  Attachment B.2.3-4 – Hatchery Scientific Review Group Guidelines for Hatchery Operation

- **Section B.2.4—Harvest Action**

- **Section B.2.5 – Predator Control Action**

Proposed RPA Strategy Overview

Action Objective	Strategy	Description
Hydro Action Objective for All ESUs: Improve the Survival of Juvenile and Adult Fish as They Pass Through the Hydrosystem	**Hydro Strategy 1**	Operate the FCRPS to More Closely Approximate the Shape of the Natural Hydrograph and to Enhance Flows and Water Quality to Improve Juvenile and Adult Fish Survival
	Hydro Strategy 2	Modify Columbia and Snake River Dams to Maximize Juvenile and Adult Fish Survival
	Hydro Strategy 3	Implement Spill and Juvenenile Transportation Improvements at Columbia River and Snake River Dams
	Hydro Strategy 4	Operate and Maintain Facilities at Corps Mainstem Projects to Maintain Biological Performance
Habitat Action Objective for All ESUs: Protect and Improve Tributary and Estuary Habitat to Improve Fish Survival	**Habitat Strategy 1**	Protect and Improve Tributary Habitat Based On Biological Needs and Prioritized Actions
	Habitat Strategy 2	Improve Juvenile and Adult Fish Survival in Estuary Habitat
Hatchery Action Objective for All ESUs: Fund FCRPS Mitigation Hatchery Programs in a Way that Contributes to Reversing the Decline of Downward-Trending ESUs	**Hatchery Strategy 1**	Ensure that Hatchery Programs Funded by the Action Agencies as Mitigation for the FCRPS are not Impeding Recovery
	Hatchery Strategy 2	Preserve and Rebuild Genetic Resources Through Safety-Net and Conservation Objectives to Reduce Extinction Risk and Promote Recovery
Harvest Action Objective for All ESUs: Improve Survival of Juvenile and Adult Fish as They Pass Through the Hydrosystem	**Harvest Strategy 1**	Fishery Conservation Effectiveness Programs
	Harvest Strategy 2	Potential Alternative/Terminal Fishing Locations
	Harvest Strategy 3	Develop Fishing Techniques to Enable Fisheries to Target Non-Listed Fish while Reducing Harvest-Related Mortality of ESA-Listed Species
Predation Management Action Objective for All ESUs: Improve Survival of Juvenile and Adult Fish as They Pass Through the Hydrosystem	**Predation Strategy 1**	Implement Piscivorous Predation Control Measures to Increase Survival of Juvenile Salmonids
	Predation Strategy 2	Implement Avian Predation Control Measures to Increase Survival of Juvenile Salmonids
	Predation Strategy 3	Implement Marine Mammal Control Measures to Increase Survival of Adult Salmonids at Bonneville Dam
RM&E Action Objective for All ESUs: Provide Information Needed to Support Planning and Adaptive Management and Demonstrate Accountability Related to Implementation of FCRPS ESA Hydropower and Offsite Actions for All ESUs	**RM&E Strategy 1**	Monitor Status of Selected Fish Populations Related to FCRPS Actions
	RM&E Strategy 2	Hydrosystem RM&E
	RM&E Strategy 3	Tributary Habitat RM&E
	RM&E Strategy 4	Estuary Habitat RM&E
	RM&E Strategy 5	Harvest RM&E
	RM&E Strategy 6	Hatchery RM&E
	RM&E Strategy 7	Predatation Management RM&E
	RM&E Strategy 8	Coordination and Data Management
	RM&E Strategy 9	Implementation and Compliance Monitoring

Figure B.2-1. Proposed RPA Strategy Overview

In addition to these primary objective areas, the Action Agencies are committed to an extensive research, monitoring, and evaluation (RM&E) program (Section B.2.6) that will follow the status of the specific actions or measures and determine if they are successful or need modification or changes. This program will involve all evolutionarily significant units (ESUs) or distinct population segments (DPSs). This section of B.2 includes the following attachments:

- **Section B.2.6—Research, Monitoring, and Evaluation**
  Attachment B.2.6-1 – Research, Monitoring, and Evaluation Project Tables
  Attachment B.2.6-2 – Hydropower Research, Monitoring, and Evaluation
  Attachment B.2.6-3 – Tributary Research, Monitoring, and Evaluation
  Attachment B.2.6-4 – Estuary Research, Monitoring, and Evaluation
  Attachment B.2.6-5 – Hatchery Research, Monitoring, and Evaluation

The RM&E will be implemented through a continuation of the Collaboration Framework Process. This is described in Section 2.1 of the main BA.

Section B.2.1—Hydropower Action

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ACRONYMS AND ABBREVIATIONS

AIP	Agreement in Principle
AMWG	Adaptive Management Work Group
AWS	auxiliary water supply
BA	biological assessment
BGS	behavioral guidance structure
BiOp	biological opinion
BIT	Biological Index Testing
BPA	Bonneville Power Administration
CFD	computational fluid dynamics
cfs	cubic feet per second
COMPASS	Comprehensive Fish Passage Model
COP	configuration and operational plan
Corps	U.S. Army Corps of Engineers
Council	Northwest Power and Conservation Council
CRWMP	Columbia River Water Management Program
DSI	Direct Service Industries
EA	Environmental Assessment
Ecology	Washington State Department of Ecology
EIS	Environmental Impact Statement
ESA	Endangered Species Act
ESBS	extended submersible bar screen
ESP	Ensemble Streamflow Prediction
ESU	Evolutionarily Significant Unit
FCRPS	Federal Columbia River Power System
FEIS	Final Environmental Impact Statement
FGE	fish guidance efficiency
FONSI	Finding of No Significant Impact
FPE	fish passage efficiency
FPOM	Fish Passage Operations and Maintenance Coordination Team
FPP	Fish Passage Plan
IT	Implementation Team
JBS	juvenile bypass structure
kcfs	thousand cubic feet per second
M&I	municipal and industrial
MAF	million acre-feet
MFWP	Montana Fish, Wildlife, and Parks
MOP	minimum operating pool
MOU	memorandum of understanding
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NRCS	Natural Resources Conservation Service
NTS	Non-Treaty Storage
NWRFC	Northwest Rivers Forecast Center
ODEQ	Oregon Department of Environmental Quality
PH1	Bonneville Powerhouse No. 1
PH2	Bonneville Powerhouse No. 2
PIT	passive integrated transponder (tag)
PUD	Public Utility District

ACRONYMS AND ABBREVIATIONS (CONTINUED)

QA/QC	quality assurance/quality control
Reclamation	U.S. Bureau of Reclamation
RM&E	research, monitoring, and evaluation
RPA	Reasonable and Prudent Alternative
RSW	removable spillway weir
SAR	smolt-to-adult return
SEPA	State Environmental Policy Act
SOI	Southern Oscillation Index
SOR	System Operations Request
SRBA	Snake River Basin Adjudication
TDG	total dissolved gas
TMT	Technical Management Team
TSP	Turbine Survival Program
TSW	temporary spillway weir
URC	upper rule curve
USFWS	U.S. Fish and Wildlife Service
WMP	Water Management Plan
WQP	Water Quality Plan for Total Dissolved Gas and Water Temperature in the Mainstem Columbia and Snake Rivers
WQT	Water Quality Team
WSF	Water Supply Forecast

B.2.1 HYDROPOWER ACTION

B.2.1.1 Introduction

Hydropower actions will be a key component in the steps to recovery of anadromous salmonids listed under the Endangered Species Act (ESA). The Federal Columbia River Power System (FCRPS) projects are operated for multiple purposes including fish and wildlife, flood control, irrigation, navigation, power, and recreation. The following Proposed Reasonable and Prudent Alternative (RPA) focuses on actions that support listed species while also providing for the multipurpose operations (that are also part of the Proposed RPA) that are as described in Appendix B.1 and associated attachments unless specifically amended in this appendix. The Action Agencies are committing to provide the necessary modifications to facilities and operations at the hydropower projects in an effort to improve adult and juvenile fish passage survival at FCRPS dams.

The Action Agencies have developed an initial hydropower action that includes water management operations; juvenile and adult dam passage modifications; operation improvements for spill and transport of juvenile fish; and operational and maintenance activities aimed towards improving juvenile passage survival and adult returns.

B.2.1.2 Specific Strategies for Hydropower

The Action Agencies have identified four specific hydropower strategies that will be implemented (Figure B.2.1-1):

- Hydropower Strategy 1 – Operate the FCRPS to more closely approximate the shape of the natural hydrograph and to enhance flows and water quality to improve juvenile and adult fish survival
- Hydropower Strategy 2 – Modify Columbia and Snake River dams to maximize juvenile and adult fish survival
- Hydropower Strategy 3 – Implement spill and juvenile transportation improvements at Columbia River and Snake River dams
- Hydropower Strategy 4 – Operate and maintain juvenile and adult fish passage facilities at Corps' mainstem projects to maintain biological performance

Underlying each of these specific strategies are one or more actions that are already in progress or will be undertaken. The following section describes these specific strategies and the actions.

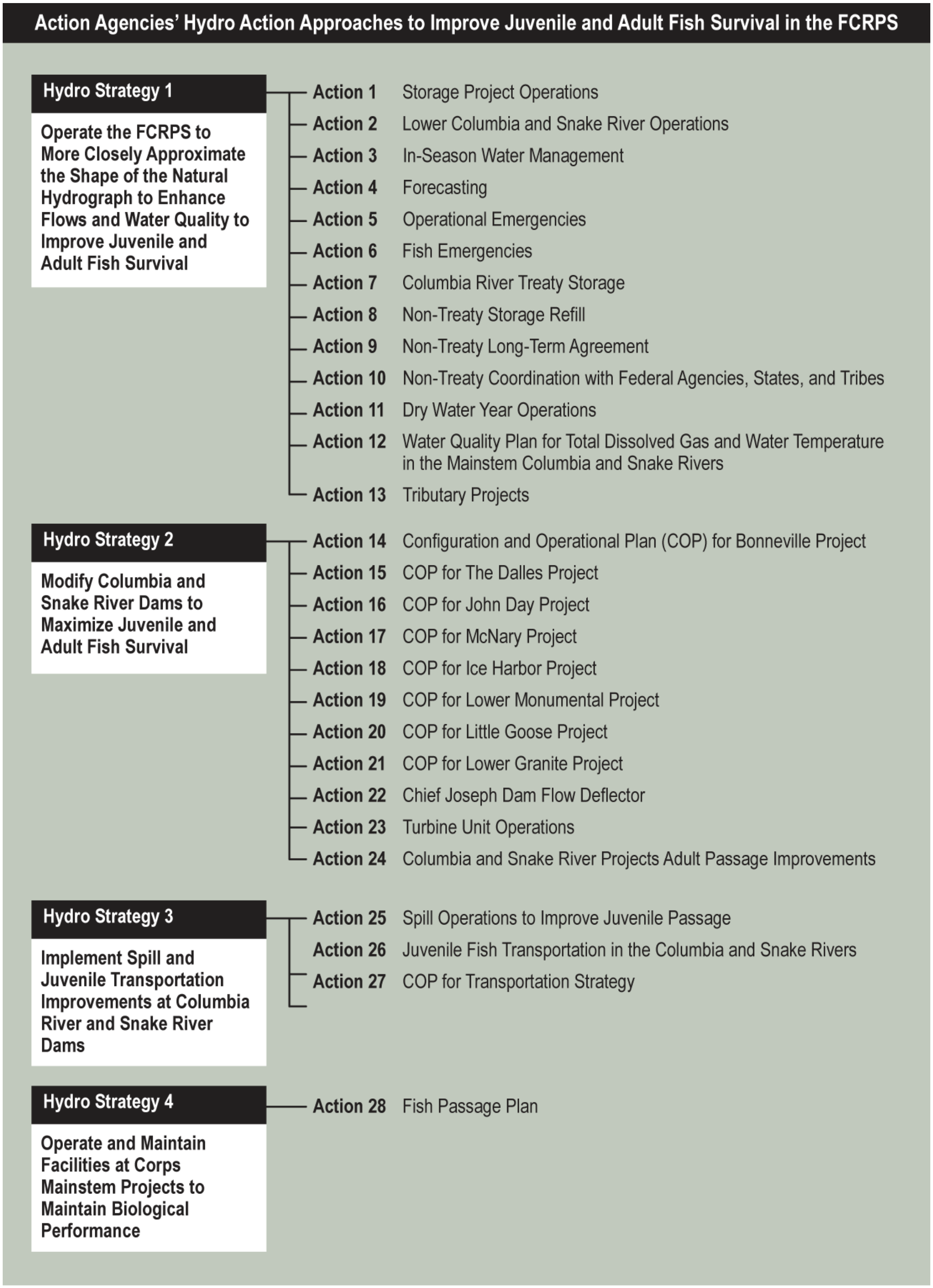

Figure B.2.1-1. Action to Improve Juvenile and Adult Fish Survival as They Pass through the Hydrosystem

B.2.1.2.1 Strategy 1 – Operate the FCRPS to More Closely Approximate the Shape of the Natural Hydrograph and to Enhance Flows and Water Quality to Improve Juvenile and Adult Fish Survival

The Action Agencies will operate the FCRPS storage projects to shape spring and summer flows as needed to benefit fish migration, and will operate certain run-of-river projects to minimize water travel time through the lower Columbia and Snake rivers as follows. Strategy 1 has thirteen actions.

Action 1 - Storage Project Operations

The Action Agencies will operate the FCRPS storage projects (Libby, Hungry Horse, Albeni Falls, Grand Coulee and Dworshak projects) for flow management to aid anadromous fish.

Specific operations for each storage project are identified in Table B.2.1-1. The storage project operations will be included in the annual WMP. These projects are operated for multiple purposes including fish and wildlife, flood control, irrigation, power, recreation, and navigation. Table B.2.1-1 primarily identifies operations that are designed to benefit flow management specifically for listed species. For more detail on operation of storage projects for other purposes see Appendix B.1

Table B.2.1-1. Storage Project Operations to be Included in the Annual WMP

Storage Project	Operation
Dworshak	• Operate to standard flood control criteria; shift system flood control to Grand Coulee in below average water years, when possible. • When not operating to minimum flows, operate to reaching the upper flood control rule curve on or about April 10 (the exact date to be determined during in-season management) to increase flows for spring flow management. • Provide minimum flows while not exceeding Idaho State total dissolved gas (TDG) water quality standard of 110 percent. • Refill by about June 30. • Draft to elevation 1535 feet by the end of August and elevation 1520 feet (80 feet from full) by the end of September unless modified per the Agreement between the U.S. and the Nez Perce Tribe for water use in the Dworshak Reservoir. • Regulate outflow temperatures to attempt to maintain water temperatures at Lower Granite tailwater at or below the water quality standard of 68° F. • Maximum project discharge for salmon flow augmentation to be within state of Idaho TDG water quality standards of 110 percent.
Libby	• Follow VARQ[1/] (variable outflow) flood control procedures. • Follow variable December 31 flood control draft based on early season water supply forecast. • Operate consistent with the Columbia River Treaty, and the International Joint Commission and the 1938 Order on Kootenay Lake.

[1/] In December 2002, the Corps prepared an Environmental Assessment (EA) and signed a Finding of No Significant Impact (FONSI) to implement VARQ on an interim basis at Libby starting in January 2003. Reclamation has been following VARQ flood control procedures at Hungry Horse Dam on an interim basis since 2002 based on an EA and a FONSI signed in March 2002. The Corps, in cooperation with Reclamation, completed preparation of the Upper Columbia Alternative Flood Control and Fish Operations Final Environmental Impact Statement (EIS) in 2006 to evaluate the long-term impacts of implementation of alternative flood control operations, including VARQ, and fish flow operations at Libby and Hungry Horse dams. Both agencies are working toward completing compliance with National Environmental Policy Act (NEPA) for a decision on long-term flood control operations and fish flow operations at Libby and Hungry Horse dams.

Table B.2.1-1. Storage Project Operations to be Included in the Annual WMP

Storage Project	Operation
Libby (continued)	• When not operating to minimum flows, operate to achieve 75 percent chance of reaching the upper flood control rule curve on or about April 10 (the exact date to be determined during in-season management) to increase flows for spring flow management. • Operate to provide tiered white sturgeon augmentation volumes to achieve habitat attributes for sturgeon spawning/recruitment consistent with the 2006 U.S. Fish and Wildlife Service (USFWS) Biological Opinion (BiOp) in May, June and July; shaped in coordination with Regional Forum TMT. • To provide for summer flow augmentation, refill by early July (exact date to be determined in-season), determined by available water supply and shape and spring flow operations, while also avoiding involuntary spill and meeting flood control objectives. • Provide even or gradually declining flows following sturgeon flows during the summer months (minimize double peak) as determined through TMT in-season management. • Experimental draft to 10 feet from full by the end of September (except in lowest 20th percentile water years, as measured at The Dalles, when draft will increase to 20 feet from full by end of September). If project fails to refill to draft limit, release inflows or operate to meet minimum flows. Rationale for the experimental draft was adopted by the Northwest Power and Conservation Council (Council) and further details of the evaluation follow in this section of the Biological Assessment (BA). Meet minimum flow requirements for bull trout from May 15 to September 30 as described in the USFWS 2006 Libby BiOp and 4,000 cubic feet per second (cfs) in October through April for resident fish. • Limit spill to avoid exceeding Montana State TDG standard of 110 percent, when possible, and in a manner consistent with the Action Agencies' responsibilities for ESA-listed resident fish. • Limit outflow fluctuations by operating to ramping rates set in the 2006 USFWS BiOp to avoid stranding bull trout.
Grand Coulee	• Use standard flood control criteria including adjustments for flood control shifts from Dworshak and Brownlee. • Operate to achieve 85 percent probability of reaching upper rule curve (URC) elevation by about April 10. • Refill by about June 30 each year (exact date to be determined during in-season management). • Take advantage of reservoir draft for flood control during high water years to perform drum gate maintenance. Drum gate maintenance may be deferred in some dry water years; however, drum gate maintenance must occur at a minimum one time in a 3-year period, two times in a 5-year period, and three times in a 7-year period. • Draft to meet salmon flow objectives during July-August with variable draft limit of 1278 to 1280 feet by August 31 based on the water supply forecast. Future evaluation of this element may be accomplished as discussed in this BA. • Reduce pumping into Banks Lake and allow Banks Lake to operate up to 5 feet from full pool (elevation 1565) during August to help meet salmon flow objectives when needed.

Table B.2.1-1. Storage Project Operations to be Included in the Annual WMP

Storage Project	Operation
Grand Coulee (continued)	• If the Lake Roosevelt drawdown component of Washington's Columbia River Water Management Program (CRWMP) is implemented, it will not reduce flows during the juvenile salmon flow objective period (April to August). The metric for this is that Lake Roosevelt will be drafted by an additional 1.0 foot in non-drought years and by about 1.8 feet in drought[2/] years by the end of August. A third of this water will go to in-stream flows. A more detailed description of this element is provided in this section of the FCRPS BA.[3/] • May be used to help meet tailwater elevations below Bonneville Dam to support chum spawning and incubation. • Operate to help meet Priest Rapids flow objective to support fall Chinook salmon spawning and incubation. • Operate to minimize TDG production.
Hungry Horse	• Follow VARQ flood control procedures.[4/] • Maintain minimum flows all year for bull trout with a sliding scale based on the forecast. Operate to meet minimum flows of 3200-3500 cfs at Columbia Falls on the mainstem Flathead River and 400-900 cfs in the South Fork Flathead River. • When not operating to minimum flows, operate to achieve 75 percent probability of reaching URC elevation by about April 10. • Refill by about June 30 each year (exact date to be determined during in-season management). • Experimental draft during July-September to a draft limit of 3550 feet (10 feet from full) by September 30, except in the driest 20 percentile of water conditions limit draft to 3540 feet (20 feet from full) when needed to meet lower Columbia flow augmentation objectives, If don't refill to the draft limit pass inflows or operate to meet minimum flows. Rationale for the experimental draft was adopted by the Council and further details of the evaluation are provided in the BA. • Provide even or gradually-declining flows during summer months (minimize double peak). • Limit spill to maximum of 15 percent of outflow to avoid exceeding Montana State TDG standards of 110 percent to the extent possible. • Limit outflow fluctuations by operating to ramping rates set in 2006 USFWS BiOp to avoid stranding bull trout.

[2/] The definition of drought year in this case is when the March 1 water supply forecast for the April through September period at The Dalles is less than 60 MAF.
[3/] Reclamation will not implement this action unless the state of Washington has secured the concurrence of the Tribes and Reclamation has separately consulted with them on a Government-to-Government basis. In addition, the State and Reclamation would need to comply with their respective Environmental Policy Acts and Reclamation would need to submit a water permit application for approval by the State.
[4/] Reclamation has been following VARQ flood control procedures at Hungry Horse Dam on an interim basis since 2002 and will complete NEPA for long-term implementation.

Table B.2.1-1. Storage Project Operations to be Included in the Annual WMP

Storage Project	Operation
Albeni Falls	• Operate to standard flood control criteria. • Operate to provide Lake Pend Oreille shoreline spawning conditions for kokanee (winter pool levels of 2055 feet or 2051 feet elevation) determined through interagency coordination per USFWS BiOp of 2000. • Interagency coordination of winter pool levels for kokanee in consideration of spawning and incubation needs for lower Columbia River chum salmon.

The Action Agencies will continue to use the following general guidelines in operating storage projects:

- When not operating to meet minimum flows, operate storage projects to be at their upper flood control elevation on or about April 10, (the exact date to be determined during in-season management) to increase flows for spring flow augmentation for fish. The Action Agencies will manage storage reservoirs to ensure they are as full as possible at the start of each spring fish passage season while recognizing flood control requirements, in-season management decisions, emergency provisions, or other extraordinary requirements for dam safety, thereby making available as much water as possible for the spring migration period.
- Storage projects will be managed (pass inflow, fill, or draft) as necessary to help meet requested weekly average flow objectives during the spring migration period, consistent with flood control operations and reservoir refill considerations and other authorized purposes as described in the annual WMP. These include minimum recommended project outflows for listed resident and anadromous fish, ramping rates and limited outflow fluctuations to avoid stranding fish.
- Storage projects will be refilled prior to the summer migration period to the extent possible given available water supply, spring operations, and consistency with flood control requirements.
- Storage projects will be drafted to elevation limits to provide flow augmentation and cool water releases to improve downstream water quality. If the project does not refill to the draft limits identified below, the project will release inflows or operate to meet minimum project flows.
- Storage projects will be operated to help provide fall and winter tailwater elevations/flows to support chum salmon spawning and incubation in the Ives Island area below Bonneville Dam and provide access for chum salmon spawning in Hamilton and Hardy creeks.

As part of Action 1 (above), the Action Agencies included an experimental draft of the Libby and Hungry Horse projects, and implementation of the Lake Roosevelt drawdown component of Washington's CRWMP, which are discussed further below. In addition, there is a proposed study of Lake Roosevelt drawdown which is under consideration; and the Action Agencies are completing NEPA documentation for long-term flood control operations at Libby and Hungry Horse concerning VARQ flood control operations.

Experimental Drafts of Libby and Hungry Horse (from the 2003 Council's Fish and Wildlife Program Mainstem Amendments)

The Action Agencies will implement a draft of Hungry Horse and Libby Reservoirs on an experimental basis from July through September of 10 feet from full pool for the wettest 80 percentile of water conditions, and a draft of 20 feet from full pool for the driest 20 percentile of water conditions. The Action Agencies are charged with evaluating and meeting the needs of both resident and anadromous fish species. Operations that are based solely on efforts to achieve anadromous fish flow objectives in the lower Columbia River, may adversely affect listed resident fish. The Action Agencies agree that an evaluation of an experimental draft is appropriate, and as part of the Proposed RPA, include the following. In its fiscal year2007 to 2009 funding decision, the Bonneville Power Administration (BPA) committed to fund and implement the Montana Fish, Wildlife, and Parks' (MFWP's) proposal for evaluation of the biological and physical effects of this operation on the fisheries upstream and downstream of Hungry Horse and Libby dams in Montana. The study will utilize MFWP's current biological baseline data as a basis for comparison. There are no specific studies or research planned to evaluate the effects in the lower Columbia River on salmon.

The MFWP's study results will be used to determine the benefits to resident fish associated with the new reservoir operations relative to the baseline. The Action Agencies propose to continue the experimental draft into the future unless information gathered informs future policy considerations that the experimental drafts of Libby and Hungry Horse reservoir operations are biologically unsound. While no study in the lower river is planned, any new information that may become available relative to salmon will be considered.

Washington State's Columbia River Water Management Program (CRWMP): Early Actions – Lake Roosevelt Drawdown

The 2006 Washington State Legislature passed the CRWMP Act (House Bill 2860) directing the Washington Department of Ecology (Ecology) to pursue development of new water supplies in the mainstem Columbia River, over the next 20 years, for both instream and out-of-stream uses. The new water supplies are to be developed through storage, conservation, improved management of existing facilities, voluntary regional water management agreements, water rights transfers and exchanges, and potentially increased access to Canadian storage. Consistent with advice provided by the National Academies of Science, Water Science and Technology Board, the intent of the statute and the program is to bind state allocation of new economic uses of water to concurrent actions that result in positive contributions to streamflows and salmon recovery during critical periods.

Ecology describes how it intends to implement the new legislation in a Final Programmatic Environmental Impact Statement (FEIS) for the CRWMP dated February 15, 2007 (2007 FEIS) that was prepared pursuant to the State Environmental Policy Act (SEPA). Three early implementation actions are also evaluated, two of which, a new Lake Roosevelt Drawdown and Potholes Reservoir Supplemental Feed Route, involve Reclamation cooperation.

In 2004, Reclamation entered into a Memorandum of Understanding (MOU) with the State of Washington and the Columbia Basin Project irrigation districts (the South Columbia Basin Irrigation District, the East Columbia Basin Irrigation District, and the Quincy-Columbia Basin Irrigation District). The MOU describes roles and expectations of those parties during conduct of the then anticipated CRWMP (known then as the Columbia River Initiative), and specifically contemplates the new Lake Roosevelt drawdown. The MOU, and subsequently the 2007 FEIS, specifically describe the allocated use of the stored water as follows:

In non-drought years (wettest 96 percent of water years), 82,500 acre-feet will be provided as follows:

- 25,000 acre-feet of municipal/industrial (M&I) supply,
- 30,000 acre-feet of irrigation water to replace ground water supply in the Odessa Subarea, and
- 27,500 acre-feet for streamflow enhancement downstream of Grand Coulee Dam.

In drought years (driest 4 percent of water years when the March 1 April to September water supply forecast at The Dalles is less than 60 million acre-feet (MAF) (statistically 1 in 26 years of record), an additional 50,000 acre-feet will be distributed as follows:

- 33,000 acre-feet for Columbia River mainstem interruptible water right holders, and
- 17,000 acre-feet for streamflow enhancement downstream of Grand Coulee Dam.

For any withdrawal from Lake Roosevelt, the CRWMP provides that one-third of the water would be available to supplement water for fish flows during the juvenile salmon migration periods (April through August period). This "no net loss plus 33 percent" formula delivers water below Grand Coulee Dam that would not be available under current operations to benefit ESA-listed fish anytime from April through August.

The current understanding of flow and survival is changing as is the Evolutionarily Significant Unit (ESU) most in need of further flow management. Although past operations prioritized summer migrants, these priorities are changing. Ecology has indicated that in the driest 20 percent of water years, the water allocated for streamflow enhancement would be released in the April through June period. For the remainder of water years, the sovereigns' governance process would identify the best use of water such that it provides the maximum biological benefit to the ESUs most in need of survival improvement to ensure their survival and opportunity for recovery. This process would also address overall cost-effectiveness, and include an analysis of impacts on tribal interests in resident fish and cultural resources in Lake Roosevelt.

When implemented as described, the new CRWMP drawdown would result in a net increase to instream flows from McNary Dam during the April through August flow augmentation period. When used in the summer months, the increase in instream flows would be roughly 225 cfs average (corresponding to the 27,500 acre-feet listed above) in non-drought years and roughly 360 cfs average (44,500 acre-feet, which represents the sum of the 27,500 acre-feet and 17,000 acre-feet listed above) in drought years.[1] The instream component of the new drawdown, however, could also be utilized at any time from April through August. In the lowest 20 percent of water years, the fish flow enhancement shall be provided in the April through June period to aid spring migrants, and in the rest of the years the water will be provided for the ESU most in need of survival improvement. This is a very small increase in stream flow; however, the purpose of the flow is to ensure that there is no flow reduction during the juvenile salmon migration period.

The proposed delivery would result in an additional drawdown of approximately 1-foot in non-drought years, and another 0.8 foot in drought years. Recent operations provided that during July through August, Lake Roosevelt may be drafted to 1280 feet elevation in the wettest 50 percent of water years, and to 1278 feet in the driest 50 percent for flow augmentation. Therefore, when conjoined with recent operations, the new CRWMP drawdown would lower the end of August elevation to 1279 feet in the wettest 50 percent of water years, to elevation 1276.2 feet in the driest 4 percent of water years, and to elevation 1277 feet in the other years (between 4 percent driest and 50 percent wettest years). Computer models indicate that refill of Lake Roosevelt would not be affected by the implementation of this additional draft.

According to a 2005 Government-to-Government Agreement in Principle (AIP) between the State of Washington and the Confederated Tribes of the Colville Reservation, the reservoir space vacated by the new draft would be refilled by September 30 of each year to ensure access to spawning habitat for

[1] Note that flow numbers may increase slightly due to return flows from M&I supply.

resident kokanee populations in Lake Roosevelt. This action would add to the reduction in September flow that occurs after the end of prescribed flow augmentation in August; however, this action is part of a suite of actions in this Proposed RPA, certain elements of which have the potential to offset this reduction.

In accordance with Section 24 of the 2004 MOU regarding ESA consultation, Reclamation proposes to implement the Lake Roosevelt drawdown as described above. This consultation is intended to cover only the Early Action - Lake Roosevelt Drawdown component of the CRWMP. Implementation of any non Lake Roosevelt Drawdown Program components will require separate ESA compliance at the appropriate time. Fundamental commitments made in the AIP, indicate that for the duration of the CRWMP, the State will not seek further drawdowns from Lake Roosevelt for use in meeting stream flow requirements or out-of-stream water supply needs along the mainstem of the Columbia River.

Section 23 of the 2004 MOU recognizes that the primary effects of the drawdown would be to Lake Roosevelt elevations and may affect the interests of the Confederated Tribes of the Colville Reservation and the Spokane Tribe of Indians. Reclamation will not implement this drawdown unless the State of Washington has secured the concurrence of the Tribes and Reclamation has separately consulted with them on a Government-to-Government basis.

In addition, the State, as well as Reclamation, must comply with the SEPA and NEPA. Finally, Reclamation would need to submit a water permit application for approval by the State.

Proposal to Evaluate Drafting Lake Roosevelt to 1278 Only in Lower Water Years

Drafting Lake Roosevelt and other reservoirs in July and August provides flow augmentation for migrating juvenile salmonids. Currently and as included in the Proposed RPA, Lake Roosevelt is drafted to 1280 feet when the Water Supply Forecast (WSF) is greater than 92 MAF (wettest 50 percent of water years) April through August at The Dalles. When the WSF is lower than 92 MAF (driest 50 percent of water years) at The Dalles, Lake Roosevelt is drafted to elevation 1278 feet. During the Remand process, there was a proposal to evaluate drafting Lake Roosevelt to elevation 1278 during July through August in the lowest 20 percentile of water years only; in other years, it would only be drafted to 1280 feet. This would lessen effects on Lake Roosevelt, but provide less downstream flow in other water years. This proposal would be subject to future evaluation and modeling. Based on future evaluations, drafting Lake Roosevelt to 1278 only in lower water years may be considered for future operations under adaptive management.

Action 2 - Lower Columbia and Snake River Operations

The Action Agencies will operate the FCRPS run-of-river mainstem lower Columbia River and Snake River projects (Bonneville, The Dalles, John Day, McNary, Ice Harbor, Lower Monumental, Little Goose and Lower Granite projects) to minimize water travel time through the lower Columbia and Snake rivers to aid in juvenile fish passage as defined below. These projects are operated for multiple purposes including fish and wildlife, irrigation, navigation, power, recreation, and limited flood control. The following description primarily identifies operations that are designed to benefit listed anadromous species.

- Lower Snake River projects (Ice Harbor, Lower Monumental, Little Goose and Lower Granite projects) will be operated at minimum operating pool (MOP) with a 1-foot operating range from April 3 until small numbers of juvenile migrants are present (approximately September 1) unless adjusted to meet authorized project purposes, primarily navigation. Lower Granite reservoir may be raised as needed after September 1, in order to operate the adult fish holding facilities to support brood stock collection.
- Except for the John Day Project, the Lower Columbia River projects (Bonneville, The Dalles, and McNary) will be operated at normal operating range for each project. John Day Reservoir will be operated at the lowest elevation (elevation 262.5 to 264.0) (with a 1.5-foot operating range) that continues to allow irrigation withdrawals from April 10 through September 30. Slight deviations from these levels, based on navigation needs, load following, and operational sensitivity, may be required on occasion.
- These run-of-river operations will be included in the annual WMP.

Flow Objectives and Velocities

The Action Agencies will use a variety of operational objectives to operate the FCRPS throughout the year for various fishery needs. Inherent in the operation is recognition that available storage—water that actually can be managed—is limited relative to total annual runoff in the Columbia River Basin. One of the purposes of the storage projects in the Columbia River Basin is to reduce peak flood flows. These projects, however, do not have sufficient storage to alter the overall shape of the natural hydrograph. Flow objectives have been identified for the purpose of planning and implementing annual, seasonal and shorter time-step operations to best meet biological needs of salmon and steelhead within the context of meeting flood control objectives.

Although there is a limited amount of water available for flow, augmentation and flow objectives provide guidelines for how that water should be shaped. It should be recognized, however, that there are tradeoffs associated with operating for each flow objective. The use of the available water to improve flows for one ESU could affect the water available for another. For example, water releases from November through the spring that enhance chum salmon spawning and incubation and flows to benefit Hanford Reach fall Chinook salmon spawning and incubation could affect the ability to meet flow objectives in the spring, and/or could affect the probability of meeting summer refill targets at storage projects. Likewise, operations to help meet spring flow objectives can impact project refill and vice versa. The level to which one objective impacts the ability to meet another objective changes from year to year because of water supply and shape of runoff variability.

The purpose of the flow objectives shown in Table B.2.1-2 are intended to be used for purposes of pre-season planning and in-season water management, but are not achievable in all years or periods because they are largely dependent on annual and seasonal water conditions, including natural runoff volume and shape.

Table B.2.1-2. Seasonal Flow Objectives and Planning Dates for the Mainstem Columbia and Snake Rivers

Location	Spring Dates	Spring Objective (kcfs)	Summer Dates	Summer Objective (kcfs)
Snake River at Lower Granite Dam	4/03 to 6/20	85 to 100[1/]	6/21 to 8/31	50 to 55[1]
Columbia River at McNary Dam	4/10 to 6/30	220 to 260[1/]	7/01 to 8/31	200
Columbia River at Priest Rapids Dam	4/10 to 6/30	135	N/A	N/A
Columbia River at Bonneville Dam	11/1 – emergence	125 to 160 [2/]	N/A	N/A

Notes:
1/ Objective varies according to water volume forecasts.
2/ Objective varies based on actual and forecasted water conditions.
kcfs - thousand cubic feet per second

Computer modeling was used to assess the ability of the hydrosystem to augment flows for migrating juvenile anadromous fish. Using 70 historical water conditions (1929 to 1998) in the Columbia River Basin and augmenting those natural flows with reservoir operations within the limits prescribed in the Proposed RPA, spring and summer season average flows are equal to, or greater than, the season average flow objectives as follows:

	Number of years between 1929 to 1998 where average modeled flows were equal to or greater than average flow objectives
Lower Snake spring	46 (66%)
Lower Snake summer	8 (11%)
Lower Columbia spring	48 (68%)
Lower Columbia summer	18 (26%)

The seasonal objective will be shaped each week for particular reaches through the Regional Forum TMT. To help meet the weekly flow objectives, the seasonal flow augmentation volumes in the storage projects will be used. Sovereigns can submit operational requests, System Operational Requests (SORs), to adjust flow on a weekly average basis consistent with parameters described in Action 3, In-Season Water Management. Such requests are not precluded from exceeding weekly or seasonal flow objectives.

The Action Agencies will seek to meet these weekly flow requests based on optimal overall use of available volumes in storage reservoirs to benefit migrants and spawners, as necessary throughout the seasons. These requests will take into account the needs of resident fish and other reservoir objectives through implementation of the water management provisions that determine the actual managed flows that can be provided at a given time. For example, available storage will not necessarily be used to achieve weekly flow objectives if available storage would be prematurely depleted; rather, the available water would be distributed across the expected migration season to optimize biological benefits/fish survival.

Lower Snake River project operations at MOP are intended to increase water velocity and reduce surface area to assist in moderating water temperature. These projects were designed to accommodate navigation, which includes maintaining a navigation channel and navigation locks to enable passage past these projects. To ensure safe navigation, minimum pool elevations are necessary to allow barge traffic to move through the navigation channel and locks, which are designed with a 15-foot sill. Minimum operating pool elevation for the lower Snake River projects are:

	Minimum	Maximum
Lower Granite	733	738
Little Goose	633	638
Lower Monumental	537	540
Ice Harbor	437	440

The Action Agencies seek to meet water temperature objectives at the Lower Granite Dam tailrace for the summer migration period through the use of available tools, including releases of cool water from Dworshak project. However, as in the case of flow objectives, it is recognized that temperature objectives cannot be achieved at all times and under all water conditions due to reservoir storage limits, tributary inputs, TDG limits, and natural temperature conditions.

The Action Agencies will also consider other flow-related objectives in water management including flows for Hanford Reach Fall Chinook Salmon, ESA-listed chum salmon, as well as flows for ESA-listed sturgeon and bull trout.

The weekly flow performance will be translated mathematically through a simple conversion into a velocity. Flow objectives to velocity conversion tables are presented for the lower Columbia River and lower Snake River, respectively, in Tables B.2.1-3 and B.2.1-4.

Table B.2.1-3. Lower Columbia River (Ice Harbor Dam to Bonneville Dam) Flow Objectives to Velocities Conversion Table

Scenario	July- Aug Average (kcfs)	Water Travel Time at Flow (days)[1/]	Water Travel Velocity at Flow (feet/second)
Minimum. Spring BiOp	220	8.8	0.97
Maximum. Spring BiOp	260	7.4	1.15
Summer BiOp	200	9.7	0.89

Note:
1/Travel times and velocities are presented here from Ice Harbor Dam to Bonneville Dam.

Table B.2.1-4. Lower Snake River (Lower Granite Pool to Ice Harbor Dam) Flow Objectives to Velocities Conversion Table

Scenario	Flow Average (kcfs)	Water Travel Time at Flow (days)[1/]	Water Travel Velocity at Flow (feet/second)
Minimum Spring BiOp	85	10.1	0.71
Maximum Spring BiOp	100	8.6	0.84
Minimum Summer BiOp	50	17.2	0.42
Summer BiOp	55	15.6	0.46

Note:
1/Travel times and velocities are presented here from Lower Granite pool to Ice Harbor Dam.

The velocity component is neither established for, nor monitored and evaluated as absolute physical performance requirements of the hydrosystem. Hydrosystem performance regarding attributes associated with flow will be assessed annually by considering how water was stored and released consistent with the identified constraints.

Action 3 - In-Season Water Management

Prioritization of the use of flow augmentation water is done through in-season management. Each fall, the Action Agencies prepare an annual WMP and seasonal updates that describe planned hydrosystem fish operations for the upcoming fall and winter, and for the spring and summer passage seasons. The annual WMP strives to achieve the best possible mainstem passage conditions, recognizing the priorities established in this document and the need to balance the limited water and storage resources available in the region. Fall/winter and spring/summer updates are prepared as more data is available on the water conditions for that year. A draft of the annual WMP will be prepared by October 1 each year, with a final plan completed by January 1. The fall/winter update to the WMP will be drafted by November 1 and finalized by January 1. A draft of the spring/summer update to the WMP will be prepared by March 1 and finalized by May 15.

The WMP and seasonal updates are reviewed by the Regional Forum Technical Management Team (TMT). The Regional Forum TMT was initiated with the 1995 FCRPS BiOp and is the body within the Regional Forum in which technical representatives from Federal agencies with regulatory or action authority in the Columbia River Basin, and sovereign States and Tribes with management responsibility over fish and wildlife resources in the Columbia River Basin, work together to adaptively manage operations of the FCRPS for ESA-listed fish species while meeting other project objectives. The TMT meetings are public and facilitated by an impartial third party. Recommendations to the Action Agencies are made on a consensus basis. Consensus is defined as the lack of formal objection.

The Regional Forum TMT considers in-season changes to FCRPS operations, which include changes formally proposed as an SOR. If the TMT cannot reach consensus on an SOR, the proposed operational change may be elevated to the Implementation Team (IT), which includes policy representatives from the same Federal agencies, States and Tribes. The TMT also serves as a forum for the exchange of data and research findings, which assures that the FCRPS is managed according to the most up-to-date information available.

SORs will be made consistent with the following general principles:

- Consideration will be given to listed and non-listed resident and anadromous fish when making operational decisions.
- The greatest flexibility exists in-season (April through August).
- While specific minimum reservoir elevations, flow priorities, minimum flows and flow objectives are identified in the Proposed RPA, after meeting statutory and legal obligations, there is some latitude to adjust level of flow, and shaping of flow during the April through August period (subject to April through July flood control limits).
- Operations at Dworshak for temperature control during July and August are to be consistent with the Snake River Basin Adjudication (SRBA) agreement and meet Corps' Clean Water Act obligations regarding temperature and TDG standards.

Action 4 - Forecasting

The Action Agencies will hold annual forecast performance reviews looking at in-place tools for seasonal volume forecasts and to report on the effectiveness of experimental or developing/emerging technologies and procedures. As new procedures and techniques become available and are identified to have significant potential to reduce forecast error and improve the reliability of a forecast, the Action Agencies will discuss the implementation possibilities with regional interests. The purpose is to improve upon achieving upper rule curve (URC) elevations by reducing forecasts errors and thereby providing for improved spring flows.

Forecasts are used by the Action Agencies to assist in identifying appropriate flood control operations at the storage projects during the winter/spring and inform regional discussions on water supply for fishery operations. Various forecasts are prepared:

- Each project operator is responsible for the preparation of the water supply forecast at their respective headwater storage project: BC Hydro prepares Mica, Keenleyside, and Duncan; the Corps prepares Libby and Dworshak; and Reclamation prepares Hungry Horse.
- Additional statistical water supply forecasts are prepared for all other basins and subbasins by the National Weather Service River Forecast Center (NWRFC).
- The Natural Resources Conservation Service (NRCS) also produces water supply forecasts for a subset of basins in the Northwest.

The final, official water supply forecasts from the Corps and the NWRFC are generally made available during the first 10 days of each month from January through June. These water supply forecasts are prepared once each month because they typically require snow course data readings, which are only taken once each month. All of the above forecasts are statistical forecasts from regression equations based on such variables as precipitation and snowfall, and in some cases, a climate indicator such as the Southern Oscillation Index (SOI).

In addition to the "final" forecast prepared early in the month, the National Weather Service River Forecast Center also prepares mid-month and early bird water supply forecasts. The mid-month forecast uses about half the precipitation reports and no updated snow or runoff values. The early-bird forecast is prepared toward the end of a month; it includes about half the precipitation reports, estimated end-of-month snow from available automated snowpillow sites, and estimated monthly runoff. Since these forecasts do not include a complete input dataset, the mid-month and early-bird forecasts are only used as a trend of the forecast and are not used to determine specific reservoir operations.

The NRCS has recently developed water supply forecasting models that are updated daily. However, these forecasts are currently only available for a limited subset of sites. The NRCS forecasts are currently utilized only for comparison to the "official" forecasts.

The National Weather Service River Forecast Center also prepares Ensemble Streamflow Prediction (ESP) hydrographs for all projects on at least a weekly schedule. The ESP model utilizes physical based equations to produce a collection of possible streamflows at each site. A water supply volume can be calculated from each ESP streamflow series and a statistical analysis can be done to provide a probabilistic look at the seasonal water supply. The ESP water supply forecast product is not used to determine reservoir operational strategies; however individual hydrologic sequences that are developed by the ESP may be used to test the sensitivity of particular operations from the headwater project to The Dalles Dam pool.

The Action Agencies held a regional workshop in June 2006 to discuss currently available seasonal volume forecast procedures and ways of improving water supply forecasting. Some suggestions from this workshop included:

- Resurrecting a forecasting group to annually examine WSF methods and verification at the end of each water year;
- Focusing the next workshop on both short- and long-term in-season streamflow forecasting and/or
- Incorporating other forecast methods (e.g., Bayesian techniques), developed by universities and other agencies, to improve the forecasting process and product.

The Action Agencies will hold annual forecast performance reviews to assess performance of existing forecast tools and effectiveness of emerging technologies.

Action 5 - Operational Emergencies

The Action Agencies will manage interruptions or adjustments in water management actions, which may occur due to unforeseen power system, flood control, navigation, dam safety, or other emergencies. Such emergency actions will be viewed by the Action Agencies as a last resort and will not be used in place of operations outlined in the annual WMP. Emergency operations will be managed in accordance with TMT Emergency Protocols in the Fish Passage Plan (FPP) and other appropriate Action Agencies emergency procedures. The Action Agencies will take all reasonable steps to limit the duration of any emergency impacting fish.

During winter power system emergencies, water being held in reservoirs for spring and summer flow augmentation may be drafted. Once the emergency is resolved, the Action Agencies will strive to replace this water as soon as, and to the maximum extent, possible. During summer emergencies, storage reservoirs may be drafted below BiOp draft limits, spill for fish passage may be reduced, or turbines may be operated outside of the 1 percent best efficiency range. Discussion of emergencies with effects of exceptional magnitude or duration will include involvement of regional executives.

Action 6 - Fish Emergencies

The Action Agencies will manage operations for fish passage and protection at FCRPS facilities. They may be modified for brief periods of time due to unexpected equipment failures or other conditions. These events can result in short periods when projects are operating outside normal specifications due to unexpected or emergency events. Where there are significant biological effects of more than short duration resulting from emergencies impacting fish, the Action Agencies will develop (in coordination with the Regional Forum) and implement appropriate adaptive management actions to address the situation. The Action Agencies will take all reasonable steps to limit the duration of any fish emergency.

Fish emergencies may occur for several reasons, including but not limited to those listed below.

- Mechanical breakdown, malfunction, failure, or closing of:
  - Adult or juvenile fish passage/collection facilities
  - Transport barges, tanks, or trucks
  - Spillway, powerhouse, navigation lock, and project structures
- Unexpected outages or repairs for dam safety reasons
- Severe debris loads requiring special project operations
- Untreated chemical contaminant releases or spills (e.g., oil, fuel, or herbicides). This may occur at the project or at another location in the river where water will flow through project structures and fish passage facilities
- Adjustments in discharges or navigation lock operation for vessel safety (e.g., due to grounding or sinking)

These emergencies will be managed in accordance with the Regional Forum TMT Emergency Protocols and provisions for emergency facility operations in the FPP (see Action 28). The Action Agencies will take all reasonable steps to limit the duration of any fish emergency.

The following section of the Hydropower Action includes activities related to:

- The Columbia River Treaty storage for possible use of Treaty storage to support U.S. flow operations that would benefit the ESA-listed ESUs during the migration season, considering ESU status;
- Non-Treaty storage (NTS) refill;
- Non-Treaty Long-Term Agreement;
- Coordination with Federal agencies, States, and Tribes regarding non-Treaty matters.

Action 7 - Columbia River Treaty Storage

BPA and the Corps will pursue negotiations with Canada of annual agreements to provide 1 MAF of storage in Treaty space by April 15 consistent with:

- Providing the greatest flexibility possible for releasing water to benefit U.S. fisheries May through July;
- Giving preference to meeting April 10 URC elevation or achieving refill at Grand Coulee Dam over flow augmentation storage in Canada in lower water supply conditions; and
- Releasing flow augmentation storage to avoid causing damaging flow or excessive TDG in the U.S. or Canada.

BPA and the Corps will coordinate with Federal agencies, States and Tribes on Treaty operating plans.

The Columbia River Treaty between the United States and Canada provides far-reaching measures for cooperative development and operation of the Columbia River hydrosystem for flood control and power purposes. In addition to the Treaty itself, there are the Treaty Protocol and Treaty Annexes that were negotiated between the governments of the United States and Canada in the 1960s. These supplementary documents serve to interpret the provisions of the Treaty and provide more specific direction on the agreed-upon approach to management of the Columbia River Basin. When considering the Treaty, it is important to keep in mind that although the Treaty calls for cooperation between the United States and Canada, the Treaty also clearly gives Canada great discretion to operate its storage facilities in Canada in whatever manner it sees fit, with little to no say by the United States, so long as Treaty objectives for flow at the border are met.

BPA and the Corps will coordinate with Federal agencies, States, and Tribes on Treaty operating plans. In a given operating year, this coordination will include holding discussion(s) with Federal agencies, States, and Tribes about planned operations and operating plans to solicit ideas and information, informing Federal agencies, States, and Tribes of the final selected operation and/or operating plan, and providing an annual update during the fish passage season.

Action 8 - Non-Treaty Storage Refill

BPA, in concert with BC Hydro, will refill the remaining NTS space by June 30, 2011, as required under the 1990 non-Treaty storage agreement. Refill will be accomplished with minimal adverse impact to fisheries operations, to the extent possible.

When the Canadians constructed the Mica Project on the Columbia River in Canada in the 1970s, Canada elected to construct this dam significantly larger than called for by the Columbia River Treaty. Specifically, Mica also was constructed to provide an additional 5.0 MAF of storage beyond that required by the Columbia River Treaty. As such, this additional storage is not operated under the Treaty; it thus is referred to as Non-Treaty Storage (NTS), which is managed for Canada by BC Hydro.

There are two important limitations on use of NTS. First, in accordance with Treaty terms, this additional storage may not be operated in a manner that would reduce the flood control and power benefits produced under the Treaty operation. Second, the United States and BPA have no inherent right to use of this storage. BC Hydro, however, has occasionally agreed to allow BPA use of this storage when its use is consistent with Treaty requirements and provides mutual benefits to both parties. Agreements involving use of this storage are referred to as NTS agreements. The most recent NTS agreement was negotiated in 1990 and expired in June of 2004, following a one-year extension. Under that agreement, the parties have until June 30, 2011 to refill the NTS space, which, as of April 15, 2007, is about 78 percent full. At the present time, there is no agreement in place with BC Hydro that would allow the U.S. or BPA to provide a release of water from NTS space.

It is recognized that BPA and BC Hydro have a contractual obligation to refill NTS by 30 June 2011. The purpose of the following guidelines is to enable this refill to occur in a prudent manner. Storage into NTS should be accomplished with minimal adverse impact to fisheries operations to the extent possible.

Minimizing adverse impact to fisheries operations is in large measure determined by the ability to maintain flows during the fish passage season while reducing the likelihood that storage will occur during a low flow year to meet the contractual refill obligation. There are alternative views as to what flow standard should be used during the April to August fish passage season to define acceptable storing conditions. Storage would occur in a manner that allowed meeting flow objectives (Table B.2.1-2) to the extent possible while still meeting the 2011 obligation to refill.

Alternative suggested guidelines or criteria for storage operations include storage to refill NTS space that may occur when flows at Priest Rapids and McNary are (1) expected to meet flow targets both on a season-average basis and on a weekly basis during the week in which the storage occurs; or (2) 120 percent of the flow target during the week in which storage occurs; (3) when flows exceed the flow target and are expected to exceed flow targets for 80 percent of the remaining weeks in the season; or (4) weekly average flow targets or when dissolved gas standards are exceeded; or if (5) NTS space still remains unfilled in spring 2011, storage to refill must occur whether any of the preceding four conditions exist.

Action 9 - Non-Treaty Long-Term Agreement

BPA will seek to negotiate a new long-term agreement on use of non-Treaty space in Canada so long as such an agreement provides both power and non-power benefits for BC Hydro, BPA, and Canadian and U.S. interests. As part of these negotiations, BPA will seek opportunities to provide benefits to ESA-listed fish, consistent with the Treaty. If a new long-term non-Treaty agreement is not in place, or does not address flows for fisheries purposes, BPA will approach BC Hydro about possibly negotiating an annual/seasonal agreement to provide U.S. fisheries benefits, consistent with the Treaty.

BPA will seek to negotiate a new long-term agreement with BC Hydro to enable use of NTS space in Canada once (a) BPA and BC Hydro have made substantial progress in refilling NTS space, and (b) the collective U.S. interests in terms of such a new agreement are established.

A new long-term agreement utilizing NTS space is viable only if it provides power and non-power benefits for BC Hydro, BPA, and Canadian and U.S. interests. If a new long-term agreement is not in place, or does not address flows for fisheries purposes, BPA will approach BC Hydro about possibly negotiating an annual/seasonal agreement to provide U.S. fisheries benefits consistent with the Treaty. In accordance with Treaty requirements, NTS may not be operated under any new agreement to reduce Treaty power and flood control benefits.

If BC Hydro agrees to attempt to negotiate a new long-term non-Treaty agreement that is mutually beneficial, as part of these negotiations, BPA will attempt to achieve opportunities to provide benefits for ESA-listed ESUs by using the storage to shape water releases within the year and between years to improve flows in the lowest 20th percentile water years to the benefit of the ESA-listed ESUs, considering ESU status.

Action 10 - Non-Treaty Coordination with Federal Agencies, States, and Tribes

Prior to negotiations of new long-term or annual non-Treaty storage agreements, BPA will coordinate with Federal agencies, States, and Tribes to obtain ideas and information on possible points of negotiation, and will report on major developments during negotiations.

If BC Hydro is interested in negotiating a new annual or long-term NTS agreement, BPA will coordinate with Federal agencies, States, and Tribes prior to any such negotiation to obtain ideas and information on possible points of negotiation, and will report on major developments during the negotiations. If negotiations are successful and result in a new agreement between BPA and BC Hydro, BPA will report to Federal agencies, States, and Tribes on the resulting agreement.

Action 11 - Dry Water Year Operations

Flow management during dry years is often critical to maintaining and improving habitat conditions for ESA-listed species. A dry water year is defined as the lowest 20th percentile years based on the Northwest River Forecast Center's (NWRFC) averages for their statistical period of record (currently 1971 to 2000) using the May final water supply forecast for the April to August period as measured at The Dalles. The Action Agencies propose the following activities to further the continuing efforts to address the dry flow years:

- Within the defined "buckets" of available water (reservoir draft limits identified in Action 1), flexibility will be exercised in a dry water year to distribute available water across the expected migration season to optimize biological benefits and anadromous fish survival. The Action Agencies will coordinate use of this flexibility in the Regional Forum TMT.
- In dry water years, operating plans developed under the Treaty may result in Treaty reservoirs being operated below their normal refill levels in the late spring and summer, therefore, increasing flows during that period relative to a standard refill operation.
- Annual agreements between the U.S. and Canadian entities to provide flow augmentation storage in Canada for U.S. fisheries needs will include provisions that allow flexibility for the release of any stored water to provide U.S. fisheries benefits in dry water years, to the extent possible.
- BPA will explore opportunities in future long-term NTS storage agreements to develop mutually beneficial in-season agreements with BC Hydro to shape water releases using NTS space within the year and between years to improve flows in the lowest 20th percentile water years to the benefit of ESA-listed ESUs, considering their status.
- Upon issuance of the FCRPS BiOp, the Action Agencies will convene a technical workgroup to scope and initiate investigations of alternative dry water year flow strategies to enhance flows in dry years for the benefit of ESA-listed ESUs.
- In very dry years, the Action Agencies will maximize transport for Snake River migrants in early spring, and will continue transport through May 31.
- BPA will implement, as appropriate, its *Guide to Tools and Principles for a Dry Year Strategy* to reduce the effect energy needs may pose to fish operations and other project purposes.

The specific dry water year operations are described in the following subsections.

Flexibility in Managing Flows

Dry water years can amplify the tradeoffs inherent in managing flows to meet competing fishery objectives. For example, maintaining rearing flows for chum salmon below Bonneville Dam and fall Chinook salmon in the Hanford Reach can reduce the amount of water available for spring migrants, and refilling reservoirs for summer migrants may divert flows for spring migrants. The operational flexibilities outlined in Action 1 can be used to address such tradeoffs and to distribute the available water across the expected migration season to optimize biological benefits and anadromous fish survival in dry years, while taking into account the needs of resident fish and other reservoir objectives. Exercise of this flexibility will be coordinated through the TMT's in-season management process.

Treaty and Non-Treaty Storage Operations

Flows in dry water years can be affected by Treaty or NTS operations. Approaches for addressing these include:

- Operations of Treaty Storage in Dry Years. Operating plans, prepared in advance of the operating year, are developed to meet power and flood control objectives under the Treaty. These operating plans include a raft of Treaty projects in low water conditions to meet regional loads – termed "proportional draft." In dry water years, Treaty reservoirs would be operated below their normal refill levels in the late spring and summer, therefore increasing flows during that period relative to a standard refill operation.
- Store in Canada for Non-Power Purposes. To the extent possible, annual agreements described in Action 6 between the U.S. and Canadian Entities to provide flow augmentation storage in Canada for U.S. fisheries needs will include provisions that allow flexibility for the release of any stored water to provide U.S. fisheries benefits.
- Use of NTS Space. BPA will explore opportunities in future long-term NTS agreements to develop mutually beneficial in-season agreements with BC Hydro to shape water releases using NTS space within the year and between years to improve flows in the lowest 20th percentile water years to the benefit of ESA-listed ESUs, considering ESU status.

Investigation of Other Dry Water Year Flow Strategies

The issue of improving spring flows in dry water years has been deliberated in the Remand Collaboration Process. Though the relationship of flow levels to survival of juvenile fish migrating through the hydroelectric system is not clear, it is generally understood that in-river survival of juvenile migrants is considerably lower in low flow years than in average and higher flow years.

During the Collaboration, several scenarios were modeled to investigate alternative flow management actions that might improve spring flows in low flow years for the benefit of juvenile spring Chinook salmon, steelhead, and sockeye salmon from the upper Columbia and Snake rivers. Though the Collaboration did not reach definitive conclusion on this topic, the Action Agencies believe this issue warrants further investigation and propose the following:

- Upon issuance of the FCRPS BiOp by the National Marine Fisheries Service (NMFS, also called the National Oceanic and Atmospheric Administration [NOAA] Fisheries), the Action Agencies will convene a technical workgroup under the guidance of the Policy Work Group to scope and initiate investigations of a dry water year flow strategy. The investigations will include modeling of FCRPS operations, fish survival modeling (using COMPASS, the Comprehensive Fish Passage Model), and consideration of compatible operations of Canadian projects including possible new NTS agreements.
- Operational constraints and guidelines under the discretion of the Action Agencies and the fishery management entities will be relaxed, as needed and appropriate, to ensure consideration, evaluation, and development of options to improve spring flows in dry water years. Biological and economic effects of various dry water year flow options will be estimated. Changes in administrative procedures and agreements necessary to implement a given option will be documented and assessed.
- A technical workgroup will be convened and preliminary results will be reported by August 31, 2008.

Implementation of BPA's Guide to Tools and Principles for a Dry Year Strategy

Implementation of BPA's *Guide to Tools and Principles for a Dry Year Strategy* (Guide) may reduce the effect energy needs may pose to other projects purposes, including fish and wildlife needs, by increasing the supply or reducing the demand for energy in dry years. The Guide was developed in response to the energy crisis of 2000 and 2001 and addresses principles and tools BPA will employ to meet its load obligations in dry water conditions; the Guide does not address changes to fish operations, but lists the tools to be considered in dry water conditions.

During dry years, BPA will make decisions on what dry year tools to pursue to maintain power system stability and reliability, while meeting other statutory responsibilities, including responsibilities to:

- Balance both non-power and power uses during the energy shortage;
- Maintain Federal trust responsibilities;
- Protect fish and wildlife consistent with ESA; the 1980 Northwest Power Act, and other laws; and
- Act in a sound and business-like manner;
  - Provide an adequate, efficient, economical, and reliable power supply, and
  - Provide a cost-effective solution to the energy shortage to maintain rates as low as possible to minimize the economic impact to the region and the FCRPS.

It is impossible to create, in advance, a meaningful and prioritized list of events that would trigger the use of dry year tools. The individual circumstances associated with a dry year (such as the regional scope and the state of the regional economy) and the relative cost (including energy and commodity market prices) and availability of tools all impact the appropriate response. Therefore, the use of dry year tools can be used at any time to temporarily solve energy shortages that threaten the ability of BPA to meet its load obligation.

Dry Year Tools that Add Flow to the Columbia River and Reduce Power Emergency Risk

- Reclamation and the irrigation districts would enter in agreements to leave project land fallow, capped at some percent in order to limit disruption to the local agricultural economy. Approximately 4 acre-feet of water per acre of land left fallow would remain in the mainstem Columbia River to improve flows and increase power generation. This would also save energy by reducing energy consumed pumping water into Banks Lake from Lake Roosevelt. This program has to be triggered early in January/February before investments and contracts are entered into by irrigators.
- BPA's and its eastside load-following customers would enter into agreements to reduce irrigation pump load (either aquifer or surface water lift). Note that this program has to be triggered in January/February before investments are made in planting. In addition, because this program is done on a public utility or electric cooperative scale, it is difficult to assign what portion of the program would be attributable to pumps that take water directly out of surface streams or rivers to those pumps which access aquifer storage.

Dry Year Tools that Reduce Power Emergency Risk

- Direct Service Industries (DSIs) no longer purchase power directly from BPA, but receive a capped financial benefit based upon their levels of operation and other criteria. DSIs are also currently operating at levels substantially below historical levels. These two factors limit the potential amount of load reduction that could be achieved.
- Three energy efficiency programs could by implemented relatively quickly: compact fluorescent bulbs, irrigation scheduling, and commercial pre-rinse valves.

- The four largest industrial end-use consumers of BPA's load-following customers consume approximately 400 average megawatts total. There may be opportunities to either substitute market purchases for energy intensive processes (such as buying market pulp as opposed to grinding it on site) or to temporarily shut down processes or machines. The price and quantity of opportunities depend in part on the economic conditions of the commodity products that these mills produce.
- There are power products available in power markets that can be used to meet BPA's load obligations, but prices and quantities available may not always be advantageous.
- Power from one utility is exchanged for power from another utility system. Utilities may have unique load and resource characteristics that make energy trades advantageous. For example, California generally has peak load in the summer, while in the Pacific Northwest, loads in the major west-side load centers peak in the winter.
- This can be acted on alone or the first step before a Regional Curtailment is enacted. The amount of energy conserved by eliciting public requests is hard to quantify, but it has been estimated at around 5 percent. The amount of energy conserved is also not only unpredictable, it is usually only for very short-term periods.
- Coordinate with regional governors to exercise emergency powers to impose mandatory load curtailments.
- Storage agreements between BPA and other utilities that have storage capability may be used to improve reliability in a low-flow period. This would reduce power production in one period while increasing it in another. This type of agreement involving energy shaping can usually be reached in a short time frame. In order to provide additional water (not just energy) during dry water years the only likely reservoirs that can be used are in Canada and it takes considerably more time to develop agreements and store the water to be re-shaped. Any such storage agreements would be under the auspices of the Columbia River Treaty or would utilize NTS space in Canada, as discussed previously.

Action 12 – Water Quality Plan for Total Dissolved Gas and Water Temperature in the Mainstem Columbia and Snake Rivers

The Action Agencies will continue to update the *Water Quality Plan for Total Dissolved Gas and Water Temperature in the Mainstem Columbia and Snake Rivers* (WQP) and implement water quality measures to enhance ESA-listed juvenile and adult fish survival and mainstem spawning and rearing habitat. The WQP is a comprehensive document which contains water quality measures needed to meet both ESA and Clean Water Act responsibilities. For purposes of this Proposed RPA, the WQP will include the following measures to address TDG and water temperature to meet ESA responsibilities:

- Real-time monitoring and reporting of TDG and temperatures measured at fixed monitoring sites,
- Continued development of fish passage strategies with less production of TDG [(e.g., removable spillway weirs (RSWs)],
- Continued development and use of SYSTDG model for estimating TDG production to assist in real-time decision making,
- Continued development of the CE-QUAL-W2 model for estimating river temperatures to assist in real-time decision making for Dworshak Dam operations, and
- Continued operation of lower Snake River projects at minimum operating pool (MOP).

The Action Agencies will continue development and implementation of water quality measures to enhance juvenile and adult fish survival and mainstem spawning and rearing habitat. This includes actions as identified in the comprehensive WQP that will make further progress towards meeting water quality standards for TDG and water temperature.

Other measures include continued water quality monitoring in the mainstem rivers, performing the necessary quality assurance/quality control (QA/QC) to ensure accurate measurements and sharing this information on a real-time basis. Additional measures would include performing the necessary modeling efforts (including SYSTDG) in both the Action Area and conjoining areas to make the best in-season management decisions for operating the river and implementing voluntary spill to improve fish passage and survival. The Action Agencies will continue to use the SYSTDG model as a river operations management tool. SYSTDG results will be coordinated through the Water Quality Team (WQT), the TMT, and the Mid-Columbia Public Utility Districts (PUDs).

Total Dissolved Gas (TDG) Measures

The Corps prepared a total dissolved gas abatement study which was completed in 2002 and was used as a basis for development of the Columbia/Snake River TDG Total Maximum Daily Load (TMDL). The Action Agencies continue to operate in accordance with actions identified in the WQP and the TMDL. The Corps has worked with the States of Oregon and Washington on “variances” or “waivers” of the TDG water quality standard for fish passage spill. The Action Agencies have worked with a WQT subcommittee on a systematic review of the forebay fixed monitoring sites. Changes at some sites have been implemented. Review and evaluation of forebay fixed monitoring stations at McNary Dam and the Snake River projects was initiated during the 2003 spill season and continued during the 2004 spill season. Alternative monitor locations were evaluated and compared to the existing monitoring sites. Findings and recommendations for more representative alternate forebay fixed monitoring sites were presented to the WQT in October 2004, and recommendations adopted by the Action Agencies were implemented.

The Corps will continue to monitor and prepare an annual report of the physical monitoring program for TDG, and will continue to coordinate the annual reporting of biological monitoring. The reports will be sent annually to the Oregon Department of Environmental Quality (ODEQ) and Ecology. The program currently consists of forebay and tailwater monitoring stations, along with a few locations in free-flowing reaches. The use of back-up monitors and a QA/QC program have been implemented.

Spillway flow deflectors have been installed to reduce TDG production at most mainstem dams and there are plans to install end bay deflectors at Little Goose Dam. At various projects, spillwalls will be considered for reducing TDG supersaturation of powerhouse flows and to increase survival of juvenile salmonid migrants. Spillwalls may be necessary concurrent with spill reducing measures such as RSWs.

RSWs, behavioral guidance structures (BGSs), or similar devices also can reduce gas entrainment through reduced spill, while maintaining or improving juvenile passage survival. The Action Agencies will continue research to determine TDG effects on both juvenile and adult salmonids and implement solutions where appropriate.

Temperature Measures

The Action Agencies have been working with an ongoing WQT subcommittee since 2001 to develop a plan to model water temperature effects of alternative Snake River operations. The 2001 and 2002 subcommittee work efforts determined the goals of water temperature modeling, investigated and evaluated multi-agency existing data, determined what questions can be answered without modeling, recommended and started additional water temperature and meteorological data collection, and recommended numerical models to be considered.

The technical team recommended to the regional WQT that the CE-QUAL-W2 model be adopted for development in the river reaches of interest and identified a data collection strategy. The workgroup proposed to build the model in phases. The initial Phase 1 includes the North Fork Clearwater at the mouth, Mainstem Clearwater at Orofino, Upstream Snake River at Anatone to the Downstream Snake River at Lower Granite Dam. Phase 2 will include Dworshak Reservoir, and the Snake River up to the tailwater of Hells Canyon Dam, Phase 3 would extend the model up the Snake River to include the Brownlee Reservoir. Phase 1 was completed in 2004. Phase 2 is currently in progress and is scheduled for completion in 2007.

The Action Agencies will continue to refine the water temperature model and its use as a river operations management tool. Forebay temperature strings are deployed at Dworshak Dam, the four lower Snake River projects, and McNary Dam. These will continue to be used as in-river measurement points. The model applications and results will be coordinated with the WQT and the TMT.

The Action Agencies will complete studies to evaluate temperature effects on adult Snake River steelhead and fall Chinook salmon of drafting Dworshak Reservoir to elevation 1520 and extending the draft period into September. Provisions of the SRBA Agreement will be implemented, which will include Dworshak drafting to elevation 1535 feet by the end of August and the remaining 200,000 acre-feet from elevation 1535 feet to elevation 1520 feet in September. This operation has proven to be an effective tool to cool the temperature at the tailwater of the Lower Granite Dam. The Action Agencies currently coordinate through TMT and the Nez Perce Tribe (for SRBA actions) to determine water temperature releases from Dworshak during late June through September to make best use of the cool water at depth in the reservoir. Additionally, the Lower Snake River MOP operation reduces the reservoir cross-section and surface area, which is another tool to assist in moderating temperatures.

Temperature studies that include the Columbia River upstream of McNary Dam, trash racks, gatewells, and draft tubes were completed in 2004 and 2005. A computational fluid dynamics (CFD) model of the hydrodynamics and thermal characteristics of the project was completed in 2006. This model is currently being used to evaluate several temperature management alternatives at McNary Dam. Similarly, a study that examines the spatial and temporal characteristics of the 2004 temperature dataset, along with a comparison to historical information is currently underway. The model and this information will be used to investigate optimal powerhouse operations or structural modifications for minimizing thermal stress of juvenile salmon collected in the summer.

In 2003, Reclamation conducted a preliminary investigation into the feasibility of meeting water temperature standards below Grand Coulee Dam. Three conceptual alternatives were evaluated, all of which relied on thermal stratification in Lake Roosevelt and the premise of evacuating warm water early in the year to conserve cool water for discharge later in the year when temperature standards are exceeded. The three alternatives were:

- modify operations at the left, right, and third powerhouse;
- install multi-level intake structures (selective withdrawal) on the left and right intakes; and
- implement structural and/or operational changes in the Banks Lake pumping facilities.

While a more detailed analysis would be necessary to accurately determine the full extent of standards attainability under the three alternatives, the preliminary investigation suggests that full achievement of the standards is not possible. For example, it was preliminarily determined that implementation of first two alternatives would only decrease the number of days exceeding the standards by 28 percent and 31 percent, respectively. The third alternative was even less effective. Furthermore, there is a limited duration of downriver cooling effects due to weak stratification in Lake Roosevelt and downriver impoundments. These results indicate that it is unlikely that a feasible alternative is available to provide significant water quality related salmon habitat improvement from Grand Coulee Dam.

Action 13 - Tributary Projects

The tributary projects that have not yet completed ESA Section 7 consultation are located in the Yakima, Okanogan, and Tualatin rivers. Reclamation will, as appropriate, work with NMFS in a timely manner to complete supplemental, project-specific consultations for these tributary projects. These supplemental consultations will address effects on tributary habitat and tributary water quality, as well as direct effects on salmon survival in the tributaries. The supplemental consultations will address effects on mainstem flows only to the extent to which they reveal additional effects on the in-stream flow regime not considered in the FCRPS and Upper Snake BA/Comprehensive Analysis.

Reclamation submitted a BA on the Yakima Project and is currently preparing updates to this document. Reclamation is expected to complete a BA for the Tualatin Project by fall of 2007. Reclamation is preparing a BA for the Okanogan projects, which will be provided in draft form to the Okanogan Irrigation District and the Confederated Colville Tribes in August 2007. Following a coordinated review, the BA will be finalized and transmitted to NMFS.

B.2.1.2.2 Strategy 2 – Modify Columbia and Snake River Dams to Maximize Juvenile and Adult Fish Survival

There are 11 actions to address this strategy. Presently, FCRPS mainstem dams that have anadromous fish passing upstream, are being operated to balance fish passage and water quality performance with cost effective authorized project purposes, under the existing configuration, using the best available data. To achieve this, a combination of fish passage configurations and operations are used on a project-by-project basis, considering the needs of both adult and juvenile fish [as informed by the research, monitoring, and evaluation (RM&E) process described in Section B.2.6].

The following provides an overview of the primary mechanisms of how fish are passed at the dams and the rationale for why specific operations are in place as of May 2007. The following also sets the scene for what is currently in place and why the configuration and operations modifications that are proposed are appropriate.

As might be anticipated, dates of operations typically reflect when fish are likely present and might encounter the project. While it is generally understood that some ESA-listed fish may reside within the hydrosystem year round or over winter, in general, the operations were designed to protect the vast majority of the fish as they pass the project. Where possible, some level of passage or protection measure is provided for fish that may encounter the projects when outside of the normal migration periods.

In general, juvenile fish pass the dams via a few primary routes including through spillways, surface passage routes, conventional bypass systems, and through the turbines. Typically, spillways and surface bypass routes are thought to provide the quickest and safest route of passage at the projects; however this is not always the case as some spillways have lower than desired survival. While conventional bypass systems can improve the survival of fish by routing them around turbines, they are thought to be less desirable than surface passage routes.

Turbines continue to be, overall, one of the lowest survival routes for passage at the dams; however, as with spillways, this must be examined on a case-by-case basis as there are exceptions to the rule. For example, Bonneville PH1 units that have been retrofitted with minimum gap runner (MGRs). Adult fish passage configurations and operations typically provide high upstream success, however, at times, operations for juvenile passage can cause negative impacts to adults, and this is detailed below. In addition, there are currently measures in place to protect downstream migrating adults (e.g., kelts, fallbacks).

Developing the configurations and operations to balance the requirements is challenging and not without contention. The following will discuss operations specific to the adult and juvenile migrations, both from a system-wide approach for some passage routes and on a project-by-project basis, where appropriate. These operations will be explained in further detail, where appropriate. Where survival estimates are reported, these numbers are derived for COMPASS modeling.

The Action Agencies will continue to evaluate and make capital investments to improve fish passage survival rates. The Action Agencies will generally give schedule and funding priority to modifications at dams where the passage survival rates are lowest, but will coordinate final actions through the Regional Forum. To accomplish this, the Action Agencies will develop comprehensive passage modification plans for each passage dam. These plans will guide future configuration investments and aid hydrosystem operations in meeting hydrosystem passage survival targets and standards.

Key Actions for Passage Modifications

Summarized below are the existing configuration, operations, and major modifications that the Action Agencies are considering as key alternatives for development at each dam.

Development of configuration and operational plans (COPs) for each project is underway, and therefore, the ultimate configuration (and related operational) recommendations at each project cannot yet be specified. The Action Agencies will compare biological effectiveness and costs to determine the optimum configuration and operation at each project that will contribute to achievement of performance requirements.

The COPs will consider multiple alternatives for configuration and operation changes and will prioritize those alternatives into Phase I and Phase II actions. Phase I modifications are those that are anticipated to increase survival levels to meet or exceed the hydrosystem performance standards and are being proposed in the Action. However, if the proposed modifications fail to meet the targets, then Phase II items will be considered for further implementation. The modifications in configurations and operations will be evaluated through RM&E as appropriate.

Actual construction of these features and schedules will be dependent on results of on-going research, regional collaboration and prioritization, and future appropriations.

Bonneville Dam

The existing configuration and operations of Bonneville Dam, specific to fish passage is presented in Table B.2.1-5.

Table B.2.1-5. Existing Configuration and Operations of Bonneville Dam in Relation to Fish Passage

Bonneville Dam	Current Configuration	Current Operation
Spillway	18 Spill Bays, Vertical lift Leaf Gates Flow deflectors every bay	4/10 to 6/30 100 kcfs Day/Night 7/1 to 8/31 75 kcfs Day/ Gas Cap (~120 kcfs) Night)
Juvenile Bypass System (PH1)	Submerged Traveling Screens - 2 Units	9/15 to 12/15 (Adult Fallback Operation Only)
Juvenile Bypass System (PH2)	Submerged Traveling Screens - 8 Units Bypass to tailrace	3/1 to 12/15
Surface Bypass (PH1)	Yes - Ice and Trash Sluiceway	3/1 to 11/30, 1.6 kcfs in addition to spill
Surface Bypass (PH2)	Yes - Corner Collector	4/10 to 8/31, 5 kcfs in addition to spill
Turbines (PH1)	10 Main Units, 7 of which are MGRs[1/]	1% Soft Constraint (11/1 to 3/31)
Turbines (PH2)	PH2 Priority Operation, 8 Main Units (STS[2/]) 2 Fish Units (No STS but otherwise screened)	1% Hard Constraint, (4/1 to 10/31)
Transportation	NA	NA
Fish Ladders	2 Main Ladders, 4 primary ascension routes	2 ladders with counting 3/1 to 11/30 1 ladder minimum 12/1 to 2/28

[1/] MGR - Minimum Gap Runners
[2/] STS – Submersible Traveling Screen

Rationale for Operations

Spring Operations

Presently at Bonneville Dam, the surface bypass routes at both powerhouses are operated for fish passage to provide good juvenile egress and survival, ranging from 93 percent survival at Powerhouse 1 (PH1) to 100 percent survival at Powerhouse 2 (PH2) for Chinook salmon. The juvenile bypass facility is also operated at PH2, providing approximately 98 percent survival, which is an improvement over turbine passage survival of roughly 94 percent. The juvenile bypass system at PH1 is no longer in operation because of the installation of Minimum Gap Runners (MGRs, new turbine runners). Survival through those routes (~97 percent) was higher, therefore the screens were pulled and the bypass system abandoned.

PH2 has been designated as the priority powerhouse for power generation in part due to high survival through the passage routes. However, it has also been prioritized because the propensity for adults to pass upstream via the PH2 ladder system, which improves overall adult performance by reducing fallback and eventual overall upstream passage success.

Spill is presently provided in the spring at 100 kcfs both day and night. Spillway survival for Chinook salmon at Bonneville Dam is not as high as through other passage routes, ~90 percent during the day and ~97 percent at night, so increased spill has not been proposed due to higher spill levels drawing more fish away from the higher survival routes. In addition, higher spill levels during daylight hours causes greater potential for both passage delay and fallback of adult fish attempting to pass and migrate upstream, thereby decreasing overall upstream passage success. Spill is also limited to 100 kcfs towards attempting to get closer to the requirements of the Clean Water Act with respect to TDG and to protect redds and organisms residing in shallow water habitats downstream from the dam.

Summer Operations

Summer operations at Bonneville Dam differ somewhat from the spring operations in that reduced levels of spill are provided during the daytime and increased levels of spill are provided during the night. Spill survival at Bonneville for fall migrants has been estimated at around 91 percent, and passage through the other routes, including turbines, has been estimated at higher than 92 percent. In 2007, daytime spill is being evaluated at 85 kcfs to improve tailrace egress conditions and improve daytime spill survival. Spill is also limited towards attempting to get closer to the requirements of the Clean Water Act with respect to TDG and to protect organisms residing in shallow water habitats downstream from the dam.

Action 14 - COP for Bonneville Project

The Corps will prepare a COP for the Bonneville Project (2007). As part of the first phase of modifications, the Corps will include the following:

Bonneville PH1

- Sluiceway modifications to optimize surface flow outlet to improve fish passage efficiency (FPE) and reduce forebay delay (2009), and
- MGR installation to improve survival of fish passing through turbines (2009).

Bonneville PH2

- Screened bypass system modification to improve fish guidance efficiency (FGE) and reduce gatewell residence time (2008), and
- Shallow BGS installation to increase Corner Collector efficiency and reduce forebay delay (prototype 2008).

Bonneville Dam Spillway

- Spillway operation or structure (e.g., spillway deflectors) modification to reduce injury and improve survival of spillway passed fish; and to improve conditions for upstream migrants (2013).

The COP will be updated periodically and modifications may be altered as new biological and engineering information is gathered. Modifications will be coordinated through the Regional Forum. If Phase I actions fail to meet the intended biological targets, Phase II actions will be considered for further implementation.

Passage modifications at Bonneville Dam are anticipated to directly affect all populations of fish originating upriver from the dam and reservoir (Bonneville Lake). However, in that most populations of Lower Columbia River Chinook Salmon, Steelhead, Coho Salmon; and Columbia River Chum Salmon occur downstream of the project, only portions of those ESUs are anticipated to be directly affected by actions at Bonneville Dam.

The Action Agencies, in coordination with the Regional Forum, are updating a planning document that presents the strategy for prioritizing and carrying out actions for fish passage actions at Bonneville Dam. This document, the Bonneville Dam COP (previously titled the Bonneville Decision Document) will consider the alternatives listed below.

Powerhouse 1 Surface Bypass (Sluiceway Modifications)

The Action Agencies are investigating modifications in the sluiceway for passing juvenile salmonids. These sluiceway alternatives may include automating sluiceway entrances, removing the juvenile bypass wall, and returning it to its original design while improving and smoothing the sluiceway conveyance. In collaboration with the Regional Forum, a subset of these alternatives will be implemented and construction could begin as soon as 2007. While these modifications are expected to increase sluiceway passage efficiency up to as much as 60 percent for yearling Chinook salmon and steelhead, fish passage modeling has shown no direct increase in dam survival (survival across the concrete) from this action.

The reason that modeling has shown no dam passage survival increase due to this action is that current input data were collected under limited PH1 operation. As such, using these data to predict future performance indicates that fish survival through the PH1 turbines is as high as or higher than fish survival through the sluiceway. Route-specific survival, however, could be very different under higher flow conditions, when more smolts would pass PH1 and survival rates on those fish may differ. In addition, modifications to the sluiceway are expected to reduce forebay residence time, which may decrease the potential for forebay mortality due to predation and could reduce potential stressors associated with latent mortality. Mortality in the forebay of Bonneville Dam has not been estimated in past studies, and is therefore not part of the analysis of effects in this assessment.

Spillway Survival Modifications

In 2002, six new lower spillway flow deflectors were installed in spillbays that previously did not have deflectors (1, 2, 3, 16, 17, and 18) enabling greater volumes of water to be spilled in the summer without exceeding TDG limits. This was assumed to have a positive effect on juvenile salmonid survival. However, post construction juvenile fish survival studies demonstrated that spillway passage survival was lower than desired at lower discharges and was lower at bays with the higher elevation deflectors. These same studies indicated that survival for fish passing through the PH2 Corner Collector and PH2 juvenile bypass system (JBS) were both higher than survival through the spillway. In addition, adult salmonid migration over Bonneville Dam was delayed when daytime spill was at the TDG cap.

Further analysis of these data indicates that the spill discharge threshold for this delay is around 100 kcfs. Operational changes are presently being pursued, however, additional measures, including changes to the flow deflectors, are presently being considered for 2008 to 2010. Spillway measures, whether structural or operational, are anticipated to result in an increase in spillway survival of up to 4 percent for yearling and subyearling Chinook salmon and steelhead. This could equate to a dam survival increase of up to 0.5 percent for yearling Chinook salmon, 1.8 percent for steelhead, and 3.9 percent for subyearling Chinook salmon.

Powerhouse 2 Fish Guidance Efficiency and Bypass Modifications

The Action Agencies are presently performing construction modifications that decrease turbine entrainment of juvenile salmonids by improving the FGE of the turbine intake screens at PH2. These modifications are scheduled to be completed by 2008. FGE increases of up to 8 percent for yearling Chinook salmon and up to 18 percent for subyearling Chinook salmon would yield an increase in dam survival of 0.2 percent for yearling Chinook salmon and 0.3 percent for subyearling Chinook salmon.

The Corps and BPA have implemented less-intrusive, passive integrated transponder (PIT) tag interrogation methods at Bonneville Dam; including full flow PIT-tag detection capability in the PH2 juvenile bypass system. While no direct survival effects are anticipated, bypassing fish through a larger pipe in a larger volume of water than for normal PIT-tag detection is expected to help reduce stress of bypassed fish. Concern with orifice passage at PH2 is also an issue that has been raised and orifice passage will be investigated in 2008.

The Corps will investigate the use of a trash shear boom as a way to increase the proportion of salmon that pass PH2 through the Corner Collector in 2008. It is assumed that the trash boom will act as a behavioral guidance device diverting more fish which could increase the Corner Collector efficiency for yearling and subyearling Chinook salmon up to 15 percent and up to 5 percent for steelhead. These increases in efficiency would result in dam passage survival increases of 0.2 percent for yearling Chinook salmon, subyearling Chinook salmon, and steelhead.

First Powerhouse Installation of Minimum Gap Runners

The Action Agencies will continue to install MGRs at the Bonneville Dam first powerhouse. Currently, six MGRs are installed and biological testing has indicated that a 40 percent reduction in injury rate to juvenile Chinook salmon compared to the existing turbine units may be achievable. The remaining four units are scheduled to have new runners installed by 2010, pending funding for the installation. Main unit 10 is to be commissioned in 2007, bringing the total MGR units completed at PH1 to seven. The new runners are estimated to increase the turbine passage survival rates of yearling and subyearling Chinook salmon and steelhead by 2 percent, 2 percent, and 1.5 percent, respectively, and a reduction in stressors that may lead to reduced latent mortality for all ESUs originating upstream from the dam.

Changes in Passage Survival

The Actions, including all combined construction and operational modifications at Bonneville Dam, are expected to increase survival by as much as 1.5 percent for yearling Chinook salmon, 2.8 percent for steelhead, and 4.9 percent for subyearling Chinook salmon. These actions are also expected to decrease the potential for latent mortality for all species originating upstream from the dam.

The Dalles Dam

The existing configuration and operation of The Dalles Dam, specific to fish passage is presented in Table B.2.1-6.

Table B.2.1-6. Existing Configuration and Operations of The Dalles Dam in Relation to Fish Passage

The Dalles Dam	Current Configuration	Current Operation
Spillway	23 Spill Bays, Tainter Gates, No Flow deflectors	4/10 to 8/31 40% Spill Day/Night
	Spill Wall between bays 6 and 7	Bulk spill to the north of the spill wall
Juvenile Bypass System	NA	NA
Surface Bypass	Yes - Ice and Trash Sluiceway	4/1 to 11/30 4.6 kcfs in addition to spill
Turbines	22 Main Units, 2 Smaller Fish Units, No Fish Screens	1% Soft Constraint (11/1 to 3/31) 1% Hard Constraint, (4/1 to 10/31)
Transportation	NA	NA
Fish Ladders	2 Main Ladders, 2 primary ascension routes	Both Ladders 3/1 to 11/30, 1 Ladder Minimum, 12/1 to 2/28

Rationale for Operations

Spring and Summer Operations

At The Dalles Dam, 40 percent spill is provided in a bulked pattern through the northernmost 6 spillbays during both fish passage seasons for 24 hours. This operation, in tandem with sluiceway operation, tends to pass 80 to 90 percent of the juvenile migrants through non-turbine routes. While the sluiceway typically provides the highest survival of all routes (~95 to 99 percent), the spillway tends to be next highest (~86 to 92 percent), and turbine survival tends to be the lowest (~80 to 84 percent).

Spill is provided at the 40 percent level because this level not only provides a high percentage of fish passing over the spillway (~70 to 80 percent), but also provides reasonable egress in the tailrace and limits the exposure to predation by reducing entrainment of fish into the higher predation areas in the south shore islands downstream. In addition, spill volume behind the spill wall is limited by maximum gate opening because of the potential for spillway erosion and unknown effects on fish survival.

The 40 percent spill level, while shifting adult fish use away from the north shore ladder, has not resulted in additional delay or reduced passage success at the project. Adults have simply increased usage of the east ladder with no apparent increase in adult passage times through the project.

Action 15 - COP for The Dalles Project

The Corps will prepare a COP for The Dalles Project (2007). As part of the first phase of modifications, the Corps will include the following:

- Turbine operation optimization to improve overall dam survival (2011), and
- Extended tailrace spill wall to increase direct and indirect survival of spillway passed fish (2009).

The COP will be updated periodically and modifications may be altered as new biological and engineering information is gathered. Modifications will be coordinated through the Regional Forum. If Phase I actions fail to meet the intended biological targets, Phase II actions will be considered for further implementation.

A list of potential Phase II actions are:

- Sluiceway entrance modification to improve FPE and reduce forebay delay,
- Sluiceway outfall relocation to further improve aggress and reduce predation on sluiceway passed fish if needed to achieve performance standards, and
- Forebay BGS installation to improve FPE and reduce spill, thereby lowering TDG levels.

Passage modifications at The Dalles Dam are anticipated to directly affect all populations of fish originating upriver from the dam and reservoir (Lake Celilo).

The Action Agencies, in coordination with the Regional Forum, are developing a COP for prioritizing and carrying out fish passage actions at The Dalles Dam. Actual implementation of Phase I actions will be dependent on results of ongoing research, regional collaboration and prioritization, and future appropriations.

Spillway Modifications

The spillway at The Dalles Dam is the primary juvenile fish passage route; however, survival of spillway-passed fish at The Dalles is substantially lower than spillway survival at other dams. A spillwall that was constructed in 2003 to 2004 reduced direct injury and mortality, but did not show an appreciable total survival increase for juvenile Chinook salmon that passed through the spillway. To reduce predation on spillway-passed fish, the spillwall will be extended downstream to the river's thalweg. This action is expected to achieve 98 percent total survival for juvenile salmon and steelhead that pass through the spillway.

Assuming an increased spillway survival rate to 98 percent and the current passage distribution estimates, overall dam-passage survival could increase by as much as 4 percent for both yearling Chinook salmon and steelhead, and 3 percent for subyearling Chinook salmon. These increases alone could result in dam survival rate increases of 2.0 percent, 2.0 percent, and 2.4 percent for yearling Chinook salmon, steelhead, and subyearling Chinook salmon, respectively, and a reduction in stressors that may lead to latent mortality.

Sluiceway Guidance Efficiency Modifications

The Action Agencies will evaluate ways to increase passage efficiency of the ice and trash sluiceway for juvenile salmonids by either modifying gate entrance configurations or increasing overall sluiceway capacity (or a combination of both). This would increase dam-passage survival at The Dalles Dam and would also reduce forebay residence time, which may also decrease juvenile salmonids' exposure to native and exotic predation. Assuming a 50 percent reduction in turbine entrainment occurs for all ESUs as a result of sluiceway entrance modifications, dam survival would increase by 0.3 percent for yearling Chinook salmon, 0.1 percent for steelhead, and 1.0 percent for subyearling Chinook salmon, and a reduction in stressors that may lead to latent mortality.

Turbine Survival Actions

The Action Agencies will evaluate turbine operation and geometry as a way to increase turbine-passage survival. This effort will employ the Biological Index Testing (BIT) strategy to examine both the internal turbine environment as well as the effects turbines have on tailrace egress conditions. The anticipated result of this work is an increase in turbine survival for spring and summer juvenile salmonid migrants, as well as a reduction in stressors that may lead to latent mortality.

Changes in Passage Survival

Phase I of the Actions, including all combined construction and operational modifications at The Dalles Dam, indicates a potential to increase survival from 2.0 to 5.0 percent for yearling Chinook salmon, 2.0 to 4.8 percent for steelhead, and 2.4 percent to 8.1 percent for subyearling Chinook salmon. These actions are also expected to decrease the potential for latent mortality for all species originating upstream from this dam.

Optional Alternatives

If the Phase I items described above do not realize the effects anticipated and the overall performance standards are not being met, Phase II items, as outlined in the COP will be considered. For The Dalles Dam, potential alternatives for consideration include moving the sluiceway outfall or developing a BGS in the forebay.

John Day Dam

The existing configuration and operation of John Day Dam, specific to fish passage is presented in Table B.2.1-7.

Table B.2.1-7. Existing Configuration and Operations of John Day Dam in Relation to Fish Passage

John Day Dam	Current Configuration	Current Operation
Spillway	20 Spill Bays, Tainter Gates, Flow deflectors every bay	4/10 to 6/30 (0%/60% Day/Night) 7/1 to 8/31 (30% Day/Night)
Juvenile Bypass System	Submerged Traveling Screens - All Units Bypass Downstream to Tailrace	4/1 to 12/15 Juvenile Passage and Adult Fallback
Surface Bypass	No	NA
Turbines	16 Units, 4 Skeleton (Empty) Turbine bays	1% Soft Constraint (11/1 to 3/31) 1% Hard Constraint, (4/1 to 10/31)
Transportation	NA	NA
Fish Ladders	2 Main Ladders, 2 primary ascension routes	Both Ladders 3/1 to 11/30 1 Ladder Minimum, 12/1 to 2/28

Rationale for Operations

Spring Operations

For spring operations at John Day Dam, 0 percent daytime and 60 percent nighttime spill is provided (April 10 to 20 June) in tandem with operation of the juvenile bypass system to reduce overall turbine entrainment and increase survival for fish passing the project. This combination of operations, which approaches the TDG waiver limits for 60 percent spill, is believed to provide the highest dam passage survival for yearling Chinook salmon and steelhead based on two years of evaluations of "night spill only" versus "24-hour spill" (91 to 93 percent).

These studies indicated that when daytime spill of 30 percent was provided, steelhead survival was reduced compared to "night spill only" operations. In addition, two years of evaluating 12- vs. 24-hour spill at John Day Dam also showed that there was no survival benefit to yearling Chinook salmon by spilling during the day, and that turbine entrainment for yearling Chinook salmon and steelhead (hatchery and wild) was not reduced.

Fish passage and hydraulic model observations have indicated that spill at higher levels can increase tailrace egress times of fish that pass not only through the juvenile bypass system, but also through turbines, and studies at John Day Dam have demonstrated that longer tailrace egress times are related to lower survival.

Summer Operations

During the summer (June 21 to August 31), 30 percent of the total river flow is spilled 24 hours per day in tandem with the juvenile bypass system operation. This operation is based on survival data from 2 years of study (2002 and 2003) which indicate that 24-hour spill results in higher survival for subyearling Chinook salmon compared to 12-hour night spill. Data from these studies also suggested that increasing spill percentages increases tailrace egress times and decreases survival of subyearling Chinook salmon that pass through the juvenile bypass system. Based on hydraulic model studies, this would also likely be the case for fish that pass through turbines.

Action 16 - COP for John Day Project

The Corps will prepare a COP for the John Day Project (2007). As part of the first phase of modifications, the Corps will include the following:

- Full-flow bypass and PIT-tag detection installation to reduce handling stress of bypassed fish (2007),
- Turbine operation optimization to improve overall dam survival (2011), and
- Surface flow outlet(s) construction to increase FPE, reduce forebay delay and improve direct and indirect survival (prototype 2008 with final installation by 2013).

The COP will be updated periodically and modifications may be altered as new biological and engineering information is gathered. Modifications will be coordinated through the Regional Forum. If Phase I actions fail to meet the intended biological targets, Phase II actions will be considered for further implementation.

A list of potential Phase II actions are:

- Install extended-length guidance screens to improve FGE, if needed to achieve performance standards;
- Relocate juvenile bypass outfall to improve egress and reduce predation on bypassed fish, if needed to achieve performance standards;
- Construct ailrace divider wall to improve egress and reduce predation; and to reduce entrainment of powerhouse flow into spillway flow, thereby reducing TDG levels;
- Tailrace bathymetry modification to improve egress conditions; and
- Install additional weirs, skeleton bay surface bypass structure, and/or BGS to improve FPE and reduce forebay delay.

Passage modifications at John Day Dam are anticipated to directly affect all populations of fish originating upriver from the dam and reservoir (Lake Umatilla).

The Action Agencies, in coordination with the Regional Forum, are developing a COP that will present a strategy for carrying out fish passage actions at John Day Dam. Recent survival estimates suggest that there is good potential for additional survival improvements at this project.

Surface Flow Bypass and Tailrace Egress Actions

Good tailrace egress is a critical factor for improving juvenile fish survival at John Day Dam. Alternatives that reduce the proportion of smolts passing through turbine units and improve tailrace egress ranked highest in the draft COP. The concept of surface flow bypass is to divert a proportion of turbine-bound fish to the spillway or skeleton bay surface bypass outlet. The COP analyzed surface flow bypass under a range of 24-hour operations. The Action Agencies assumed a 20 kcfs surface flow outlet with 30 percent training spill. Design of these alternatives will include consideration of improvements to tailrace egress.

Tailrace egress actions may involve a spillway divider wall (a wall dividing the powerhouse from the spillway), turbine operations, modifying tailrace bathymetry, surface bypass outfall flow in the skeleton bay area, relocating the juvenile bypass outfall, or a combination of these. Locating a surface flow outlet at or near the north end of the powerhouse is estimated to provide up to a 50 percent reduction in the proportion of fish passing through the powerhouse for all ESUs, assuming a 24-hour 30 percent spill level. In addition, tailrace egress changes could increase survival of fish passing through the juvenile bypass system by up to 1 percent for yearling Chinook salmon and up to 3 percent for steelhead as well as reduce the stressors that may lead to latent mortality.

The potential dam passage survival increase estimated for surface flow bypass and tailrace egress actions (assuming 20 percent training spill) is up to 1.4 to 2.7 percent for yearling Chinook salmon, 1.4 to 4.1 percent for steelhead trout, and 4.4 to 7.0 percent for subyearling Chinook salmon. Surface flow bypass is also anticipated to reduce forebay residence time for juvenile salmon and steelhead.

Turbine Survival Actions

Starting in 2006, the Action Agencies began evaluating turbine operation and geometry, seeking ways to increase turbine survival. The effort will employ the BIT test strategy to examine both the internal turbine environment as well as the effects turbines have on the overall tailrace (see tailrace actions above). The anticipated result of this work is an increase in turbine survival for spring and summer juvenile salmonid migrants.

Full Flow Bypass PIT-Tag Monitoring

The Action Agencies are evaluating less-intrusive, PIT-tag interrogation methods at John Day Dam, including full flow PIT-tag detection capability, in the juvenile bypass system. This is anticipated to help reduce the potential for stress and reduce the potential for latent mortality.

Changes in Passage Survival

Phase I of the Actions, including all combined construction and operational changes at John Day Dam, is anticipated to increase survival by up to 1.4 to 2.7 percent for yearling Chinook salmon, 1.4 to 4.1 percent for steelhead, and 4.4 to 6.4 percent for subyearling Chinook salmon. These actions are also expected to decrease the potential for latent mortality for all species originating upstream from the dam.

Optional Alternatives

If the Phase I items described above do not realize the effects anticipated and the overall performance standards are not being met, Phase II items, as outlined in the COP, will be considered. Additional juvenile fish passage alternatives that will be considered include extended length submersible bar screens, juvenile bypass outfall relocation, and a forebay BGS.

McNary Dam

The existing configuration and operation of McNary Dam, specific to fish passage is presented in Table B.2.1-8.

Table B.2.1-8. Configuration and Operations of McNary Dam in Relation to Fish Passage

McNary Dam	Current Configuration	Current Operation
Spillway	22 Spill Bays, Vertical-Lift Split Leaf Gates	4/10 to 6/30 (40% Day/Night)
	Flow Deflectors Every Bay	7/1 to 8/31 (40%/40% vs. 60%/60% Day/Night testing)
Juvenile Bypass System	ESBS - All Units	4/1 to 12/15
	Bypass Downstream to tailrace or Transport	Juvenile Passage and Adult Fallback
Surface Bypass	Yes - 2 Temporary Spillway Weirs (TSWs)	~14 kcfs as part of Spill
Turbines	14 Units	1% Soft Constraint (11/1 to 3/31) 1% Hard Constraint, (4/1 to 10/31)
Transportation	Yes - Summer/Fall Only	~6/20 ~ 8/15 Barge Transport ~ 8/16 ~ 9/31 Truck Transport
Fish Ladders	2 Main Ladders, 2 primary ascension routes	3/1 to 12/31

Rationale for Operations

Spring Operations

During the spring, operations at McNary include a combination of 40 percent spill and full flow bypass to provide safe passage and egress and avoid turbine passage for spring migrants. This level of spill, based on research comparing spill levels at gas cap, provided higher spillway survival estimates. Spillway passage typically provides the highest survival route at the project (~96 percent), followed by the bypass system (~91 to 96 percent) and turbines (~80 to 97 percent). Bypass system passage and 40 percent spill provides a high percentage of migrating smolts with a non-turbine passage route. The Corps estimates that survival through the dam for spring migrants at approximately 94 to 95 percent. While 40 percent spill is the planned operation, limited powerhouse capacity routinely forces the spill percentage to vary above that level. Operation of McNary Dam with 40 percent spill is expected to provide a reasonable level of survival, a trend towards a balanced flow through the project, and good tailrace egress for powerhouse and spillway passed fish, while also achieving TDG waiver goals in the tailrace.

While McNary Dam has the potential to transport fish during the spring, transport evaluations to date have been inconclusive and transport operations were discontinued in the 1995 BiOp. However, with a juvenile fish facility constructed in 1994, an evaluation of transportation versus in-river migration and bypass with Upper Columbia River Chinook Salmon and Steelhead is currently in progress, but adult returns from this are needed to complete the evaluation. When results of this research are finalized, operations may be revisited.

Summer Operations

During the summer, operations at McNary Dam include a combination of 40 percent and 60 percent spill (presently under evaluation) and transportation to provide safe passage and egress and avoid turbine passage for spring migrants. This operation is provided because the spillway typically provides the highest survival route at the project (~100 percent), followed by the bypass system (~85 percent) and turbines with unknown, but anticipated lower survival. Preliminary results from 2006 with subyearling Chinook salmon show slightly higher survival through both the spillway and the bypass system with 60 percent spill. Under 60 percent spill, the Corps estimates project survival for summer migrants to be approximately 97 percent. Transportation is provided, in part, due to the lower bypass survival and due to the deterioration of in-river conditions late in the summer, including high water temperatures and low total river discharges.

Action 17 - COP for McNary Project

The Corps will prepare a COP for the McNary Project (2009). As part of the first phase of modifications, the Corps will include the following:

- Optimize turbine operation to improve survival of fish passing through turbines (2013);
- Improve debris management to reduce injury of bypass and turbine passed fish (2011);
- Relocate juvenile bypass outfall to improve egress, direct, and indirect survival on bypassed fish (2011); and
- Install surface flow outlet to increase FPE, reduce forebay delay, and improve direct and indirect survival (temporary structure testing in 2007 and 2008 to develop a permanent system).

The COP will be updated periodically and modifications may be altered as new biological and engineering information is gathered. Modifications will be coordinated through the Regional Forum. If Phase I actions fail to meet the intended biological targets, Phase II actions will be considered for further implementation.

A list of potential Phase II actions are:

- Install additional spillway weirs or alternative spillway or powerhouse surface bypass structures and/or BGS to improve FPE and reduce forebay delay; and/or
- Construct tailrace divider wall to improve egress and reduce predation; and to reduce entrainment of powerhouse flow into spillway flow, thereby reducing TDG levels.

Passage actions at McNary Dam are anticipated to directly affect all populations of fish originating upriver from the dam and reservoir (Lake Walulla). Effects to populations of the Mid Columbia River Steelhead ESU in the Walla Walla River and Yakima River populations are expected. No direct effect from actions at McNary Dam is anticipated for downstream populations of this ESU.

The Action Agencies, in coordination with the Regional Forum, will develop a COP that will present a strategy for prioritizing and carrying out additional fish passage actions at McNary Dam. This plan will consider the alternatives listed below, as well as additional potential alternatives, under a range of flows and project operating conditions.

Powerhouse Actions

Fish survival effects identified through the BIT strategy of existing turbine operations could provide improvements in direct survival and/or the tailrace egress of turbine-passed fish. This may also help minimize predation that can occur in the tailrace. It is anticipated that improvements in operations and tailrace conditions could provide a 2 percent survival increase for yearling Chinook salmon, steelhead, and subyearling Chinook salmon passing through turbines at McNary Dam.

Debris Management

During the spring, large volumes of vegetative debris can accumulate on turbine intake trash-racks at McNary Dam. Both screened bypass and turbine-passed fish experience elevated injury and mortality as a result of passage through debris-clogged trash-racks. In the summer, aquatic vegetation clogs the vertical barrier screens. Changes in debris monitoring, management, and cleaning procedures could reduce injury and mortality of fish passing through turbines and the screened bypass system and is expected to provide a 0.5 percent increase in turbine and bypass survival for yearling Chinook salmon, subyearling Chinook salmon and steelhead.

Surface Passage Actions

Surface passage routes at other Columbia River projects have proven to be highly effective at passing juvenile salmonids. As a result, two temporary spillway weirs (TSWs) will be constructed, installed, and evaluated in 2007 to determine the potential for surface passage structures to help improve fish passage survival at McNary Dam. If preliminary biological testing results show high passage and survival, two additional TSWs may be constructed and installed for additional testing in 2008. Biological information gained from these prototype structures will inform final decisions on the optimum number, location, and effectiveness of permanent spillway surface passage routes. Spillway surface passage route alternatives at McNary are anticipated to have a passage effectiveness of approximately 4.0:1 with a survival equal to current survival through the spillway (yearling Chinook salmon 96.2 percent, subyearling Chinook salmon 98 percent, and steelhead 95.9 percent), however powerhouse entrainment is anticipated to be reduced.

Juvenile Fish Facility Actions

Actions to the juvenile fish facility will include relocation of the juvenile fish facility outfall pipe to improve egress conditions and reduce piscivorous and avian predation at the outfall site for juvenile salmon. Anticipated survival improvements are 3 percent for yearling Chinook salmon and steelhead and 5 percent for subyearling Chinook salmon.

Changes in Passage Survival

Analysis of the proposed Phase I alternatives including all combined construction actions expected to be implemented during the period of this BiOp at McNary Dam, with 40 percent spill 24 hours a day in both spring and summer, is estimated to affect direct survival between -0.6 percent and 0.1 percent for yearling Chinook salmon, -0.1 percent and 0.5 percent for steelhead, and -0.1 percent and 0.5 percent for subyearling Chinook salmon. While the values of these ranges demonstrate modeled potential, the baseline was not modeled with the full complement of the range of survival estimates. Therefore, the low end of the range for these estimates (negatives) are likely an artifact of the analysis process. In addition, because these actions are also expected to decrease the potential for latent mortality for all species originating upstream from the dam, the overall value of the improvements may not be quantifiable.

Optional Alternatives

If the Phase I items described above do not realize the effects anticipated and the overall performance standards are not being met, Phase II items, as outlined in the COP will be considered. For McNary Dam, potential alternatives for consideration include additional spillway weirs, surface bypass system in the powerhouse, a BGS in the forebay, and a divider wall in the tailrace.

Ice Harbor Dam

The existing configuration and operation of Ice Harbor Dam, specific to fish passage is presented in Table B.2.1-9.

Table B.2.1-9. Configuration and Operations of Ice Harbor Dam in Relation to Fish Passage

Ice Harbor Dam	Current Configuration	Current Operation
Spillway	10 Tainter Gates, Flow deflector every bay RSW Bay 2	4/3 to 8/31 Testing Operations (30%/30% vs 45 kcfs/gas cap Day/Night)
Juvenile Bypass System	STS, All Units Bypass Downstream to tailrace	4/1 to 12/15 Juvenile Passage and Adult Fallback
Surface Bypass	Yes - RSW	~8 kcfs as part of Spill
Turbines	6 Units	1% Soft Constraint (11/1 to 3/31) 1% Hard Constraint, (4/1 to 10/31)
Transportation	NA	NA
Fish Ladders	2 Main Ladders, 2 primary ascension routes	3/1 to 12/31

Rationale for Operations

Spring and Summer Operations

The 2000 BiOp called for a spill level of 45 kcfs during daylight hours and gas cap at night. The gas cap level at Ice Harbor is near 100 kcfs. This operation is intended to maximize fish passage over the spillway at Ice Harbor, where survival is thought to be highest. The lower spill level during daylight hours is intended to facilitate better adult salmonid passage.

Survival through the juvenile bypass system is very high as well, but spill passage has been preferred due to research showing that adult returns may be lower for fish that have passed through multiple bypass systems. With the installation of a RSW in 2005, the lower spill level (30 percent spill) was evaluated. This lower spill level was tested to determine if similar levels of passage and survival could be attained, thus lowering TDG levels in the tailrace. Evaluations in 2005 and 2006 have indicated that the 30 percent spill, while passing fewer fish through the spillway, is providing comparable levels of dam survival and using much less water for spillway passage.

Action 18 - COP for Ice Harbor Project

The Corps will prepare a COP for the Ice Harbor Project (2008). As part of the first phase of modifications, the Corps will include the following:

- Guidance screen modification to improve FGE (2010),
- Turbine operation optimization to improve survival of turbine passed fish (2011),
- Spillway chute and/or deflector modification to reduce injury and improve survival of spillway passed fish through the RSW (2009), and
- Turbine unit 2 replacement to improve the survival of fish passing through turbines and reduce oil spill potential (2011).

The COP will be updated periodically and modifications may be altered as new biological and engineering information is gathered. Modifications will be coordinated through the Regional Forum. If Phase I actions fail to meet the intended biological targets, Phase II actions will be considered for further implementation.

A list of potential Phase II actions are:

- Replace Units 1 and 3 if needed to achieve performance standards
- Install extended-length guidance screen to improve FGE, if needed to achieve performance standards
- Install forebay BGS structure to improve FPE and reduce forebay delay,
- Construct tailrace divider wall construction to improve egress and reduce predation, and to reduce entrainment of powerhouse flow into spillway flow, thereby reducing TDG levels, and
- Create additional spillway or powerhouse surface flow outlet to improve FPE and reduce forebay delay.

Passage actions at Ice Harbor Dam are expected to directly affect all populations of fish originating upriver from the dam and reservoir (Lake Sacajawea).

The Action Agencies, in coordination with the Regional Forum, will develop a COP that will present a strategy for prioritizing and carrying out additional fish passage actions at Ice Harbor Dam. This plan will consider the alternatives listed below, as well as additional potential alternatives evaluated under a range of flows and project operating conditions.

Removable Spillway Weir Actions

Fish passing near the ogee of the spillway at Ice Harbor Dam experience relatively high rates of injury and the Action Agencies believe the injuries are likely caused by impact on the spillway chute and/or flow deflectors. Further, across many studies and dams, bays with deflectors tend to have lower survival rates. As the RSW is concentrating passage through one spillbay, modification of the spillway chute and/or deflector in this bay could decrease both injury and direct mortality. The Action Agencies believe the survival rate of all stocks passing the RSW could increase by 1 percent with the proper chute and/or flow deflector modifications. Also, the overall effects could include a reduction in latent mortality, as the observed injuries may not result in immediate mortality, but may occur days or even weeks after a fish passes Ice Harbor Dam.

Powerhouse Actions

Relative survival of bypassed fish has consistently been near 100 percent, while turbine survival has been under 90 percent; therefore, increased FGE would likely increase dam survival by diverting additional fish from turbine passage, which has a higher mortality rate. Model investigations of the Ice Harbor Dam turbine intake indicate a significant gain in FGE may be obtained through minor modifications to the existing submerged traveling screens by way of gap closure, flow vanes, or even raising the screen. The Action Agencies anticipate this could increase FGE up to 5 percent for yearling and subyearling Chinook salmon and up to 2.5 percent for steelhead. Because of the high survival rates of bypassed fish (consistently near 100 percent), improvements in FGE would result in an overall increase in dam survival.

Turbine Survival Actions

The Action Agencies will evaluate turbine operation and geometry as a way to increase turbine-passage survival. This effort will employ the BIT test strategy to examine both the internal turbine environment as well as the effects turbines have on tailrace egress conditions. The anticipated result of this work is 2 percent increase in turbine survival for both spring and summer juvenile salmonid migrants, and a reduction in stressors that may lead to latent mortality.

In support of major hydropower system rehabilitations and replacement of aging turbine units, a research test turbine will be developed for fish passage improvements. This turbine will be installed at Ice Harbor Dam as a replacement to Unit 2 and will be tested as a proof of concept for fish passage. If successful, Units 1 and 3 may be replaced as well.

Given lower summer river discharges and expected fish spill, all turbine passage would likely be through these new units. Therefore, the Action Agencies estimate subyearling survival through the turbines could increase by as much as 3 percent. However, during spring, some of the existing units (four to six) would likely be operating, so only a portion of the turbine-passed fish would be going through the new turbines; therefore, the Action Agencies estimate survival to increase through the turbines for both yearling Chinook salmon and steelhead by about 0.75 percent.

Changes in Passage Survival

Analysis of the proposed Phase I Alternatives including all combined construction actions expected to be implemented during the period of this BiOp at Ice Harbor Dam with 30 percent spill 24 hours per day, is estimated to increase direct survival between 0.2 percent and 1.1 percent for yearling Chinook salmon, greater than 0.1 percent and 0.9 percent for steelhead, and 0.1 percent and 1.3 percent for subyearling Chinook salmon. These actions are also expected to decrease the potential for latent mortality for all species originating upstream from this dam.

Optional Alternatives

If the Phase I items described above do not realize the effects anticipated and the overall performance standards are not being met, Phase II items, as outlined in the COP will be considered. For Ice Harbor Dam, potential alternatives for consideration include a BGS in the forebay, extended turbine intake screens, tailrace divider wall, and additional spillway or powerhouse surface flow outlets.

Lower Monumental Dam

The existing configuration and operation of Lower Monumental Dam, specific to fish passage is presented in Table B.2.1-10.

Table B.2.1-10. Configuration and Operations of Lower Monumental Dam in Relation to Fish Passage

Lower Monumental Dam	Current Configuration	Current Operation (Spring)/(Summer)
Spillway	8 Tainter Gates, Flow deflector every bay Bulk Spill to Gas Cap	4/3 to 6/20 (~27 kcfs Day/Night) 6/21 to 8/31 (17 kcfs Day/Night)
Juvenile Bypass System	STS, All Units Bypass Downstream to tailrace or Transport	4/1 to 12/15 Juvenile Passage and Adult Fallback
Surface Bypass	No	NA
Turbines	6 Units	1% Soft Constraint (11/1 to 3/31) 1% Hard Constraint, (4/1 to 10/31)
Transportation	Yes	~5/4 ~ 8/15 Barge Transport ~ 8/16 to 9/31 Truck Transport
Fish Ladders	2 Main Ladders, 2 primary ascension routes	3/1 to 12/31

Spring Operations

During spring at Lower Monumental Dam, the project is operated using a combination of spill, bypass, and transportation in an effort to increase survival of fish passing the dams. This operation reduces turbine entrainment and trends towards balancing flow through the project. The Corps estimates this provides a project survival through the dam of roughly 95 percent. High spillway survival rates have been achieved in recent years by using fewer spillways with the gates opened wider. This operational change was based on survival research conducted during 2004 and 2006 with yearling Chinook salmon. When larger volumes of spill are passed through narrower areas at the project, the TDG production has increased and, therefore, lowers the gas cap for spill to 27 kcfs. Transportation is provided at Lower Monumental during spring, when evaluations have shown that adult returns trend higher compared to allowing fish to migrate in-river.

Summer Operations

During the summer, Lower Monumental Dam uses a combination of spill (17 kcfs) and transportation, in an effort to increase survival of fish passing the dam. This level of spill is lower than the gas cap but, based on 2006 research, provides good survival. A level lower than the gas cap was coordinated for the operation at Lower Monumental because research during 2005-2006 showed that a third of tagged fish never passed the project even when a spill route was available. The Corps estimates that this operation provides survival through the dam of roughly 94 percent. While transportation is believed to be a good tool for managing the summer migration, the determination of whether in-river migration or transportation yields more adult returns has not yet been established, therefore a "spread-the-risk" approach has been adopted, until a definitive evaluation has been conducted. In order to spread-the-risk, an operation of 17 kcfs spill would likely serve to achieve an appropriate split of in-river and transport.

Action 19 - COP for Lower Monumental Project

The Corps will prepare a COP for the Lower Monumental Project (2009). As part of the first phase of modifications, the Corps will include the following:

- Primary bypass operations with PIT-tag detection installation to reduce handling stress of bypassed fish (2007),
- Juvenile bypass system outfall relocation to improve egress, direct and indirect survival on bypassed fish (2011),
- Turbine operation optimization to improve the survival of fish passing through turbines (2013), and
- Removable spillway weir installation to improve FPE, reduce forebay delay, and improve direct and indirect survival (2008).

The COP will be updated periodically and modifications may be altered as new biological and engineering information is gathered. Modifications will be coordinated through the Regional Forum. If Phase I actions fail to meet the intended biological targets, Phase II actions will be considered for further implementation.

A list of potential Phase II actions are:

- Install forebay BGS to improve FPE and reduce forebay delay,
- Construct tailrace divider wall to improve egress and reduce predation, and to reduce entrainment of powerhouse flow into spillway flow, thereby reducing TDG levels,
- Install extended-length guidance screen to improve FGE if needed to achieve performance standards, and
- Create additional spillway or powerhouse surface flow outlet to improve FPE and reduce forebay delay.

Passage actions at Lower Monumental Dam are expected to directly affect all populations of fish originating upriver from the dam and reservoir (Lake Herbert G. West). However, few Snake River Fall Chinook Salmon may occasionally spawn in the Snake River downstream of the powerhouse near Lower Monumental Dam, and are not subject to direct effects to passage.

The Action Agencies, in coordination with the Regional Forum, will develop a COP that presents a strategy for prioritizing and carrying out additional fish passage actions at Lower Monumental Dam. This plan will consider the alternatives listed below, as well as additional potential alternatives evaluated under a range of flows and project operating conditions.

Removable Spillway Weirs

A RSW is planned to be installed for operation during the spring of 2008. RSW passage survival is estimated to be about 98 percent (96 to 100 percent), representing an increase in survival through that spill bay of 1.9 percent for yearling Chinook salmon and steelhead and 3.7 percent for subyearling Snake River Fall Chinook Salmon, with an assumed passage effectiveness ranging from 3.5 to 7.3:1 for all species. With the RSW in operation, fewer fish should pass through the turbines, increasing overall dam survival. In addition to the direct survival actions, reduced forebay delay and safe passage through the RSW should decrease the potential for latent mortality.

Primary Bypass

Currently when not transporting from Lower Monumental, fish collected in the bypass system are routed through the juvenile fish facility to get PIT-tag detections. This operation subjects them to additional dewatering, size separation, and routing through relatively small pipes and flumes. In 2007, the Action Agencies will install a full flow juvenile PIT-tag monitoring system on the primary bypass system leading to the 36-inch outfall pipe. This will allow for PIT-tag detections, while avoiding potential stressors in the facility and bypassing collected fish back to the river. This modification is estimated to increase bypass survival by about 0.5 percent for all species.

The Action Agencies also plan to relocate the outfall to an area with higher water velocities and consistent downstream flow. This is expected to decrease predation on the bypassed fish. These actions are estimated to provide up to a 2 percent improvement in survival for steelhead and yearling Chinook salmon and up to a 3 percent improvement for subyearling Chinook salmon. Additional effects of reduced latent mortality could result by lower stress, less delay, and lower probability for disease transmission.

Turbine Survival Actions

The Action Agencies will evaluate turbine operation and geometry as a way to increase turbine-passage survival. This effort will employ the BIT test strategy to examine both the internal turbine environment as well as the effects turbines have on tailrace egress conditions. The anticipated result of this work should yield a 2 percent increase in turbine survival for yearling Chinook salmon, subyearling Chinook salmon, and steelhead, and a reduction in stressors that may lead to latent mortality.

Changes in Passage Survival

Analysis of the proposed Phase I alternatives, including all combined construction actions expected to be implemented during the period of this BiOp at Lower Monumental Dam with 30 percent spill (combined RSW and standard spillbay), is estimated to increase direct survival between 0.6 percent and 3.4 percent for yearling Chinook salmon, 0.5 percent and 3.3 percent for steelhead, and 1.3 percent and 4.2 percent for subyearling Chinook salmon. These actions are also expected to decrease the potential for latent mortality for all species.

Optional Alternatives

If the Phase I items described above do not realize the effects anticipated and the overall performance standards are not being met, Phase II items, as outlined in the COP will be considered. For Lower Monumental Dam, potential alternatives for consideration include extended length intake screens, tailrace divider wall, a BGS in the forebay, and additional spillway or powerhouse surface flow outlets.

Little Goose Dam

The existing configuration and operation of Little Goose Dam, specific to fish passage is presented in Table B.2.1-11.

Table B.2.1-11. Configuration and Operations of Little Goose Dam in Relation to Fish Passage

Little Goose Dam	Current Configuration	Current Operation (Spring)/(Summer)
Spillway	8 Tainter Gates, Flow deflectors middle 6 bays	4/3 to 6/20 (30% Day/Night) + 14 days of gas cap 6/21 to 8/31 (30% Day/Night)
Juvenile Bypass System	Extended Submersible Bar Screen (ESBS), All Units	4/1 to 12/15
	Bypass Downstream to tailrace or Transport	Juvenile Passage and Adult Fallback
Surface Bypass	No	NA
Turbines	6 Units	1% Soft Constraint (11/1 to 3/31) 1% Hard Constraint, (4/1 to 10/31)
Transportation	Yes	~5/1 ~ 8/15 Barge Transport ~ 8/16 ~ 10/31 Truck Transport
Fish Ladders	1 Main Ladder, 1 primary ascension route	3/1 to 12/31

Spring and Summer Operations

At Little Goose Dam, the Action Agencies use a combination of 30 percent spill, bypass, and transportation in an effort to increase survival of fish passing the dam through reducing turbine entrainment and improving tailrace conditions. The Corps estimates that this operation provides survival through the dam of roughly 97 percent in the spring and 92 percent in the summer. Dissolved gas levels are also maintained below TDG waiver limits with this operation.

Spills greater than 30 percent tend to create large, strong eddies on both the north and south sides of the tailrace, increasing the predation risk to juveniles and causing adult upstream passage concerns. During the spring of 2006, higher percent spills occurred, and the Lower Monumental and Little Goose ladder counts suggested some delay or blockage in adults passing Little Goose. Further, in the summer of 2005, passage was completely blocked by tailrace conditions until the spill proportion was dropped to 30 percent.

Transportation is provided at Little Goose later in the spring season when evaluations have shown that adult returns of transported fish have been higher than fish remaining in-river during their outmigration. While transportation is believed to be a good tool for managing the summer migration, the determination of whether in-river migration or transportation yields more adult returns has not yet been established, therefore a “spread-the-risk” approach has been adopted, until a definitive evaluation has been conducted. In order to spread-the-risk, an operation of 30 percent spill would likely serve to achieve an appropriate split of in-river and transport.

Action 20 - COP for Little Goose Project

The Corps will prepare a COP for the Little Goose Project (2009). As part of the first phase of modifications, the Corps will include the following:

- Turbine operation optimization to improve the survival of fish passing through turbines (2014),
- Primary bypass operations with PIT-tag detection installation to reduce handling stress of bypassed fish (2008),
- Primary bypass outfall relocation to improve egress, direct and indirect survival on bypassed fish (2008), and
- Surface spillway weir and deflector installation to improve FPE, reduce forebay delay, and improve direct and indirect survival (2009).

The COP will be updated periodically and modifications may be altered as new biological and engineering information is gathered. Modifications will be coordinated through the Regional Forum. If Phase I actions fail to meet the intended biological targets, Phase II actions will be considered for further implementation.

A list of potential Phase II actions are:

- Install forebay behavioral guidance structure to improve FPE and reduce forebay delay,
- Construct tailrace divider wall to improve egress and reduce predation and to reduce entrainment of powerhouse flow into spillway flow, thereby reducing TDG levels,
- Modify spillway deflector to reduce injury and improve survival of spillway passed fish,
- Create additional spillway or powerhouse surface flow outlet to improve FPE and reduce forebay delay, and
- Install north shore eddy abatement structure to improve tailrace egress conditions.

Passage actions at Little Goose Dam are expected to directly affect all populations of fish originating upriver from the dam and reservoir (Lake Bryan). However, no direct effects would be attributed to Snake River Steelhead or Spring/Summer Chinook Salmon populations that spawn in the Tucannon River or the populations of Snake River Fall Chinook Salmon that are released downstream of Little Goose Dam from Lyon's Ferry Hatchery, or those that are naturally produced in the Tucannon River, Palouse River, and the mainstem Snake River downstream of Little Goose Dam.

The Action Agencies, in coordination with the Regional Forum, will develop a COP that presents a strategy for prioritizing and carrying out additional fish passage actions at Little Goose Dam. This plan will consider the alternatives listed below, as well as additional potential alternatives evaluated under a range of flows and project operating conditions.

Removable Spillway Weir

A RSW is scheduled for operation in spring 2009. A survival rate of 98 percent is expected for yearling Chinook salmon and steelhead (0.8 percent), and 94 percent survival for subyearling Chinook salmon (1.0 percent) through this route based on available survival estimates through spill bays. The RSW operation should decrease the portion of fish passing the turbines, thus increasing survival.

Turbine Survival Actions

The Action Agencies will evaluate turbine operation and geometry as a way to increase turbine-passage survival. This effort will employ a BIT test strategy to examine both the internal turbine environment as well as the effects turbines have on tailrace egress conditions. The anticipated result of this work may yield up to a 2 percent increase in turbine survival for spring and summer juvenile salmonid migrants, and a reduction in stressors that may lead to latent mortality.

Primary Bypass

Modification of the primary bypass system is scheduled for 2008. Presently, the primary bypass outfall is near the shore in a less than optimum location. However, the facility outfall is well off shore in faster water. The Action Agencies will move the primary outfall to the more preferred location and will include PIT-tag detection, allowing for primary bypass and PIT-tag detection, while avoiding secondary dewatering, separation, and smaller flumes. The modification of the bypass system at Little Goose is anticipated to increase survival rates of bypassed yearling Chinook salmon and steelhead by about 0.5 percent and subyearling Chinook salmon by about 1 percent. Additional effects will likely include reduced latent mortality through reductions in stress, delay, and potential for disease transmission for bypassed fish.

Changes in Passage Survival

Analysis of the proposed Phase I alternatives, including all combined construction actions expected to be implemented during the period of this BiOp at Little Goose Dam with 30 percent spill (RSW and standard spillbays combined), is estimated to increase direct survival between 0.2 percent and 1.7 percent for yearling Chinook salmon, 0.3 percent and 1.6 percent for steelhead, and 0.9 percent and 2.1 percent for subyearling Chinook salmon. These actions are also expected to decrease the potential for latent mortality for all species.

Optional Alternatives

If the Phase I items described above do not realize the effects anticipated and the overall performance standards are not being met, Phase II items, as outlined in the COP will be considered. For Little Goose Dam, potential alternatives for consideration include a BGS in the forebay, tailrace divider wall, deflector modification in all spillbays, bypass changes, additional spillway or powerhouse surface flow outlets, and a north shore eddy abatement structure.

Lower Granite Dam

The existing configuration and operation of Lower Granite Dam, specific to fish passage is presented in Table B.2.1-12.

Table B.2.1-12. Configuration and Operations of Lower Granite Dam in Relation to Fish Passage

Lower Granite Dam	Current Configuration	Current Operation (Spring)/(Summer)
Spillway	8 Tainter Gates, Flow deflector every bay RSW Bay 1	4/3 to 6/20 (20kcfs Day/Night) 6/21 to 8/31 (17kcfs Day/Night)
Juvenile Bypass System	ESBS, All Units Bypass Downstream to tailrace or Transport	4/1 to 12/15 Juvenile Passage and Adult Fallback
Surface Bypass	RSW with Spill	~8kcfs as part of Spill
Turbines	6 Units	1% Soft Constraint (11/1 to 3/31) 1% Hard Constraint, (4/1 to 10/31)
Transportation	Yes	~4/20 ~ 8/15 Barge Transport ~ 8/16 to 10/31 Truck Transport
Fish Ladders	1 Main Ladder, 1 primary ascension route	3/1 to 12/31

Rationale for Operations

Spring Operations

During the spring, Lower Granite Dam uses a combination of spill using the RSW (20 kcfs) bypass and transportation, in an effort to increase survival of fish passing the dams through reduction of turbine entrainment and a trend towards balancing of flow through the project. The Corps estimates that this operation provides 97 percent survival through the dam, with survival levels through the bypass system and RSW ranging from 97 to 98 percent. Because bypass survival is nearly as high as RSW survival and FGE is high, higher spill levels may decrease project survival because spill through non-RSW bays tends to have lower survival. Transportation is provided at Lower Granite later in the season when evaluations have shown that adult returns of transported fish are higher than fish that remain in-river during their outmigration. Dissolved gas levels are also maintained below TDG gas waiver limits with this operation.

Summer Operations

During the summer, Lower Granite Dam uses a combination of spill using the RSW (17 kcfs) and transportation, in an effort to increase survival of fish passing the dams. The Corps estimates that this operation provides survival through the dam of roughly 92 percent. While transportation is believed to be a good tool for managing the summer migration, the determination of whether in-river migration or transportation yields more adult returns has not yet been established, therefore a "spread-the-risk" approach has been adopted, until a definitive evaluation has been conducted. In order to spread-the-risk, an operation above 17 kcfs spill with RSW would likely serve to achieve an appropriate split of in-river and transport.

Action 21 - COP for Lower Granite Project

The Corps will prepare a COP for the Lower Granite Project (2008). As part of the first phase of modifications, the Corps will include the following:

- New juvenile fish facility including orifice configuration changes, primary dewatering, holding for transport, and primary bypass to improve direct and indirect survival for all collected fish (2012); and
- Turbine operation optimization to improve survival of turbine passed fish (2014).

The COP will be updated periodically and modifications may be altered as new biological and engineering information is gathered. Modifications will be coordinated through the Regional Forum. If Phase I actions fail to meet the intended biological targets, Phase II actions will be considered for further implementation.

A list of potential Phase II actions are:

- Construct additional spillway or powerhouse surface flow outlet, if needed to achieve performance standards, and
- Install forebay BGS to improve FPE and reduce forebay delay.

Passage actions at Lower Granite Dam are expected to directly affect all populations of fish originating upriver from the dam and reservoir (Lower Granite Lake). However, no direct effects would be attributed to Snake River Steelhead or Spring/Summer Chinook Salmon populations that spawn in the Tucannon River, the populations of Snake River Fall Chinook Salmon released downstream of Little Goose Dam from Lyon's Ferry Hatchery, or those that are naturally produced in the Tucannon River, Palouse River, and the mainstem Snake River downstream of Lower Granite Dam.

The Action Agencies, in coordination with the Regional Forum, will develop a COP that presents a strategy for prioritizing and carrying out additional fish passage actions at Lower Granite Dam. This plan will consider the alternatives listed below, as well as additional potential alternatives evaluated under a range of flows and project operating conditions.

New Juvenile Fish Facility

Under consideration for the juvenile fish facility are changes to the collection channel, orifice configuration, primary dewatering, and bypass (with PIT-tag detection) without secondary dewatering. Fish facility modifications are expected to increase bypass survival of yearling Chinook salmon and steelhead up to 1 percent, and up to a 2 percent survival increase for bypassed subyearling Chinook salmon. Decreased delay, stress, chance of injury, and reduced opportunity for disease transmission in the new facility are expected to result in reductions in latent mortality for bypassed and transported fish.

Turbine Survival Actions

The Action Agencies will evaluate turbine operation and geometry as a way to increase turbine-passage survival. This effort will employ a BIT test strategy to examine both the internal turbine environment as well as the effects turbines have on tailrace egress conditions. The anticipated result of this work is a 2 percent increase in turbine survival for spring and summer juvenile salmonid migrants, and a reduction in stressors that may lead to latent mortality.

Changes in Passage Survival

Analysis of the proposed Phase I Alternatives, including all combined construction actions expected to be implemented during the period of this BiOp at Lower Granite Dam with combined spill (RSW and standard spillbay) of 20 kcfs, is estimated to increase direct survival between >0.1 percent and 0.5 percent for yearling Chinook salmon, >0.1 percent and 0.2 percent for steelhead, and >0.1 percent and 0.4 percent for subyearling Chinook salmon. These actions are also expected to decrease the potential for latent mortality for all species.

Optional Alternatives

If the Phase I items described above do not realize the effects anticipated and the overall performance standards are not being met, Phase II items, as outlined in the COP will be considered. For Lower Granite Dam, potential alternatives for consideration include a BGS in the forebay, and spillway or powerhouse surface flow outlets.

Chief Joseph Dam

With flow deflectors in place, spillway water would not plunge deep into the stilling basin and gas levels from Grand Coulee and Chief Joseph would remain below 120 percent, the commonly understood threshold for damage to fish and the recommended maximum concentration by NMFS. The effects of lower gas levels would persist downstream as far as Priest Rapids Dam in the mid Columbia River. Without flow deflectors at Chief Joseph Dam, gas concentrations could range from 120 percent to 135 percent during the spring snowmelt in one out of four years. This action is anticipated to decrease the potential for direct and latent mortality due to high TDG levels for Upper Columbia River Chinook Salmon and Steelhead.

Action 22 - Chief Joseph Dam Flow Deflector

The Corps will complete the flow deflector construction at Chief Joseph Dam by 2009. Deflector construction was initiated in 2005 in response to RPA 136 in the 2000 BiOp and previous discussions on the importance of these deflectors. Chief Joseph Dam does not have spill for fish passage, but water is spilled at this project and Grand Coulee in order to pass high flows. Investigations by the Corps concluded that installation of flow deflectors at Chief Joseph Dam, which is immediately downstream of Grand Coulee, and shifting spill and power generation between the projects is the most cost-effective alternative for gas abatement at these two dams.

Overall Anticipated Juvenile Survival Changes

Considering the suite of actions proposed at each project for improving passage success over the term of the BiOp, the potential range of per project survival actions is anticipated to yield absolute survival increases for yearling Chinook salmon, steelhead, and subyearling Chinook salmon (Table B.2.1-13). In addition, these actions are anticipated to raise dam passage parameters to the performance standards for all species and are expected to decrease the stressors that may be influencing latent mortality.

Table B.2.1-13. Survival Improvements Anticipated from Configuration and Operation Actions

	Anticipated Range of Survival Changes for Configuration and Operation Actions		
	Yearling Chinook Salmon	Steelhead	Subyearling Chinook Salmon
Bonneville	Up to 1.5%	Up to 2.8%	Up to 4.9%
The Dalles	2.0 to 4.7%	2.0 to 4.7%	2.4 to 7.1%
John Day	1.4 to 2.7%	1.4 to 4.1%	4.4 to 6.4%
McNary*	-0.2 to 0.1%	-0.2 to 0.2%	-0.2 to 0.2%
Ice Harbor	0.1 to 1.3%	>0.1- 0.9%	0.1 to 1.3%
Lower Monumental	0.6 to 3.4%	0.5 to 3.3%	1.3 to 4.2%
Little Goose	0.2 to 1.7%	0.3 to 1.6%	0.9 to 2.1%
Lower Granite	>0.1 to 0.5%	>0.1 to 0.2%	>0.1 to 0.4%

* - See text for comment

Action 23 - Turbine Unit Operations

The Action Agencies will operate turbine units within 1 percent of best efficiency at mainstem dams on the Lower Columbia and Lower Snake rivers from April 1 to October 31 (hard constraint) and from November 1 to March 31 (soft constraint) each year. Continue turbine operations evaluations and apply adaptive management to operate units in their optimum configuration for safe fish passage.

The Corps will operate turbines at mainstem dams in the lower Snake and Columbia rivers within 1 percent of best efficiency during juvenile fish outmigration seasons to provide what is assumed to be optimum survival conditions through that passage route. The time period is defined as 24 hours per day from April 1 through October 31. From November 1 through March 31, turbine units will be operated at 1 percent as a soft constraint for the low numbers of juvenile fish that are anticipated to be in the reservoirs and may pass the project at that time. Turbine discharge ranges and system load shaping guidelines to meet the 1 percent criteria can be found on a per project basis in the Corps Annual FPP.

Limitations on the 1 percent criteria include starting and stopping of units, potential for flood control, operating for system reliability, and routine maintenance and testing. If units must be operated outside these limitations, interagency coordination would occur with a lead time of no less than 2 days unless an emergency condition occurred. Significant deviations from 1 percent will be reported to the TMT and documentation as to the causes of excursions will be maintained in logs at each dam.

The Action Agencies will continue to evaluate turbine operations, including the 1 percent criteria with an objective of improving juvenile passage through turbines. Recent investigations have indicated that operating Kaplan turbines with a more "open" geometry may improve juvenile fish survival. Results of proposed studies may yield alternatives for turbine operations. Adaptive management may be applied in the future to operate units in the optimum configuration for safe fish passage.

The Turbine Survival Program (TSP) will continue to focus on the BIT strategy for unique families of turbine units, model investigations and field testing to determine the best turbine operating range for juvenile fish passage, and tailrace egress studies will to establish project operations that optimize tailrace conditions for egress of powerhouse passed fish (both turbine and bypassed fish) as well as spillway passed fish. Turbine pressure investigations will also be conducted to determine the impact of turbine pressures on juvenile fish to support future turbine designs and to support the development of better operational guidelines.
In addition, a risk assessment for turbine passed fish utilizing existing field data, laboratory data, physical hydraulic model data and CFD model data will be conducted. This assessment will be updated continually as new data become available. Validation of using the physical models to estimate biological performance of turbines and the turbine environment will also be conducted. Through this work major hydropower system rehabilitations and replacement of aging turbine units will be supported.

Surface Passage Implementation

As noted above, the Action Agencies continue commitments to pursue surface passage actions such as RSWs or similar surface bypass devices where feasible. These configuration modifications, combined with operational spill levels based on biological performance, are expected to improve juvenile survival, improve forebay and tailrace egress, reduce the potential for predation, and decrease the potential for latent mortality at Federal dams compared with existing conditions for all ESUs originating upstream from Bonneville Dam.

Reductions in TDG would also be anticipated to affect all ESUs. The Action Agencies will expedite the development, installation and testing of surface passage devices at the four lower Columbia River and four lower Snake River dams, consistent with the overall plan identified in Table B.2.1-13.

Inherent with expedited implementation are risks associated with design, cost, schedule and biological effects. The Corps will continue to collaborate regarding the implementation of these structures with the salmon managers and others through the Regional Forum.

Planning dates for development of surface passage technologies at the mainstem passage projects are identified in Table B.2.1-14. These planning dates are subject to change based on regional input, research results, design requirements, annual flow conditions, and funding availability.

Table B.2.1-14. Surface Passage Actions

Project	Progress to date	Schedule
Bonneville PH2	PH2 Corner Collector post-construction monitoring completed in 2005. High flow PIT-tag detection: installed in 2006.	• Update Bonneville Configuration and Operation Report 2007 • Hi-Q PIT-tag detection efficiency testing in 2006 and 2007. • BGS: Investigate using a commercially available shear boom to increase the Corner Collector's passage efficiency– Design, install and evaluate as warranted.
Bonneville PH1		• Completion of Ice and Trash Sluiceway Modifications Letter Report (2007) • Plans and specifications for sluiceway channel and new overflow gate design (2007). • Construct modifications if warranted (2007-08) • Post construction testing (2008)
The Dalles	Evaluate operation of existing sluiceway 2005 Spillwall completed in 2004 Biological test 2004-2006	• Monitoring/Reporting for spillwall evaluation (2006-07) • Update COP report 2006/2007. • Design for spillway modifications in 2007 and 2008. • Construct Modifications if warranted 2009 and 2010.
John Day		• Update COP report 2007 • Prototype installation of Prototype Temporary Spillway Weir in 2008/2009 pending results of the McNary test in 2007. • Anticipate 24-hour spill and spill testing in 2008 pending installation of PTSW • Surface flow bypass system construction: 2010/2011 • BGS construction if warranted: 2012 • Post Construction Testing: 2011, 2012, 2013
McNary	TSW installed, Biological testing occurring 2007	• Biological studies including approach distribution in forebay, 2005-2008 • Modeling and COP development in 2009 • Temporary spillway weir test in 2007, pending results potential additional temporary spillway weirs for further testing in 2008. • Additional prototype installation 2009 • Final construction 2012 • Determine need for Phase II actions, 2015
Ice Harbor	RSW installed 2005 Biological test 2005/06	• Complete COP report 2007/2008 • Biological test 2005 to 2007 • Determine need for Phase II actions, 2008 • Installation of Phase II actions, if warranted
Lower Monumental	Evaluate spillway approach distribution and survival 2005 to 2007	• Complete COP report 2009 • Install RSW FY08 • Biological testing 2008/09 • Determine need for Phase II actions, 2011

Table B.2.1-14. Surface Passage Actions

Project	Progress to date	Schedule
Little Goose	Biological testing approach distribution and survival 2006 to 2007	• Initiate and complete COP report 2009 • Complete design plans and specs 2007 • Install RSW 2009 • Biological testing 2009/2010 • Determine need for Phase II actions, 2012
Lower Granite	RSW installed 2001 Biological test 2002 to 2006	• Complete COP report 2008 • Biological test of BGS in 2006. • Pending results, install Phase II actions, if warranted

* McNary Dam: Pursuing testing to verify structure's safety for fish tentatively scheduled for spring 2007 prior to the juvenile migration season. If the structure is viable, install two prototypes at McNary in order to evaluate performance in 2007. This economical approach may potentially advance a final installation at McNary from the 2012 planning date.

Action 24 - Columbia and Snake River Project Adult Passage Structural Improvements

The Corps will implement the following structural improvements to adult passage at the mainstem Columbia and Snake river projects:

The Dalles Dam

- East ladder emergency auxiliary water supply system and/or north ladder entrance modifications to improve reliability of upstream adult passage (2013).

John Day Dam

- Adult ladder systems modifications to improve upstream adult passage conditions (2011).

Lower Granite Dam

- Adult trap modification to provide greater and more efficient adult collection capability and to reduce handling stress of adult salmonids during collection (2007).
- Adult fishway modification to improve upstream adult passage conditions (need will be determined by results of further research) (prototype 2011).

System-Wide

- Investigate surface-flow outlets during wintertime to provide safer fallback opportunity for over wintering steelhead (need will be determined by results of further research).

The objective of the adult passage program is to maintain a high level of adult passage survival through the FCRPS and ensure passage times through the system provide for successful escapement to the spawning grounds. Typically, all fish ladders are operated on the Columbia River from March through November and on the Snake River from March through December. However, at specific projects, as warranted and where possible, at least one ladder is operated year round for passage of over wintering steelhead.

In the 2004 BiOp, NMFS concluded that adult survival through the FCRPS is similar to survival under unimpounded conditions in the Snake and Columbia rivers. NMFS also suggested that overall travel times and migration rates of radio and PIT-tagged adult salmonids are similar to times and rates observed during early development of the FCRPS when fewer dams were operational. However, operations for juvenile passage (i.e., voluntary spill) can obstruct passage into ladders by providing unfavorable currents near downstream entrances. Juvenile operations must then be adjusted accordingly to provide good upstream passage conditions.

A considerable number of adult modifications have been incorporated at the projects over the last 30 years as well as a comprehensive adult research program. In order to maintain a high level of adult passage survival, several actions are ongoing and should be continued. These actions are included in three categories of actions including configuration actions, operations and maintenance, and research and monitoring to ensure continued adult passage success.

Lower Granite Transition Pool Modifications

Radiotelemetry studies have shown passage delay at transition pool areas in the adult passage facilities. The Lower Granite transition and junction pools were modified during January and February 2006 to decrease delay in that fishway. Adult passage is being evaluated in this area in 2006 to 2007 to determine the effects associated with this modification. Upon completion of the post construction evaluation, modifications at other projects will be considered.

John Day Ladder Modifications

Historically, adult passage times at John Day Dam have been among the longest of any FCRPS dam. In-ladder temperature differentials, relatively longer passage times when compared to other dams, fish jumping, and difficulties with counting fish have been of concern at John Day Dam for many years. A planning effort will consider modifications to the John Day ladder systems including the auxiliary water supply system, lower ladder transition pool, count station, and upper ladder flow control section. Implementation of this plan could begin in 2008, depending on the recommendations of the report. Effects of this action include reducing migration delay for adult salmonids at John Day Dam and improving the accuracy of adult counts.

Auxiliary Water Supply (AWS) Modifications

Consider auxiliary water supply modifications at The Dalles east shore. The AWS supply water to the adult fishways and modifications would increase the reliability of the adult passage facilities. There is also a need to make better use of available water through structural changes in the fishway at Lower Granite Dam (e.g., possibly reduce the width of the north shore entrances and close the floating orifice gates). Further modifications at these and all other projects would be achieved through appropriate operational changes and better maintenance.

The Dalles North and East Fish Ladder Reliability and Alternatives Study found that installation of a spillway divider wall in The Dalles Dam spillway in 2004 created high water velocities near the north fish ladder entrance. These high flows/high spill levels have caused a reduction in the utilization of the north fish ladder, 8 percent in 2006 and 25 to 30 percent between 2004 and 2005. Since the east fish ladder passes 70 percent to 90 percent of the adult fish, reliability is critical to overall adult fish passage success at The Dalles Dam.

A study will be conducted to assess the existing reliability of the north and east fish ladders, with emphasis on the east ladder AWS system, and recommend alternatives to improve this reliability. In addition, this study will investigate alternatives to improve operational performance for the north ladder due to potential impacts from the implementation of the spillwall extension planned for 2010. Pending the results of the study and follow-up discussions with the Regional Agencies and Tribes, corrective actions will be considered, if warranted.

Installation of Adult PIT-Tag Monitoring Facilities

Adult PIT-tag monitoring facilities have already been installed at Bonneville, McNary, Ice Harbor, and Lower Granite dams. Adult PIT-tag monitoring facilities will also be completed at Bradford Island and McNary north and south shore adult ladders in 2006. The intent of adult PIT-tag facilities is to provide a method for evaluating survival and passage rates for PIT-tagged fish through the hydrosystem and potentially to major tributaries.

Installation of additional PIT-tag monitoring facilities has been recommended at John Day and The Dalles dams and the Action Agencies will work with the region for installation of additional PIT facilities at other FCRPS projects as warranted.

Adult Trap Modifications at Lower Granite

The adult trap and work platform will be modified to provide for additional fish handling and holding capability.

Adult Fishway Water Temperature Modifications

A study completed by the Corps in 2004 found that water temperature differentials in the adult fishway at Lower Granite Dam during the summer can exceed 5 to 10 °F. Similar, but generally lesser differentials were documented at the other lower Snake River dams. Continuing biological studies will determine the effects of these temperature differentials on fish passage. Pending the results of the study and follow-up discussions with the regional Agencies and Tribes, corrective actions will be considered, if warranted.

Adult Surface Flow Winter Fallback Routes for Over-Wintering Steelhead

Relatively little is known about the winter distribution or behaviors of adult summer steelhead within the FCRPS. Research has indicated that adult steelhead migration during winter is complex and fallback at some dams in the lower Columbia was quite common during winter. In addition, these results suggest winter mortality in the FCRPS may be disproportionately high for Snake River populations.

Undertaking studies at surface passage routes in the lower river during the over wintering period should indicate whether operating these passage routes during the winter can improve escapement of ESA-listed steelhead. The appropriate management decision would be made in the Regional Forum after results from RM&E are finalized.

B.2.1.2.3 Strategy 3 - Implement Spill and Juvenile Transportation Improvements at Columbia River and Snake River Dams

This strategy has three actions. What is being proposed is an initial operation based upon the best available data. It must be understood that as conditions change due to the effects of operations and configurations, the effects of passage through the FCRPS will change. This will likely make the existing data less reliable and, therefore, additional RM&E will be required. Future operations will be based on adaptive management using the results of the proposed RM&E.

Action 25 - Spill Operations to Improve Juvenile Passage

The Corps and BPA will provide spill to improve juvenile fish passage while avoiding high TDG supersaturation levels or adult fallback problems. The dates and levels for spill may be modified through the implementation planning process and adaptive management decisions. The initial levels and dates for spill operations are identified in Table B.2.1-15 below. Future WMPs will contain the annual work plans for these operations and spill programs, and will be coordinated through the TMT. The Corps and BPA will continue to evaluate and optimize spill passage survival to meet both the hydrosystem performance standards and the requirements of the Clean Water Act.

Table B.2.1-15. Initial Voluntary Spill Operations at Columbia and Snake River Dams

Project	Spring Operation (Day/Night)	Spring Planning Dates	Summer Operation (Day/Night)	Summer Planning Dates
Bonneville	100 kcfs/100 kcfs	4/10-6/15	75 kcfs/Gas Cap	6/16-8/31[3/]
The Dalles	40%/40%	4/10-6/15	40%/40%	6/16-8/31[3/]
John Day	0/60%[1/]	4/10-6/15	30%/30%	6/16-8/31[3/]
McNary	40%/40%	4/10-6/15	40%/40% vs. 60%/60%	6/16-8/31[3/]
Ice Harbor	30%/30% vs. 45 kcfs/Gas Cap	4/7-6-15	30%/30% vs. 45 kcfs/Gas Cap	6/1-8/31[4/]
Lower Monumental	27 kcfs/27 kcfs (Bulk Spill Gas Cap)	4/7-6/15[2/]	17 kcfs/17 kcfs	6/1-8/31[4/]
Little Goose	30%/30%	4/5-6/15[2/]	30%/30%	6/1-8/31[4/]
Lower Granite	20 kcfs/20 kcfs	4/3-6/15[2/]	18 kcfs/18 kcfs	6/1-8/31[3/]

Notes:

[1/] John Day spill operation during the spring will likely shift to 24-hour operation after construction of surface flow outlets.

[2/] The actual transition date to summer spill will be initiated when subyearling Chinook salmon exceed 50 percent of the collection for a 3-day period for each Snake River project after June 1.

[3/] Transitions from spring to summer spill has changed from July 1 to June 16 based on updated run timing of subyearling fall Chinook salmon run timing. For further information see Attachment B.2.1-1, Section 3.5.

[4/] Termination of summer spill will occur at the four Lower Snake projects when subyearling counts fall below 1000 fish per day for 3 consecutive days on a per project basis, but no later than August 31 each year. Termination of spill at Ice Harbor Dam will be based on subyearling counts at Lower Monumental Dam. If after discontinuing spill at any of the Snake River projects after August 1, if subyearling Chinook salmon collection again exceeds 1000 fish per day for two consecutive days, spill will resume at that project. Thereafter, fish collection numbers will be re-evaluated to determine if spill should continue, using the criteria above until August 31.

The Action Agencies will examine and discuss the levels and duration of spill that should be provided at each dam to meet improved survival standards; modifications may be made through the Regional Forum. Surface passage systems (e.g., RSWs) currently operating at Lower Granite and Ice Harbor dams have proven highly effective at passing juvenile salmonids safely with less water than conventional spill. The Action Agencies anticipate similar performance with surface passage systems proposed for implementation at Lower Monumental, Little Goose, McNary, and John Day dams.

The Action Agencies will continue to consider the following general principles to establish spill priorities.

- **Dissolved gas management –** Specific spill levels will be provided for juvenile fish passage at each project, not to exceed established TDG levels (either the 110 percent TDG standard, or as modified by State water quality waivers, currently up to 115 percent TDG in the dam forebay and up to 120 percent TDG in the project tailwater). Additionally, the spill will be managed on a system basis according to a priority list. In high runoff conditions, this distributes spill across the region and prevents dissolved gas supersaturation "hotspots."

- **Adult salmon fallback and delay** – Spill for juvenile fish passage will be limited to reduce adult fish fallback and delay.
- **Passage survival research** – Spill-related research will be continued in order to evaluate juvenile passage survival, spill effectiveness in relation to spill levels and duration, effect of spill on juvenile fish retention in forebays and tailraces, tailrace egress, and effect of spill on adult fallback. The results of this research will inform future spill management decisions in the context of achieving biological performance standards and optimizing the biological benefits of current spill levels at individual dams. In some cases, normal spill operations may be modified to support such research. To the extent that greater spill duration and/or levels are required for the purposes of spill evaluation at some projects, efforts will be made to minimize or offset additional effects to the hydropower system.
- **Spread-the-Risk** – Under mid-low to above-average spring runoff conditions, spill at both transport and non-transport projects will be used to "spread-the-risk" between transportation and in-river migration. Under low-flow conditions in the spring, spill will not occur at collector projects to enable maximum transportation. Summer spill operations will be implemented as described in the Table B.2.1-14 to enable implementation of the fall Chinook salmon transport vs. in-river migration study.

The Action Agencies are developing plans to evaluate and monitor tailrace erosion in response to voluntary spill for juvenile fish passage. The current spill operations are substantially different than the operations that were anticipated when the spillways were originally designed.

The Action Agencies will continue to evaluate transmission system capabilities and transmission constraints on fish operations. If new transmission constraints to fish operations are identified, the Action Agencies will coordinate transmission system modifications with NMFS.

Action 26 - Juvenile Fish Transportation in the Columbia and Snake Rivers

The Corps and BPA will continue the juvenile fish transportation program towards meeting system survival performance metrics of Snake River and Columbia River salmon and steelhead with some adaptive management modifications based on results of RM&E. The Corps and BPA will continue to collect and transport juvenile fish at Lower Granite, Little Goose, Lower Monumental, and McNary dams, although under a modified operation as described in Tables B.2.1-16 and B.2.1-17. While the dates mentioned in this section should be considered firm planning dates, if in-season information or results of ongoing RM&E indicates a need for adaptive management, the Action Agencies will consider revising the dates and operations through the Regional Forum.

The overall intent of the proposed juvenile transportation operation is to balance transportation and in-river migration benefits, both across the season and among the various species of fish, and maximize adult returns for all species passing the collector projects. The current transport program is evolving based on the timing of early spring transport benefits for steelhead and Chinook salmon. The strategy has evolved from the results of recent studies that have shown transportation benefit for wild Snake River steelhead throughout the season, and benefits for wild yearling Chinook salmon for only part of the season. The triggers for the start of transportation are, as yet, uncertain.

What is being proposed is an interim operation based upon the best available data. It must be understood that as conditions change, due to the effects of operations and configurations, the effects of passage through the FCRPS will change. This will likely make the existing data less reliable and, therefore,

Table B.2.1-16. Interim Transportation Strategy for Snake River Collector Projects

	Spring Migrants				Summer Migrants			
Lower Granite Dam	Spill and Bypass	Spill and Transport	Transport and No Voluntary Spill	Adaptive	Spill and Transport	Adaptive	Transport and No Spill	Adaptive
Seasonal Average Flows < 65	None	None	April 3 to May 31	June	July	Aug	Sept	Oct +
Seasonal Average Flows 65 to 80	April 3 to April 20	April 21 to April 30	May 1 to May 31	June	July	Aug	Sept	Oct +
Seasonal Average Flows > 80	April 3 to April 20	April 21 to May 31	NA [1/]	June	July	Aug	Sept	Oct +
	Spring Migrants				**Summer Migrants**			
Little Goose Dam	Spill and Bypass	Spill and Transport	Transport and No Voluntary Spill	Adaptive	Spill and Transportation	Adaptive	Transport and No Spill	Adaptive
Seasonal Average Flows < 65	None	None	April 3 to May 31	June	July	Aug	Sept	Oct +
Seasonal Average Flows 65 to 80	April 5 to April 28	April 29 to May 4	May 5 to May 31	June	July	Aug	Sept	Oct +
Seasonal Average Flows > 80	April 5 to April 28	April 29 to May 31	NA [1]	June	July	Aug	Sept	Oct +
	Spring Migrants				**Summer Migrants**			
Lower Monumental Dam	Spill and Bypass	Spill and Transport	Transport and No Voluntary Spill	Adaptive	Spill and Transport	Adaptive	Transport and No Spill	Adaptive
Seasonal Average Flows < 65	None	None	April 3 to May 31	June	July	Aug	Sept	Oct +
Seasonal Average Flows 65 to 80	April 7 to May 1	May 2 to May 9	May 10 to May 31	June	July	Aug	Sept	Oct +
Seasonal Average Flows > 80	April 7 to May 1	May 2 to May 31	NA [1/]	June	July	Aug	Sept	Oct +

[1/] Under > than 80 kcfs seasonal average flows in the Snake River, the interim spill and transportation operation continues until May 31.
Notes:
All flows are in average kcfs for the April through June time period.
The term “adaptive” in this table refers to a transition between two adjacent management strategies in the table. For example, where “Adaptive” is between “Transportation and Non Voluntary Spill” and “Spill and Transportation”, the decision for each option would be made based on RM&E and in-season data.

Table B.2.1-17. Proposed Interim Transportation Strategy for McNary Dam

McNary Dam	Spring Migrants				Summer Migrants			
	Spill and Bypass	Spill and Transport	Transportation and No Voluntary Spill	Adaptive	Spill and Transport	Adaptive	Transport and No Voluntary Spill	Adaptive
Seasonal Average Flows < 125	None	None	April 10 to June 14	June 15 to June 30	July	Aug	Sept	Oct +
Seasonal Average Flows > 125	Apr 10 to June 14	None[1]	None[1/]	June 15 to June 30	July	Aug	Sept	Oct +

Notes:
[1/] Under > than 125 kcfs seasonal average flows in the Columbia River, the interim spill and bypass operation will continue through June 14.
Average flows reported in average kcfs for April through June.
The term "adaptive" in this table refers to a transition between two adjacent management strategies in the table. For example, where "Adaptive" is between "Transportation and No Voluntary Spill" and "Spill and Transportation", the decision for each option would be made based on RM&E and in-season data.

additional RM&E will be required. Future operations for transportation will be based on adaptive management using the results of the proposed RM&E.

As a result of the existing data, the Action Agencies are proposing an interim juvenile salmonid transportation program that relies less on early spring transportation, more on later spring transportation, and a mixture of transportation and in-river migration (i.e., spread-the-risk) when data is less certain. In most years, the Corps would initiate transportation in late April with a staggered start date for downstream projects, increase the reliance on transportation during May, but adaptively manage for spill and transportation in early June when more subyearling Chinook salmon were present.

In addition, flow triggers for maximization of transportation will be lower than in past years. A COP will be developed to assist in developing and prioritizing the structural modifications and RM&E which will be implemented to further refine and improve operations at the collector projects towards maximizing smolt to adult returns to the extent possible.

A detailed rationale for this interim transport operation is included as Attachment B.2.1-1.

The Corps is requesting an ESA Section 10 Permit for the operation of the Juvenile Transportation Program consistent with the application letter dated February 15, 2006 (permit application information enclosed in Attachment B.2.1-2). Per the NMFS letter dated March 27, 2007 (also included in Attachment B.2.1-2), the Corps requests a permit for a 5-year timeframe beginning in March 2008 and extending through the juvenile migration season to November 2012.

Spring Migrants

In water years when the Snake River projected seasonal average (April to June) flow is less than 65 kcfs (~ lowest 15 percent of all water years), transportation will be initiated April 3 at the Snake River collector projects (Table B.2.1-15). The seasonal average flow projection will be based on the Corps' STP model and the April final forecast (late March report). Transportation from Snake River projects will be maximized (i.e., no voluntary spill or bypass provided) until May 31. Beginning June 1, to spread-the-risk for migrating subyearling Chinook salmon, spill and transportation would be adaptively managed, such that when subyearling Chinook salmon exceeded 50 percent of the collection for a 3-day period, a spill and transportation operation would be initiated at each dam.

In water years when the Snake River projected seasonal average (April to June) flow is between 65 and 80 kcfs (~lowest 15 to 28 percent of all water years), spill and bypass would be provided beginning April 3 at Lower Granite, April 5 at Little Goose and April 7 at Lower Monumental, followed by spill and transportation in the early-mid spring, and maximized transportation in the late-mid spring until May 31 at all Snake River Collector projects (Table B.2.1-15).

Between June 1 and June 30, to spread-the-risk for migrating subyearling Chinook salmon, spill and transportation would be adaptively managed, such that when subyearling Chinook salmon exceeded 50 percent of the collection for a 3-day period at each project in turn (beginning with the most upstream project), a spill and transportation operation would be reinitiated. Until RM&E can clarify the factors affecting seasonal adult returns, spill and transportation would be initiated on a staggered basis in the Snake River (April 21 at Lower Granite, April 29 at Little Goose and May 2 at Lower Monumental). Spill and primary bypass would be provided throughout the season at McNary Dam, pending results of ongoing RM&E to evaluate the factors of estuary timing or fish condition on the differences in seasonal adult return rates.

When average seasonal flows are projected to be above 80 kcfs (~72 percent of all water years), spill would be provided beginning April 3 at Lower Granite, April 5 at Little Goose and April 7 at Lower

Monumental (Table B.2.1-15). A combination of spring spill operations and transportation would be provided through May 31, followed with adaptive management for subyearling migrants through June 30.

Until RM&E can clarify the factors affecting seasonal adult returns, the Action Agencies plan to initiate transportation on April 21, April 29 and May 2 at Lower Granite, Little Goose, and Lower Monumental dams, respectively. Adaptive management of a start date would be considered through the regional forum, with Lower Granite transportation starting no later than May 1. When involuntary spill is anticipated in May and June, project operations would be designed towards meeting both the dam passage survival performance standard and increasing the proportion transported, because all studied spring migrating stocks have demonstrated high benefit of transportation during May. This includes a reduction of spill to increase the proportion of fish transported.

If average seasonal flows in the Columbia River are predicted to be below 125 kcfs (roughly the 2001 level), transportation from McNary Dam would be maximized until June 14. This is based on low in-river survival measured in 2001 and preliminary research results of effects of transportation versus bypassed fish. Spill and transportation would be adaptively managed beginning June 15, with the similar protocols for subyearling fish to that for the Snake River projects. When seasonal average flows are predicted to be 125 kcfs or above, spill and primary bypass would be provided throughout the season at McNary Dam (Table B.2.1-16).

Ultimately, operations will be adaptively managed with consideration of in-season fish migration, in-river conditions, and results of RM&E. The transportation and in-river migration strategy that best contributes toward achievement of the highest level of adult returns for each species will be implemented. Continued RM&E, combined with key structural modifications will provide the means and information to implement a long-term transportation program to positively affect spring migrating species.

Summer Migrants

Beginning in June at Lower Snake River collector projects, with the actual date based on adaptive management (as determined by the 50 percent collection criteria above), RSW and training spill would be provided, not to exceed gas cap or at least one unit operation for station service. All collected fish would be transported, other than those necessary for research. This is consistent with a spread-the-risk operation, until RM&E indicates otherwise.

Beginning August 1, if the number of collected subyearling Chinook salmon (hatchery and naturally produced) has fallen below 1,000/day for 3 sequential days, spill would be discontinued on a per project basis, beginning with the most upstream project (Lower Granite). If after shutting off spill, collection numbers exceed 1,000 subyearling fish per day for 2 sequential days, spill would be reinitiated and fish numbers would be reevaluated. (Note: In 2005 and 2006 when summer spill was provided, the maximum number of fish collected for a single day in August and September was 242 and 303, respectively, with a daily average of 58 and 63 fish across those 2 months. The last 1,000+ fish day for both of those years was July 5 and 12, respectively).

In addition, if collected fish numbers are below 1,000 per day on a per project average, barging would be discontinued and trucking would commence. Between September 1 and 30, transportation would be maximized, and after September 30, adaptive management (i.e., bypass or transportation) will be considered based on number of fish passing the projects and other factors. After September, operation of the projects in primary bypass mode with PIT-tag detection will be conducted as necessary for research, with the potential for bypass operations to continue into December where feasible.

This operation would facilitate intensive RM&E efforts (PIT-tagging) for subyearling Chinook salmon and would occur at least through 2009 (see transportation RM&E section). After 2008, initial adult returns from PIT-tag releases from 2005 to 2006 will be assessed. If there are any significant apparent differences for the various release groups, summer operations will be reconsidered and adjusted appropriately. Transportation, spill, and use of bypass systems will be re-examined as management tools as adult study fish return and operations will be adaptively managed as appropriate by the Fish Passage Operations and Maintenance Coordination Team (FPOM), which consists of Federal, State, and Tribal representatives, and the TMT.

At McNary Dam, about June 15 to August 31, spill will be provided and all fish collected will be transported, other than necessary research fish. Transportation, spill, and bypass systems will be reexamined as management tools as RM&E is conducted, and operations will be adaptively managed as appropriate through the FPOM and TMT. Transportation will be provided in September, as long as numbers of migrants warranted and juvenile shad did not inhibit the operation.

Action 27 - COP for Transportation Strategy

The Corps, in coordination with the Regional Forum, will initiate a COP in 2008. The plan will be completed in 2010 and will present a strategy for prioritizing and carrying out further transportation actions at each dam. Construction actions for transportation are primarily in the context of changes to juvenile bypass systems. Changes meant to increase adult salmon returns through the juvenile fish transportation process are being evaluated. Some changes include additional barges, a new juvenile fish facility at Lower Granite Dam and modifications to the juvenile fish facilities at Little Goose, Lower Monumental, and McNary dams.

Continued RM&E will provide information to develop a long-term juvenile fish transportation and spill program towards increasing the smolt-to-adult returns (SAR) of spring and summer migrating species. The Action Agencies will adaptively manage activities with consideration of in-season fish migration conditions and research results, and adopt the operational strategy that most contributes toward achievement of the total system survival performance standard. Key research will include intensified efforts to determine effects to all spring migrating populations, to determine the most reasonable date or trigger to initiate transportation (estuary timing or physiological condition), to determine ways to improve transportation [including increasing the differential delayed survival (“D” value) of transported fish], to assess the effect of transportation and in-river migration on sockeye salmon (if feasible), to assess the transportation and in-river migration strategies for fall Chinook salmon, and to complete the Upper Columbia River transportation studies conducted at McNary Dam.

The COP will be updated periodically and modifications may be altered as new biological and engineering information is gathered. Modifications will be coordinated through the Regional Forum. Phase II actions will be considered for further implementation. A list of potential actions is identified below:

- Pending research results on alternative barging operations, the Action Agencies may propose to build a new barge(s) for the transportation program to facilitate alternative management strategies. Post release survival of juvenile fish transported is anticipated to increase in response to the addition of barges by facilitating potential operations including direct loading, reduced densities, alternative release scenarios, and the ability to maintain species (size) separation. These potential operations have the ability to reduce stress, predation, injuries, and disease transmission, thus reducing the potential for latent mortality for transported fish and thereby increasing SARs. Benefits from this have not yet been determined, but RM&E results are anticipated during the BiOp period.

- Changes to juvenile fish facilities that are anticipated to improve the survival of bypassed fish are also anticipated to improve conditions for transported fish. Changes at these facilities geared towards improving transportation are expected to provide better facility egress conditions, species separation, reduced potential for stress, and alternative barge loading capabilities.

While major modifications are planned for Lower Granite Dam, including a different collection channel conduit, orifices, and other structural changes, minor modifications are being considered for the other collector projects including improving flumes and separators to develop better species specific separation. Decreased potential for delay, stress, chance of injury, and disease transmission in the new and/or modified facilities are expected to result in reductions in latent mortality for transported fish, thereby increasing SARs. Benefits from this have not yet been determined, but RM&E results are anticipated during the BiOp period.

System Assessment-Flood Control Study

Regarding future system operations, a reconnaissance level study of modifying current system flood control operations to benefit the Columbia River ecosystem, including salmon was completed in 2006 and was coordinated with NMFS and the Region. The Corps does not anticipate further system flood control studies at this time.

B.2.1.2.4 Strategy 4 – Operate and Maintain Juvenile and Adult Fish Passage Facilities at Corps' Mainstem Projects to Maintain Biological Performance

There is one action for this strategy.

Action 28 – Fish Passage Plan

The Corps will annually prepare a FPP and coordinate it regionally through the FPOM. The Corps will operate its projects (including juvenile and adult fish passage facilities) year-round in accordance with the criteria in the FPP. Key elements of the plan include:

- Operate according to project-specific criteria and dates to operate and maintain fish facilities, turbine operating priorities, and spill patterns;
- Operate according to fish transportation criteria;
- Maintain turbine operations within the 1 percent of best efficiency range;
- Maintain spillway discharge levels and dates to provide project spill for fish passage;
- Implement TDG monitoring plan;
- Operate according to protocols for fish trapping and handling;
- Take advantage of low river conditions, low reservoir elevations or periods outside the juvenile migration season to accomplish repairs, maintenance, or inspections so there is little or no effect on juvenile fish;
- Coordinate routine and non-routine maintenance that affects fish operations or structures to eliminate and/or minimize fish operation impacts;
- Schedule routine maintenance during non-fish passage periods;
- Conduct non-routine maintenance activities as needed; and
- Coordinate criteria changes and emergency operations with FPOM.

Water control and fish passage facilities require periodic inspection, maintenance, and repair. Reclamation and the Corps conduct routine maintenance activities daily, monthly, semi-annually, and annually. In addition, BPA conducts maintenance on the Federal Columbia River Transmission System that can require modifications to project generation. When possible, the Agencies will take advantage of low river conditions, low reservoir elevations or periods outside the adult and juvenile migration seasons to accomplish repairs or inspections so that there is little or no effect on normal operations. In some cases, these activities may require reducing the water surface elevation or river flows. However, this is avoided whenever possible and depends on the water conditions of that particular year.

Anadromous adult fish passage facilities, such as fish ladders and auxiliary water supplies, were provided at the time many FCRPS projects were completed. The original facilities have been updated and new facilities added to improve juvenile and adult fish passage. The Action Agencies will continue to operate and maintain these facilities to aid fish passage. Each dam has staff to carry out day-to-day O&M requirements.

The O&M of fish passage facilities is an ongoing process during the fish passage seasons, and in the case of juvenile fish transportation facilities, is a 24 hour per day program. Fish passage facilities are inspected regularly by project personnel to ensure they are operating within established criteria and to make sure they are effectively and safely passing fish.

Major maintenance of fish passage facilities, such as dewatering and annual maintenance of equipment, is conducted during established winter maintenance periods. In-season maintenance of fish passage equipment is accomplished in a manner to minimize impacts on fish passage.

The FPOM develops operational priorities and O&M criteria that are summarized in the Corps' FPP. This plan is updated annually and implemented by project personnel and others involved with river operations. The plan can be accessed at: http://www.nwd-wc.usace.army.mil/tmt/documents/fpp/. Routine O&M activities will follow procedures identified in the FPP.

Non-Routine Maintenance of Facilities

Non-routine O&M activities are infrequent or one-time activities or are very extensive and, therefore, are differentiated from routine O&M. Reclamation and the Corps will conduct non-routine maintenance activities, as appropriate, as funding and prioritized needs dictate. Non-routine maintenance that affects fish operations or structures will be coordinated in FPOM and/or TMT as appropriate.

Non-routine O&M activities are periodic or one-time activities or are very extensive and so are differentiated from routine O&M. The Corps will conduct non-routine maintenance activities as appropriate as funding and priority needs dictate. Non-routine maintenance that affects fish operations or structures will be coordinated through the FPOM and/or TMT, as appropriate. To address maintenance of aging structures and equipment, the Corps will continue to inspect and evaluate the maintenance of fishways and associated structures and equipment (including spillways, turbines, and cranes). Any deficiencies identified will be evaluated and determinations made for corrective actions to be taken.

B.2.1.3 Overall Hydropower Strategies by ESU

Modifications at the projects to improve passage and survival are site specific. However, modifications at a given project may affect entire ESUs or only portions of ESUs depending on its location. For example, modifications at Bonneville Dam are anticipated to directly affect all Mid-Columbia River Steelhead, however modifications at McNary Dam may only affect some populations of the Mid-Columbia River Steelhead, and those modifications at Lower Monumental Dam are not expected to directly affect any of these populations, since they are not present in this reach. The populations that would be directly affected by modifications at each of the mainstem dams are identified in Table B.2.1-18.

The primary mechanism that the Action Agencies intend to use for adaptive management towards meeting both biological and water quality performance measures and targets, is through the development of detailed COPs for each project. The overall intent of the COPs is to develop an approach for improving fish survival through all routes of passage at each project in order to meet the requirements of the ESA, while also meeting the performance targets for the Clean Water Act. The Corps has prepared a COP for RSWs and other dam passage modifications at the Lower Columbia River and Snake River projects and one is being (or will be) developed for each of the mainstem projects and the transportation program.

Table B.2.1-18. Mainstem Projects and ESUs that are Either Entirely or Partially Affected by Upstream and Downstream Passage Actions

	Chinook					Steelhead					Sockeye	Chum	Coho
	Snake River Spring/Summer run	Snake River Fall Run	Upper Columbia Spring Run	Lower Columbia River	Upper Willamette River	Snake River Basin	Upper Columbia River	Middle Columbia River	Lower Columbia River	Upper Willamette River	Snake River	Columbia River	Lower Columbia River
Bonneville Dam	•	•	•	○		•	•	•	○		•	○	○
The Dalles Dam	•	•	•			•	•	•			•		
John Day Dam	•	•	•			•	•	•			•		
McNary Dam	•	•	•			•	•	○			•		
Ice Harbor Dam	•	•				•					•		
Lower Monumental Dam	•	◘				◘					•		
Little Goose Dam	◘	◘				◘					•		
Lower Granite Dam	◘	◘				◘					•		

• = All ESU populations

◘ = Most ESU populations

○ = Some ESU Populations

These plans will be developed in close coordination, through the Anadromous Fish Evaluation Process (AFEP) and at the technical level. In addition to considering the complexities associated with the varying authorities of the projects, the Action Agencies must take into account multiple factors associated with the environmental needs of species affected by the projects. Operation and configuration of hydropower projects for fish can be even more complex and the Action Agencies must make decisions on how to operate the projects, specifically for fish, considering a large number of variables and the best available data.

Specific information is not available for all ESUs at this time. Therefore, as applicable, the assumption was made that the effect obtained for specific actions would be similar for similar ESUs. Therefore, yearling migrant Chinook salmon, steelhead and subyearling Chinook salmon would be anticipated to have similar direct responses for the same action. For example, a turbine modification action that provides a change in survival of 2 percent at John Day Dam for Snake River Steelhead, may be assumed to have a 2 percent change for Mid-Columbia River and Upper Columbia Steelhead as well.

The FCRPS potentially affects 13 ESUs. The following describes the general hydropower strategies for each ESU for both juvenile and adult fish.

B.2.1.3.1 Snake River Spring/Summer Chinook Salmon, Steelhead, and Sockeye Salmon

Juvenile Migration

The overall hydropower strategy of the Action Agencies for juvenile Snake River spring/summer Chinook salmon, steelhead, and sockeye salmon is to produce a high level of dam passage survival and maximize adult returns. In order to do so, a strategic combination of in-river migration and transportation will be used with an emphasis on balancing the various migrational needs among the species.

Planning documents, including a COP, will be produced for each project. The documents will include an examination of some passage routes where it has been determined that survival is lower or injury is higher than desired. Configuration and operation changes will be part of a continuing process aimed at increasing direct survival and decreasing the potential for latent mortality. In addition, RM&E will be conducted, as necessary, to facilitate decision making towards adaptively managing hydrosystem operations for in-river salmonid migration, transportation, and other authorized purposes of the FCRPS.

When in-river conditions are suitable, available passage routes will be optimized to facilitate safe passage for in-river migrating fish. This will be accomplished using a combination of strategies that includes surface flow bypass (e.g., RSWs) along with spill at the Snake and Columbia River dams. These strategies are anticipated to provide benefits to downstream migrants by reducing forebay delay, and providing dam passage routes where injury potential is minimized and egress through the tailrace is optimized. Surface bypass routes are generally more efficient (greater proportion of fish passed per unit of water) and thus, are showing potential for providing effective passage with lower TDG levels. Surface passage routes also hold some potential for reducing latent mortality.

For those fish collected by juvenile bypass systems, the strategy would be to maximize their potential of survival to adulthood by using full flow bypass systems to route these fish back to the river during early April (immediately following primary dewatering of bypass system flow) to minimize handling during that time period. In addition, relocating juvenile bypass outfalls below dams, as necessary, would provide good egress conditions, minimize predation, and decrease the potential for latent mortality.

In late April to early May, downstream transportation of juvenile fish will be employed at the collector projects (Lower Granite, Little Goose, Lower Monumental, and McNary dams). As a result, this should increase the potential for maximizing adult returns. Because juvenile fish have a tendency to return at lower rates the later into the season that they migrate in-river, transportation of juvenile fish during the latter portions of their migration periods will be used to increase the adult returns of those later migrants. During the lowest of low flow years, when survival studies have shown high levels of both direct and latent mortality, transportation will be maximized in an effort to avoid prolonged in-river migration times, thereby improving adult returns.

Adult Migration

Overall, adult survival through the hydropower system has been high. The Action Agencies will monitor the passage success of adult fish to assess if performance remains at those high levels. In addition, improvements will be made to adult passage systems, as necessary, to improve passage timing. Investigations will be performed on downstream adult and kelt (post-spawned steelhead that survive and migrate downstream) steelhead passage during periods when bypass systems and spill are not normally provided, to determine the effectiveness of alternative operations.

B.2.1.3.2 Upper Columbia River Spring Chinook Salmon, Upper and Mid-Columbia River Steelhead, and Columbia River Coho Salmon

Juvenile Fish Migration

The overall hydropower strategy for juvenile Upper Columbia Spring Chinook Salmon, Upper and Mid-Columbia Steelhead, and Columbia River Coho Salmon is to produce a high level of dam passage survival and ensure that voluntary spill will not result in unsafe TDG levels for fish in shallow water areas.

Planning documents, including COPs, will be produced for each Columbia River project. This will include examination of some passage routes where it has been determined that survival is lower or injury is higher than desired (e.g., The Dalles Dam spillway and turbines). Configuration and operation improvements will continue to be used to increase survival and decrease the potential for latent mortality. In addition, RM&E will be conducted as appropriate to facilitate decision making towards adaptively managing the operations in the hydropower system for in-river salmonid migration and the other authorized purposes of the system.

Passage conditions for in-river migrating fish will be optimized. This will be accomplished using a combination of strategies that includes surface flow bypass (e.g., RSWs and Corner Collectors) along with spill at Snake River dams. These strategies are anticipated to provide benefits to downstream migrants by reducing forebay delay, and providing dam passage routes where injury potential is minimized and egress through the tailrace is optimized. Surface bypass routes are generally more efficient (greater proportion of fish passed per unit of water) and thus, show potential for providing effective passage with lower TDG levels. Surface passage routes also hold some potential for reducing latent mortality.

For those fish collected by the juvenile bypass systems, the strategy will be to maximize their potential of survival to adulthood by using full flow bypass systems to route these fish back to the river (immediately following primary dewatering of bypass system flow) to minimize handling. In addition, relocating juvenile bypass outfalls as necessary will provide good egress conditions and minimize predation. This will also serve to decrease the potential for latent mortality.

During the lowest of low flow years, when survival studies have shown high levels of both direct and latent mortality, transportation will be maximized at McNary Dam in an effort to avoid prolonged in-river migration times, thereby improving adult returns. In addition, if modifications to the bypass systems are unsuccessful, transporting collected fish will be reconsidered at this facility.

Adult Fish Migration

Overall, adult fish survival through the hydropower system has been relatively high. The Action Agencies will monitor the passage success of adult fish to assess if these relatively high levels are maintained. In addition, improvements will be made to adult passage systems as necessary to improve passage timing. Investigations will be performed on downstream adult and kelt steelhead passage during periods when bypass systems and spill are not normally provided, to determine the effectiveness of alternative operations.

B.2.1.3.3 Snake River Fall Chinook Salmon

Juvenile Fish Migration

The overall hydropower strategy for juvenile Snake River Fall Chinook Salmon is to provide a “spread-the-risk” operation of in-river passage through surface flow bypass/spill and transportation. Operations will be adaptively managed to better match the times during when fall Chinook salmon are being collected at the projects to attempt to achieve a 50/50 split of transport and in-river migrants and conduct RM&E to determine when transport and/or spill should be discontinued. When transportation is not provided, full flow bypass would occur.

Planning documents, including COPs, will be produced for each project. This will include examination of some passage routes where it has been determined that survival is lower or injury is higher than desired (e.g., The Dalles spillway and turbines). Configuration and operation improvements will continue to be used to increase survival and decrease the potential for latent mortality. In addition, RM&E will be conducted as necessary to facilitate decision making towards adaptively managing hydrosystem operations for in-river salmonid migration, transportation, rearing, overwintering, and the other authorized purposes of the system.

Adult Fish Migration

Overall, adult fish survival through the hydropower system has been high. The Action Agencies will monitor the passage success of adult fish to assess if these relatively high levels are maintained. In addition, improvements will be made to adult passage systems as necessary to improve passage timing.

B.2.1.3.4 Columbia River Chum Salmon

The overall strategy for improving conditions for the Columbia River Chum Salmon ESU will be to provide adequate surface water elevations for chum salmon in redds downstream from Bonneville Dam and ensure that voluntary spill will not result in unsafe TDG levels for juveniles rearing in shallow water areas. Adult passage will also be provided to those few fish that may migrate past Bonneville Dam.

B.2.1.3.5 Lower Columbia River Fall Chinook Salmon

The overall strategy for the Lower Columbia River Fall Chinook Salmon ESU will be to provide Corner Collector flow for Spring Creek Hatchery releases, ensure adequate water over redds downstream from Bonneville Dam, and ensure that voluntary spill will not result in unsafe TDG levels for fish in shallow water areas. Adult passage will also be provided to those fish that migrate past Bonneville Dam.

B.2.1.3.6 Lower Columbia River Steelhead

For steelhead originating from upstream of Bonneville Dam, the overall strategy will be to provide optimum passage conditions for in-river juvenile migrants originating from tributaries to Bonneville pool. Also, the Action Agencies will ensure that voluntary spill will not result in unsafe TDG levels for fish in shallow water areas. Adult passage will be provided to those fish that migrate past Bonneville Dam. Investigations for downstream kelt passage will be conducted to determine optimum management strategy.

B.2.1.3.7 Upper Willamette River Chinook Salmon and Steelhead

The main overall hydropower strategy for the Upper Willamette River Chinook Salmon and Steelhead ESUs will be to ensure that voluntary spill will not result in unsafe TDG levels for juveniles rearing in shallow water areas below the mouth of the Willamette River.

Attachment B.2.1-1
Rationale for Transport Operation

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ACRONYMS AND ABBREVIATIONS

COMPASS	Comprehensive fish Passage
DART	Data Access in Real Time
ESU	evolutionarily significant unit
FCRPS	Federal Columbia River Power System
FPOM	Fish Passage Operations and Maintenance Coordination Team
kcfs	thousand cubic feet per second
MAF	million acre-feet
PIT	passive integrated transponder
RM&E	research, monitoring, and evaluation
RPA	Reasonable and Prudent Alternative
RSW	removable spillway weir
SAR	smolt-to-adult return
STP	Single Trace Procedure

1. DEVELOPMENT OF THE RATIONALE

1.1 THE CHALLENGE

Transportation has long been viewed as a tool to decrease direct mortality of juvenile fish as they migrate through the Federal Columbia River Power System (FCRPS). While it has been successful, it has not been the silver bullet hoped for by many. Results of transport research have been debated for many years and issues including "Differential Delayed Mortality", undetected fish compared to bypassed or transported fish, seasonal effects, and the fact that a large proportion of fish tend to be transported every year (leaving fewer in-river migrants which may then be subject to higher predation) continue to be debated.

Apart from scientific debates, however, are economic and philosophic debates regarding transport. Philosophic debates include premises such as: even if transport is shown to increase adult returns by 10 percent, in-river migration is preferred in that it is a more natural migration method. Economic concerns include that although spill can provide higher survival at the individual collector projects, it is costly through lost revenue, and transport can help ameliorate those costs. Unfortunately, the lines between these three disciplines are often blurred, leading to the continued conflict.

Through the Remand Collaboration Process, a great deal of concern has been expressed about transportation. In addition to the scientific debate, some concerns have included general concepts: even with transport, fish will not reach recovery goals; and a heavy reliance on transportation will have the effect of decreasing improvements at the dams for those fish that migrate in-river.

The Endangered Species Act is clear that the Action Agencies must use the best available data to make decisions. By using this information, the Action Agencies understand that the various species of transported fish have different responses to transport, and actions that benefit some species during one part of the year, may not be beneficial at another time. Where data appears to be more certain (i.e., in low flow years and during May in most years), actions were proposed that rely on this best available data. Where data is less certain or uncertain, the Action Agencies proposed to better spread the risk (e.g., fall Chinook and late April). In addition, this rationale is further based on directing operations specifically at the species for which the Action Agencies are attempting to manage. This includes a modified, sliding scale to both the initiation and curtailment of summer operations towards better managing for Snake River fall Chinook salmon.

This transportation strategy should be considered as an interim strategy. When implementation of surface passage structures is complete at the collector projects, this strategy will need to be reevaluated through research, monitoring, and evaluation (RM&E) efforts. The Action Agencies view transportation as a reasonable tool that can be used towards increasing adult returns and furthering the goal of recovery. When used properly, it can be an effective tool. However, when used improperly, it could decrease the potential for adult returns. This Proposed Reasonable and Prudent Alternative (RPA) for Transportation was developed towards balancing those potential benefits.

1.2 WHAT WAS CONSIDERED

This rationale for the proposed transportation operation is based on consideration of the best available data regarding transportation and in-river migration, information gathered in the April 2006 meetings of the transportation technical group meeting of the Biological Opinion Remand Collaboration Process, and Comprehensive Fish Passage (COMPASS) model results. The Action Agencies also considered other relevant information including some of the uncertainties surrounding transport that may be affecting different species.

Understanding that the best available data may not be irrefutable, the Action Agencies used the most up to date reports and ad hoc analyses for developing the proposed action. For Snake River spring/summer Chinook, recent data analyses have demonstrated that for most years, in-river passage for early spring migrants appears to be the best management option. However, this data also demonstrates that late spring transport appears to be the best management alternative. Fall Chinook continue to be difficult to study and the limited existing data indicates that transport does not appear to either help or harm the species (Williams et al. 2005).

As part of the biological Remand Collaboration Process, a Transportation Technical Group convened on April 13 and 24, 2006 to discuss spring transport, including the trigger to begin transport, data sufficiency, spreading the risk and potential alternative spring transport operations. The Action Agencies considered information gathered in the technical group meeting and additional information was used to develop the proposed transport operation. While the Action Agencies feel the data appears clear in some areas, there are some critical unknowns regarding operations that may not be possible to answer either at this time or in the future.

The Action Agencies considered some preliminary COMPASS modeling efforts to assist in proposing the following information. The COMPASS results showed that seasonality of initiating transport had significant effects on maximizing adult returns for both Snake River spring/summer Chinook salmon and steelhead.

Uncertainties considered included the effect of transport on unstudied species (sockeye), need for a better understanding of the seasonal triggers that may affect this evolutionarily significant unit (ESU), differential delayed mortality, and consideration of the undetected component of fish (spillway and turbine passed fish that are not detected with the passive integrated transponder [PIT]-tag system).

2. PROPOSED FLOW TARGETS

2.1 RATIONALE FOR SNAKE RIVER FLOWS

In the 2004 Biological Opinion, an average seasonal flow (Apr-Jun) of 70 thousand cubic feet per second (kcfs) at Lower Granite Dam (~ lowest 19 percent of flow years) was the upper limit described for when the Action Agencies should maximize transport. However, in 2005, seasonal average flows were about 66 kcfs, and reasonably high (~53 percent) in-river survival was measured for yearling Chinook from the Snake River Trap to below Bonneville (Smith et al. 2006).

The Action Agencies do not yet have smolt-to-adult returns (SARs) from the 2005 outmigration to determine how relative adult return rates performed for that year. Therefore, the threshold of 65 kcfs (~lowest 15 percent of flow years) was selected as the top of the range for maximizing transport because of the reasonable in-river survival above that level. Although runoff was low for 2005, this was a unique year. There was a short peak in flow accompanied by high turbidity, which may have been responsible for the higher survival. The Action Agencies are cautious about attributing this high survival with other low runoff years because fewer migrational cues are available to in-river migrants during low flow years, which may not be represented by the 2005 year. Another low flow year was experienced in 2004 (~67 kcfs), and lower than desired in-river survival (~40 percent) was measured (Smith et al. 2006). Therefore, 65 kcfs is likely a reasonable threshold. This threshold may be revisited once SARs for both transported and in-river fish from this outmigration are analyzed.

Within the average seasonal flow range of 65-80 kcfs, there is insufficient empirical data to determine what the most appropriate flow trigger might be for this range and, therefore, the mid range was selected based on professional judgment. This professional judgment was based in part on past biological opinions where maximum transport trigger was required below 85 kcfs and 70 kcfs (2000 and 2004, respectively) and the preference of continuing an in-river operation in the early season when in-river migrants typically do better, but increasing transport levels when fish do not perform as well in-river.

When seasonal average flows exceed 80 kcfs, in-river conditions are expected to be relatively good. Therefore, an in-river operation will be used early- and a spread the risk operation will be used over the rest of the season, towards maximizing adult returns. This flow range is reasonably supported by the data (Smith et al. 2006) where spring Chinook in-river survival between Lower Granite and Bonneville dams exceeded 50 percent in 1999, 2002 and 2003 when annual average flows exceeded 80 kcfs. In addition, Plumb et al. (2006) indicated that when flows were above 85 kcfs, better in-river conditions for steelhead were provided.

2.2 RATIONALE FOR MCNARY FLOWS

In 2001, the average seasonal flow at McNary Dam was approximately 124 kcfs. During that year, little spill was provided for fish passage throughout the basin, in part due to the potential for a power emergency. Under those conditions, survival for the McNary to John Day Dam reach was approximately 82 percent for yearling Chinook salmon and approximately 35 percent for steelhead.

Recent preliminary data from the 2002 outmigration indicated that, although upper Columbia hatchery Chinook and steelhead appeared to return at higher SARs when undetected at McNary (i.e., likely passing through spill), transportation yielded roughly 20 percent more fish than bypassing fish at this location (NMFS 2006). While the Action Agencies are not proposing transport over bypass at McNary at this time as a routine operation due to the preliminary nature of the data, the indication is that transport would be a reasonable tool during the lowest of low flow years when spill may not be provided.

3. PROPOSED OPERATION DATES

3.1 SPRING – LOW FLOW CONDITIONS

In low flow years (lowest ~15 percent of all flow years), collection at the transport projects would be initiated on or around April 1, and the dates proposed for initiating transport would be April 3 on the Snake and April 10 at McNary. These have been the planning dates for initiating fish passage operations at the transport projects in the past due to the earliest migrating smolts beginning roughly at this time. By initiating transport at this date in low flow years, the Action Agencies will have the opportunity to transport as many fish through the hydrosystem as possible, thereby providing the largest proportion of ESUs with the best performing route during this low flow condition.

3.2 SPRING – ABOVE LOW FLOW CONDITIONS

In above low flow years (highest ~85 percent of all flow years), operations at the collector projects (bypass only) would be initiated consistent with the low flow years on or around April 1, with the initiation of bypass and spill operations occurring on April 3, 5, and 7 at Lower Granite, Lower Goose, and Lower Monumental, respectively. Bypassing between April 1 and the start of spill would reduce turbine entrainment (likely increasing survival) for those fish entering the turbine intakes prior to spill, but is not anticipated to have a population level effect. A staggered start date is proposed for spill, in that early in the season, the median travel time for fish migrating through the system is roughly 6 days between Lower Granite and Little Goose dams and roughly 3 days between Little Goose and Lower Monumental dams. Staggering the initiation of spill by only 2 days at each of the downstream projects is believed to provide faster migrating smolts with spill as they travel downstream.

Beginning around April 21 at Lower Granite, April 29 at Little Goose and May 2 at Lower Monumental, spill and transportation would be provided. From late-mid spring until May 31, transport would be increased or maximized at all Snake River collector projects. While these dates are considered firm planning dates, if in-season information (i.e., smolt numbers, fish condition, or in-river conditions) or results of ongoing RM&E indicates a need for adaptive management, the Action Agencies will consider revising the dates through the regional forum, with a start date of no later than May 1 at Lower Granite, as it is believed that keeping steelhead in-river past May 1 would significantly reduce returning steelhead numbers.

Best available data has demonstrated that for Chinook, there is no benefit for transporting during the early April timeframe. While there are benefits to steelhead, only a small portion of the population is migrating at that time. The proposed planning dates are meant to balance the needs between yearling Chinook and steelhead. Best available data also appears clear that effects of transport for all studied populations during the May timeframe appear to have a substantial benefit. There is some level of uncertainty as to what is the best date to transition between these two timeframes and, therefore, a spread the risk approach was taken for a mid-portion of the runs.

3.3 SUMMER INITIATION – ALL FLOW CONDITIONS

Although Snake River fall Chinook numbers have been increasing under maximized transport operations (close to interim recovery targets), the empirical data are not clear as to whether transportation helps or harms fall Chinook. Therefore, a spread the risk approach will be applied to this species until RM&E efforts yield better information.

Past biological opinions have focused on June 20 as the planning date for initiating summer operations, due in large part to the tie-in with summer flow augmentation. However, with the increasing population of fall Chinook in the Snake River and changes to hatchery practices, larger proportions of the fish are arriving earlier in June. To follow the best available data and provide spread the risk operations for fall Chinook, the Action Agencies are proposing to direct project operations for when the species (hatchery and wild) is passing, rather than for a set date.

The Proposed RPA indicates that when 50 percent of the daily collection at a collector project is composed of fall Chinook for a 3-day period, operations would be shifted to target the summer migrating fish. While the Action Agencies understand that collection at a juvenile fish facility is not always representative of the run at large due to a myriad of conditions (e.g., spill conditions, differential guidance by screens), it can provide an index of what is passing the dam and is useful for planning purposes. For reference, using the 50 percent 3 day daily passage criteria over the past 6 years would have yielded an initiation of summer operation dates at Lower Granite Dam ranging from June 4 – June 26 rather than just the June 20 date (Table 1). A 3-day criteria was selected over a 1-day criteria to ensure that the summer migration was indeed in progress. In addition, the 3-day criteria is believed to be better assurance that as many of the spring migrants have passed as can be reasonably expected, to better target operations for those species as well.

While the initiation of summer operations using a sliding scale would more accurately tie the management action of spread the risk with the species of interest, only a slightly different proportion of yearling Chinook and steelhead would experience the alternative operation. For example, at Lower Granite, by using the June 20 operation in 2003, approximately 43 percent of the collected fall Chinook were seen before that date. Using the 50 percent 3-day criteria (June 7), only 13.5 percent were detected before the June 7 date, thereby applying the summer operations more appropriately to the summer migrants (Table 1). By changing the summer operations date, the percentage of steelhead and yearling Chinook collection exposed to summer versus spring operations between June 7 and 20 would have been

Table 1. Estimates of the Percentages of Snake River ESUs that Could be Affected by Modifying the Designation of Summer Operations from June 20 to a Fall Chinook Presence Criteria Beginning June 1

Collection Criteria for LGR Summer Operations		Date	Percent of Fall Chinook Collected before:	Percent of Steelhead Collected After:	Percent of Yearling Chinook Collected After:
2001	50% / 1-day	11-Jun	10.2	4.2	0.6
	50% / 3-day	13-Jun	17.7	4.0	0.4
	Standard	20-Jun	29.6	3.1	0.2
2002	50% / 1-day	11-Jun	4.4	3.2	1.1
	50% / 3-day	26-Jun	15.8	0.8	0.3
	Standard	20-Jun	8.1	1.9	0.6
2003	50% / 1-day	2-Jun	8.6	3.5	0.7
	50% / 3-day	7-Jun	13.5	2.2	0.5
	Standard	20-Jun	43.3	0.8	0.1
2004	50% / 1-day	7-Jun	7.0	1.2	0.6
	50% / 3-day	9-Jun	13.7	1.1	0.5
	Standard	20-Jun	47.6	0.5	0.3
2005[1/]	50% / 1-day	2-Jun	48.0	1.3	1.0
	50% / 3-day	4-Jun	58.3	1.0	0.7
	Standard	20-Jun	96.5	<0.1	0.1
2006[1/]	50% / 1-day	2-Jun	29.0	1.1	0.8
	50% / 3-day	4-Jun	46.2	0.9	0.5
	Standard	20-Jun	71.0	<0.1	<0.1

Note:
[1/] Summer spill was provided these years, decreasing the total number of fish collected past June 20, skewing collection numbers towards the earlier season.

roughly 1.4 percent and 0.4 percent more, respectively. Slightly more of those percentages of spring migrants would be exposed to transportation during most flow years; however, a population level effect would not be anticipated.

3.4 SUMMER SPILL CURTAILMENT – ALL FLOW CONDITIONS

From August 1-31 at Lower Granite, Little Goose, and Lower Monumental dams, when collection of subyearling Chinook salmon (hatchery and naturally produced) falls below 1,000 per day for 3 consecutive days, spill will be discontinued on a per project basis and maximum transportation will be initiated, beginning with the most upstream project. In addition, once spill is discontinued at Lower Granite, Little Goose, and Lower Monumental dams, spill will also be discontinued at Ice Harbor Dam two days following termination of spill at Lower Monumental Dam. If collection numbers exceeded 1,000 subyearling fish per day for 2 sequential days after spill was discontinued, spill would be reinitiated at that project. Until August 31, fish collection numbers will be reevaluated to determine whether spill should continue, using the criteria above.

During August of 2005 and 2006, when summer spill was provided, fall Chinook collection and passage index estimates at Lower Granite, Little Goose, and Lower Monumental dams were low relative to June and July (Table 2). At Lower Granite Dam in 2005 and 2006, the maximum number of fish collected for

Table 2. Fall Chinook Total Collection and Passage Index Estimates During June-July and August at Lower Granite, Little Goose, and Lower Monumental Dams in 2005-06

Year/Month	Project: Lower Granite (total collection/passage index)	Project: Little Goose (total collection/passage index)	Project: Lower Monumental (total collection/passage index)
2005			
June-July	1,055,805 / 1,201,267	935,574 / 1,021,078	161,910 / 190,713
August	2,987 / 6,867	3,434 / 5,718	510 / 1,040
2006			
June-July	372,739 / 555,818	565,937 / 840,195	184,566 / 264,745
August	1,822 / 4,347	2,304 / 3,483	378 / 836

a single day in August was 242 and 134 fish, with a daily average of 96 and 59 fish respectively. The last 1,000+ fish day for 2005 and 2006 was July 5 and July 12, respectively, at these two dams. From 2001-2004, years without spill, collection of less than 1,000 fish per day for a 3-day period with a 2-day check-in, occurred between August 5 and 31 (Figure 1).

The 1,000 fish per day threshold was chosen for spill years primarily because it was much higher than the numbers anticipated to be collected in August under a summer spill operation. Over the past 6 years, a daily total of 1,000 fish collected accounted for 0.1 to 0.2 percent of total annual collection. After the 3-day 1,000 fish or September 1 threshold was met, collection amounted to a range of 1.9 to 5.7 percent of total annual collection in non-spill years and 0.6 to 1.7 percent in spill years. This threshold will likely be adjusted through adaptive management in the future.

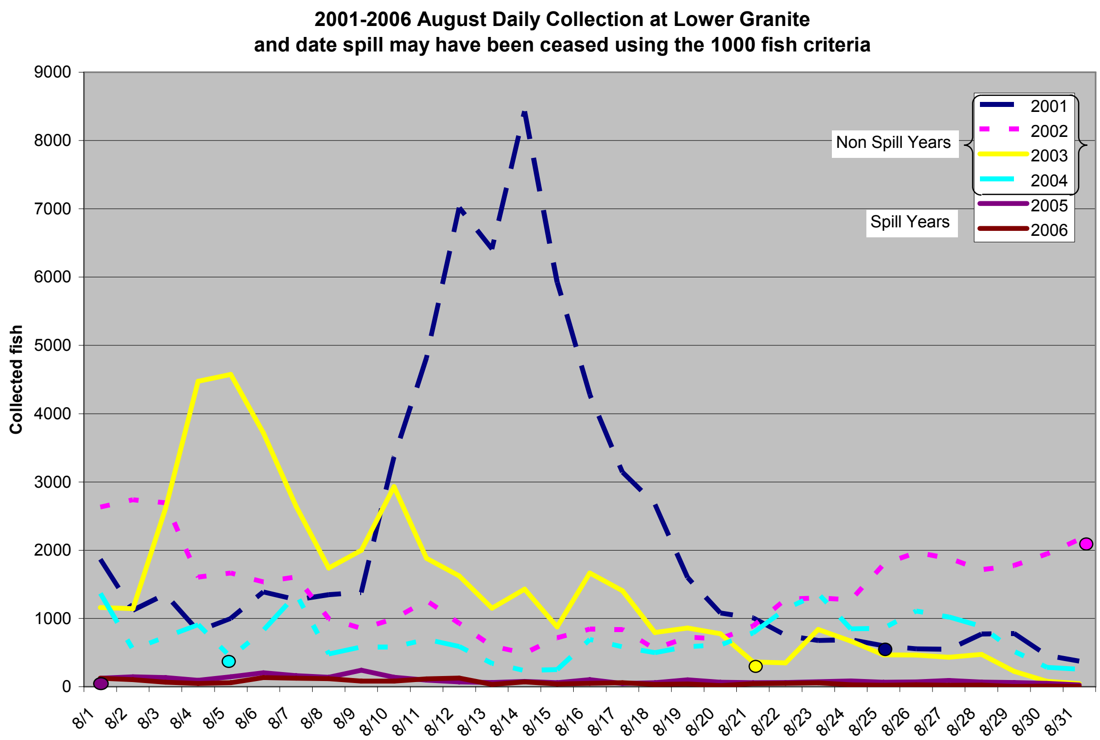

Figure 1. Numbers of Fall Chinook Collected During August at Lower Granite Dam During Non-summer Spill Years (2001-2004), and Years When Summer Spill was Provided (2005-2006)

3.5 ANALYSIS OF JUVENILE SALMONID SPECIES COMPOSITION AND RUN TIMING AT BONNEVILLE, JOHN DAY, AND MCNARY DAMS

Fish survival studies conducted at Lower Columbia River dams indicate that yearling Chinook and steelhead (spring migrants) benefit differently from a given spill operation than subyearling Chinook (summer migrants). Because of these differences, Bonneville and John Day dam operate differently for spring versus summer in order to provide the maximum survival benefit from spill.

The biologically most meaningful date to make the change from spring spill to summer spill operations is when the composition of the juvenile salmonid run changes from spring migrants to subyearling Chinook. The Action Agencies compiled 10 years of smolt monitoring data from the University of Washington Data Access in Real Time (DART) website http://www.cbr.washington.edu/dart/dart.html in order to assess run timing at Bonneville, John Day, and McNary dams.

3.5.1 Bonneville Dam

The 10-year average 95 percent cumulative passage dates for yearling Chinook, steelhead, and sockeye passage at Bonneville Dam occurred by 4 June, 11 June, and 14 June, respectively, during the 1996-2006 period (Figure 2).

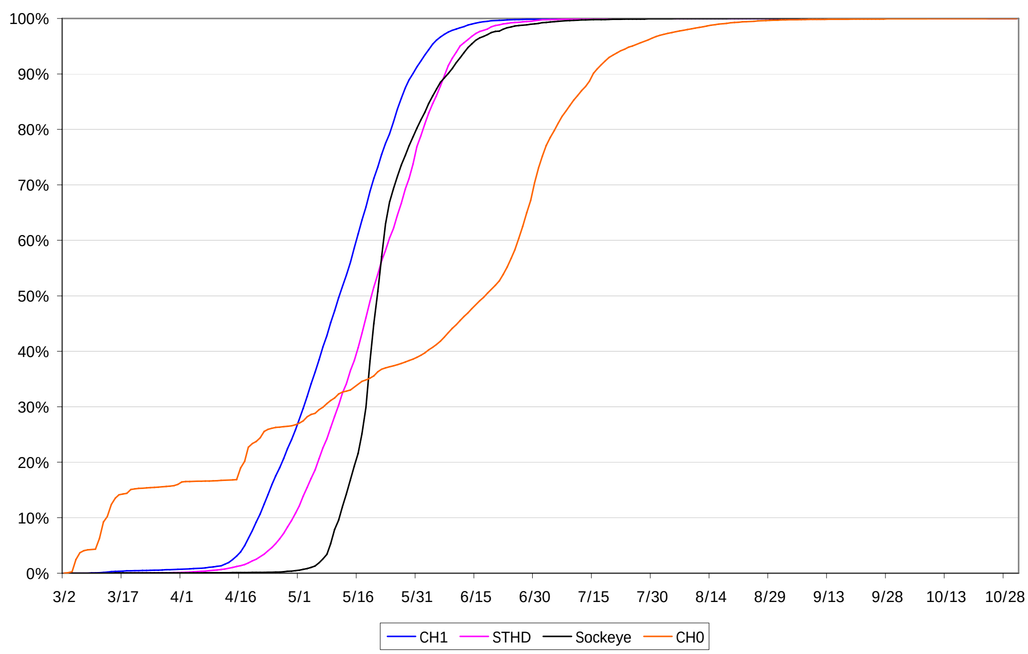

Figure 2. Average Cumulative Percent Passage for Yearling Chinook, Steelhead, Sockeye, and Fall Chinook Salmon at Bonneville Dam, 1996-2006

The average date during 1996-2006 when summer-migrating fall Chinook comprise approximately 80 percent of the juvenile salmonids migrants passing Bonneville Dam is 16 June (Figure 3).

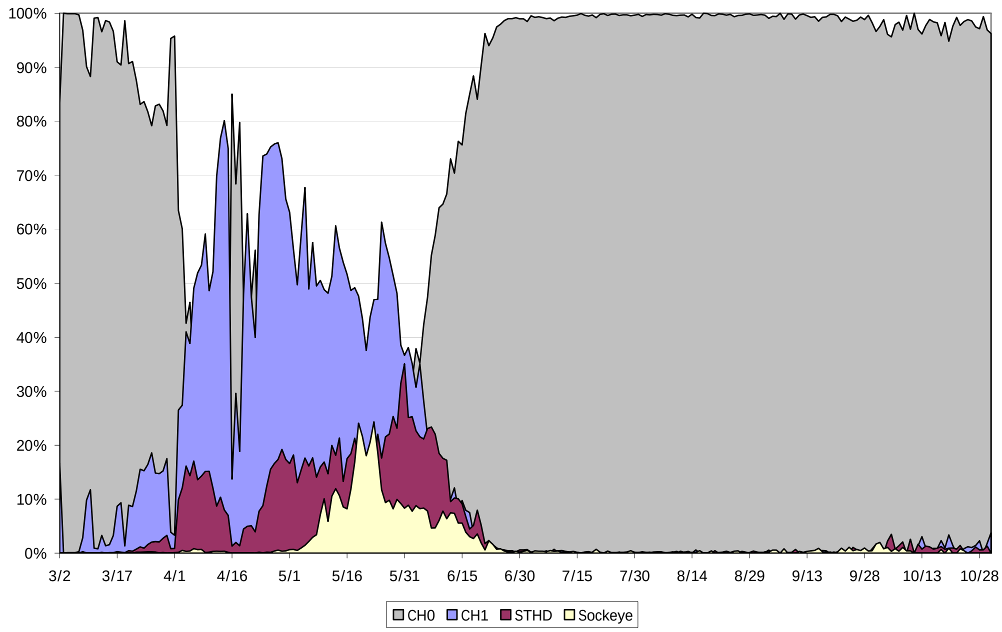

Figure 3. Average Daily Species Composition at Bonneville Dam, 1996-2006

3.5.2 John Day Dam

The 10-year average 95 percent cumulative passage dates for yearling Chinook, steelhead, and sockeye passage at Bonneville Dam occurred by 5 June, 6 June, and 10 June respectively during the 1996-2006 period (Figure 4).

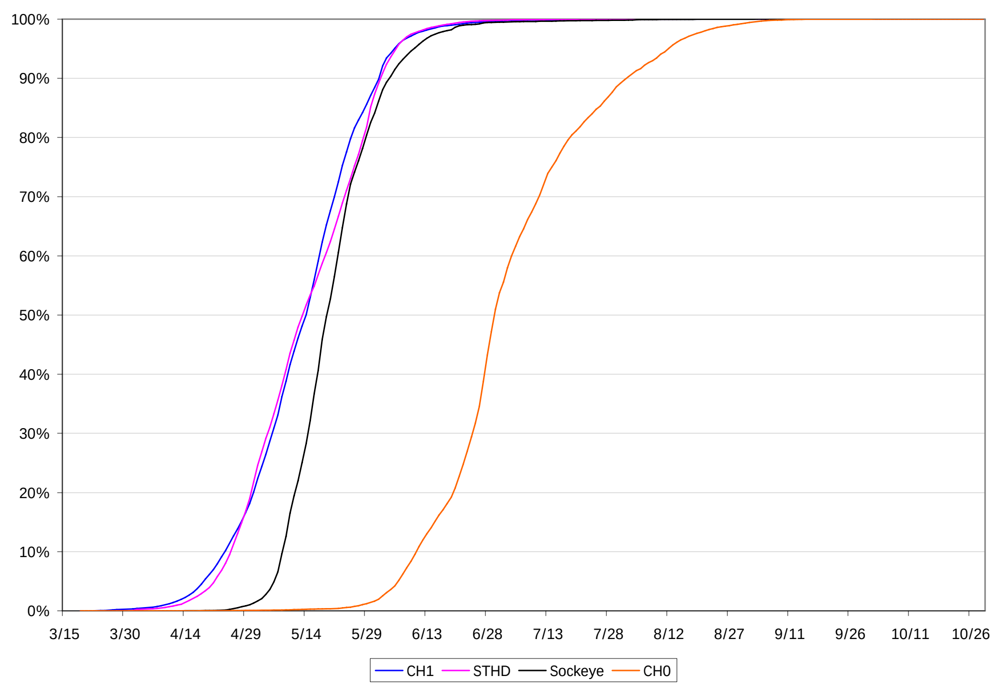

Figure 4. Average Cumulative Percent Passage for Yearling Chinook, Steelhead, Sockeye, and Fall Chinook Salmon at John Day Dam, 1996-2006

The average date during 1996-2006 when subyearling Chinook comprise approximately 80 percent of the juvenile salmonids migrants passing John Day Dam is 11 June (Figure 5).

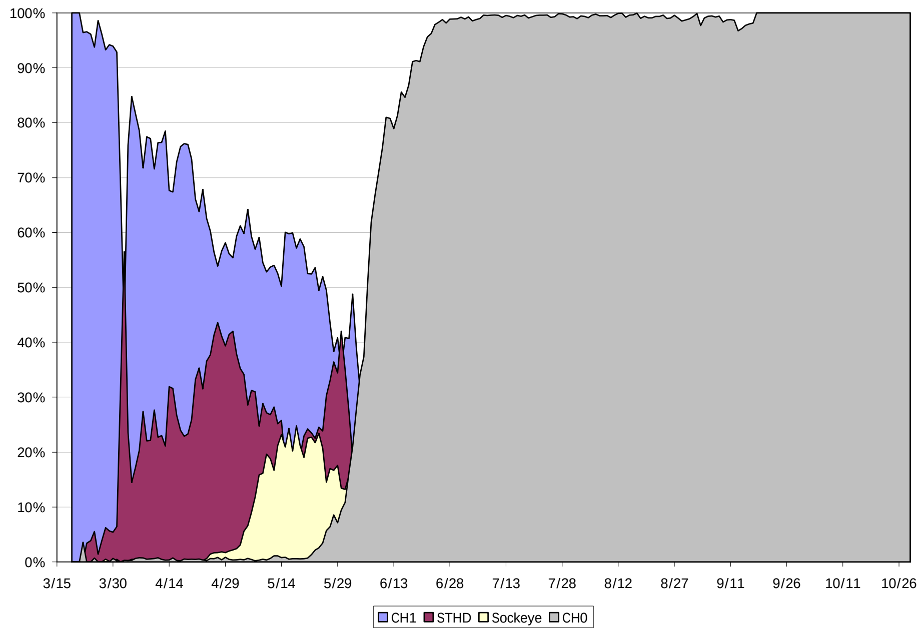

Figure 5. Average Daily Species Composition at John Day Dam, 1996-2006

3.5.3 McNary Dam

The 10-year average 95 percent cumulative passage dates for yearling Chinook, steelhead, and sockeye passage at McNary Dam occurred by 3 June, 7 June, and 7 June respectively during the 1996-2006 period (Figure 6).

The average date during 1996-2006 when subyearling Chinook comprise approximately 80 percent of the juvenile salmonids migrants passing McNary Dam is 12 June (Figure 7).

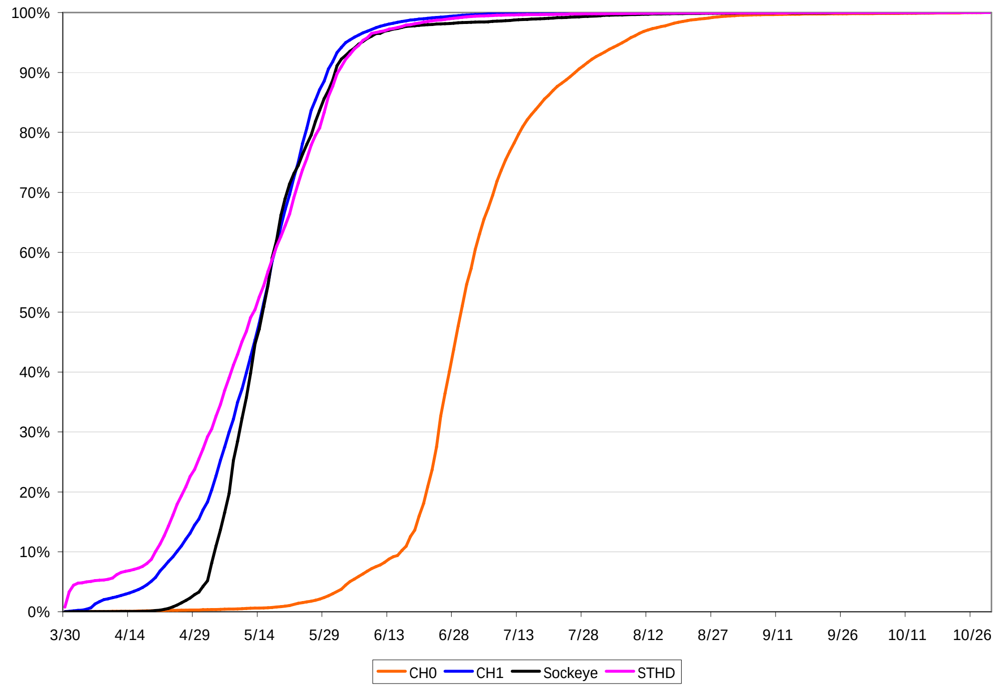

Figure 6. Average Cumulative Percent Passage for Yearling Chinook, Steelhead, Sockeye, and Subyearling Chinook Salmon at McNary Dam, 1996-2006

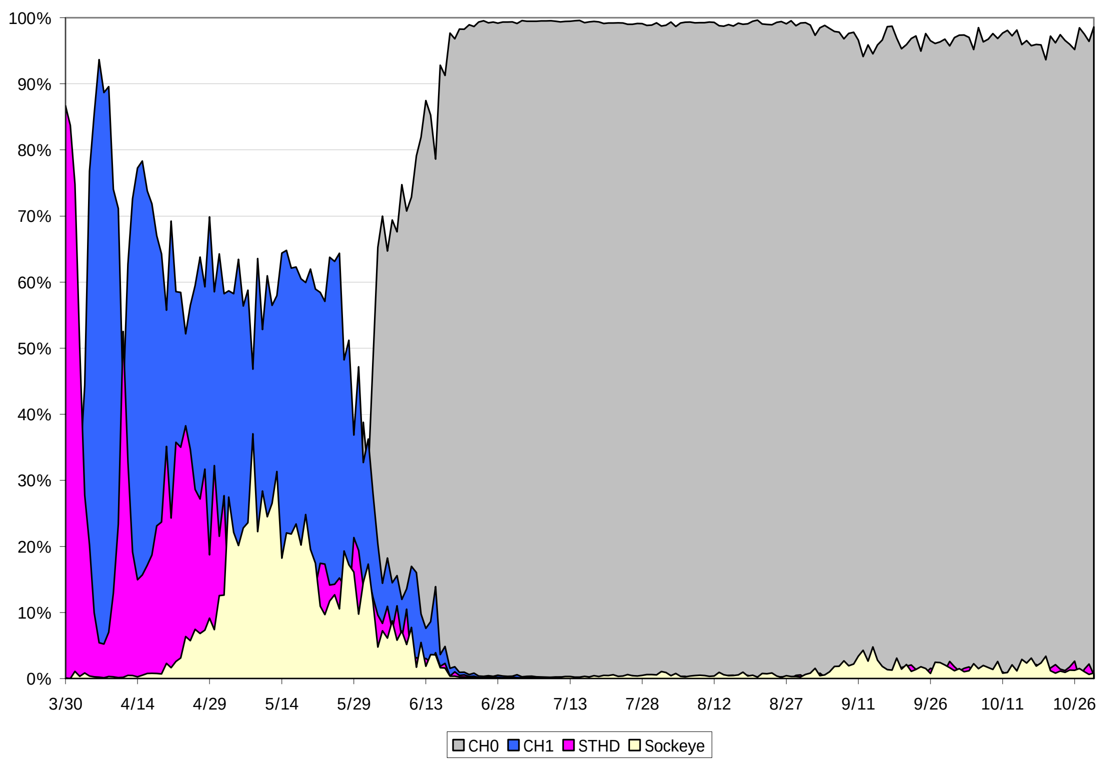

Figure 7. Average Daily Species Composition at McNary Dam, 1996-2006

3.5.4 Conclusion

By June 16, on average, the composition of juvenile salmonids passing Bonneville, John Day, and McNary dams is greater than or equal to 80 percent, and more than 95 percent of yearling Chinook, steelhead, and sockeye have passed these dams. A change in that is intended to benefit summer-migrating subyearling Chinook should therefore occur around 16 June at Bonneville, John Day, and McNary dams.

3.6 SEPTEMBER-OCTOBER OPERATIONS

Between September 1 and 30, transportation would be maximized. After September 30, adaptive management (i.e., bypass or transportation) will be considered based on numbers of fish passing the projects and other factors (e.g., overall fish numbers, numbers of other species collected, river conditions, and others). In October, operation of the projects in primary bypass mode, with PIT-tag detection, will be conducted only if necessary for research.

Recent information on trucked fish (Marsh 2006) has indicated that trucking fish in the late season has yielded SARs of around 2 to 4 percent. While this number is quite high, there remains a question in what SARs are for in-river fish during the same time. The Action Agencies believe that transportation is beneficial to fish during that operation and believe that truck transportation in the late season is a reasonable tool. The use of this tool may require revisiting and adaptive management in the future.

4. PROPOSED LOW FLOW OPERATION

In water years when the Snake River projected seasonal average (April to June) flow is less than 65 kcfs (~ lowest 15 percent of all water years), transportation will be initiated on April 3 at the Snake River collector projects. The seasonal average flow projection will be based on the Corps' Single Trace Procedure (STP) model and the March mid-month, and revisited through the May forecast. Transportation from Snake River projects will be maximized (i.e., no voluntary spill or bypass provided) until May 31.

Twenty-four hour monitoring of the smolt migration would continue at the collector projects to facilitate transportation.

4.1 RATIONALE FOR SNAKE RIVER OPERATION

In 2001, the region experienced some of the lowest flows on record from the Snake River, with a seasonal average flow of approximately 42.5 kcfs (~7.7 million acre-feet [MAF]). Although the majority of fish were transported and little or no spill was provided, in-river survival for Snake River spring/summer Chinook and steelhead were some of the lowest measured in recent years (<30 percent and <5 percent respectively). The 2000 and 2004 Biological Opinions indicated that in low flow years (below 85 kcfs and 70 kcfs, respectively), removing fish from the river was the most prudent operation. These flow levels are based on data indicating a positive relationship between flow and survival in years when river flows are lowest, defining the drier and drought years. For Snake River flows measured at Lower Granite Dam, Smith et al. (2006) and Williams et al. (2005) present data suggesting a positive relationship between flow and survival for Chinook salmon smolts when flows are less than a threshold of approximately 70 kcfs. For steelhead smolts, a similar flow threshold of between 85,000 cfs and 110 kcfs has been suggested (Plumb et al. 2006, Williams et al. 2005).

Data collected in 2001 indicated a significant transport benefit, including an 800 percent increase for wild Chinook salmon, 900 percent more hatchery spring Chinook salmon, and 1,760 percent more hatchery summer Chinook salmon (Berggren et al. 2004) than undetected in-river migrants. National Marine Fisheries Service (NMFS, also called National Oceanic and Atmospheric Administration [NOAA] Fisheries) analysis indicated that, for the entire spring transportation period, hatchery Chinook salmon returned to the river at Lower Granite experienced an overall SAR of just 0.04 percent compared to 1.09 percent for those transported. Further analysis indicated these high returns from the transport operations were consistent throughout that year, even in the early weeks (Annex 1).

4.2 RATIONALE FOR MCNARY DAM OPERATION

For McNary Dam, preliminary data for transported upper Columbia hatchery fish (NMFS 2006) has demonstrated that in a normal flow year, while spill yielded higher SARs than transported fish, transport yielded higher SARs than bypassed fish. Therefore, if not spilling during a low flow year due to power emergencies, data indicates that transport would likely yield a higher adult return for spring migrants than bypassed fish.

5. PROPOSED LOW TO MID-LOW FLOW OPERATION

In water years when the Snake River projected seasonal average (April – June) flow is between 65 and 80 kcfs (~lowest 15 to 28 percent of all water years), spill and bypass would be provided beginning April 3 at Lower Granite, April 5 at Little Goose and April 7 at Lower Monumental. Beginning around April 20 at Lower Granite and staggered downstream, spill and transportation would be provided. Transportation would be maximized from late-mid spring until May 31 at all Snake River collector projects.

Although proposing to maximize transportation during May, the Action Agencies recognize that some level of spill would be required at the collector projects because May is typically a peak runoff month regardless of water year and some involuntary spill would likely occur. However, when spill is provided, it would be managed in order to best meet the dam survival performance standards.

Between June 1 and June 30, to spread the risk for migrating subyearling Chinook, spill and transportation would be adaptively managed. When fall Chinook exceeded 50 percent of the collection for a 3-day period at each project in turn (beginning with the most upstream project), a spill and transportation operation would be reinitiated.

Although spill and transportation would be initiated on a staggered basis in the Snake River, spill and primary bypass would be provided at McNary Dam throughout the spring, until June 15 or when conditions were no longer spring like.

5.1 RATIONALE FOR SNAKE RIVER OPERATION

5.1.1 Lower Granite Dam

Under these flow conditions, voluntary spill would begin on April 3 at Lower Granite Dam and would continue through April 30. All fish collected would be bypassed back to the river through the juvenile fish facility until April 20, when fish collection for transport would be initiated. On May 1, spill would be either stopped or minimized and transportation would be maximized. If minimized, the spill level provided would be designed to provide good egress and survival conditions. In general, 50 percent of yearling spring Chinook salmon and steelhead have typically passed Lower Granite by May 1 and May 9, respectively.

The initiation of transport has been delayed in recent years (2004 Updated Proposed Action) due to evidence suggesting that early transport (on average, prior to April 20) was providing no benefit to yearling Chinook (Anderson et al. 2005). Anderson et al. reported that the benefits to in river passage versus transport reversed at water temperatures in the Lower Granite forebay of about 9.5°C. As a point of reference, the average daily water temperature met or exceeded 9.5°C on April 20 in 9 of the 11 available data years between 1995 and 2006.

Recent data from Petrosky et al. (2006) for the years 1998-2003 has indicated that SARs for bypassed yearling Chinook were 1.76 for the first third of the Chinook run, 1.03 for the middle third, and .56 for the last third of the run. On average, for 2001 to 2006, the first 1/3 of the yearling Chinook run occurs at Lower Granite around April 30. This indicates that a reasonable management option for transport would include a seasonal component.

In addition, NOAA Fisheries ad hoc analysis indicated that, for yearling Chinook and steelhead transported between April 20 and 26, there was typically a benefit for transporting over bypassing fish at Lower Granite. However, for fish transported prior to May 1, the benefits are typically more modest than during the May timeframe (where they tend to be substantial) and the 95 percent confidence intervals around the data typically contain the value 1. This provides some level of uncertainty such that recommending spill and transport be provided until sufficient data can be gathered for the late April timeframe to recommend one operation over another.

Twenty-four hour monitoring of the smolt migration would continue at Lower Granite Dam. The discussion on the importance of this monitoring in the early season after a new juvenile bypass facility is constructed will be coordinated through the Fish Passage Operations and Maintenance Coordination Team (FPOM). Primary bypass would preclude any sampling of fish at this facility, reducing the ability to conduct early season research and annual monitoring of the smolt migration, and is therefore not proposed at this time. Future configurations including the redesign of the juvenile fish facility, would allow for separate transport and bypass of fish of different sizes, or primary bypass of all fish if warranted.

5.1.2 Little Goose Dam

Under these flow conditions, voluntary spill would begin on April 5 at Little Goose Dam, and would continue through May 4. Transportation would be maximized by stopping or minimizing spill beginning May 5.

The initiation of spill at Little Goose Dam would occur 2 days after the initiation of spill at Lower Granite Dam. Data suggests that the time required for 50 percent of in-river migrant fish to travel from Lower Granite to Little Goose Dam in April is roughly 4 to 5 days and, therefore, providing spill at a 2-day stagger would provide an in-river passage route at Little Goose for faster migrating fish. Until RM&E can clarify the factors affecting seasonal adult returns, spill, and transportation would be initiated on a staggered basis, based on run timing. The initiation of transport and ceasing of spill would be staggered from Lower Granite Dam by 8 days, which is approximately the time it takes for 80 percent of the migration to pass Little Goose after passing Lower Granite in late April (Annex 2). The intent is to allow the majority of those fish migrating past Lower Granite in-river to migrate in-river past Little Goose.

After the outfall flume is routed to a better release location and full flow PIT-tag detection is added at Little Goose Dam, 24-hour sampling would be discontinued at this site until required for transport, on April 28th, to reduce the potential of fish incurring unnecessary potential stressors in the smaller pipes and flumes of the facility (which possibly lead to potential latent bypass effects). Sampling at the juvenile facility would occur on a limited basis as needed to ensure optimum facility operation and research purposes. Until construction improvements are made, fish will continue to be bypassed via the facility to collect PIT information.

5.1.3 Lower Monumental Dam

Under these flow conditions, voluntary spill would begin on April 7 at Lower Monumental Dam and continue through May 9. All fish collected would be bypassed back to the river through the juvenile fish facility until May 1, when fish collection for transport would be initiated. Spill would then be stopped on May 9, and transportation would be maximized through stopping or minimizing spill.

The initiation of spill would occur 2 days after the initiation of spill at Little Goose Dam, because data suggests that the median time for fish to travel from Lower Granite to Little Goose Dam in April is roughly 3 days. Therefore, providing spill at a 2-day interval would provide an in-river passage route to the faster migrating fish. Until RM&E provides information to support decisions on the transition date to transport from spill operations, the transition date will be based on ruming. The initiation of transport and ceasing of spill would be staggered from Little Goose Dam by 5 days, which is approximately the time it takes for 80 percent of the migrants to pass Lower Monumental after passing Little Goose in late April (Annex 2). The intent is to allow the majority of those fish migrating past Little Goose Dam in-river to migrate in-river past Lower Monumental Dam.

After the outfall flume is routed to a better location and full flow PIT-tag detection is added at Lower Monumental Dam, 24-hour sampling would be discontinued at this site until transport was initiated on May 2, to reduce the potential of fish incurring unnecessary potential stressors in the smaller pipes and flumes of the facility. Sampling at the juvenile facility would occur on a limited basis, as needed, to ensure optimum facility operation and research purposes. Until construction improvements are made, fish will continue to be bypassed via the facility to collect PIT-tag information.

The Action Agencies would perform RM&E on fish encountering Lower Monumental Dam to determine if there were benefits to transporting these fish.

5.2 RATIONALE FOR MCNARY OPERATION

Under these flow conditions, voluntary spill would begin on April 10 at McNary Dam, and would continue through June 15 or when conditions were no longer spring like. All fish collected would be bypassed back to the river through the primary bypass until June 15, when adaptive management for summer operations would begin. Sampling at the juvenile facility would be performed in a limited manner, on an as needed basis, to determine facility condition and facilitate research.

Results of RM&E conducted on upper Columbia River spring Chinook salmon and steelhead will be assessed upon completion of adult returns in 2008. The use of transportation from this facility as a management tool will be discussed with the FPOM at that time, and will either remain in its current status of no spring transport be adjusted (e.g., seasonally, by fish size, and so on) depending on the results of the research, or additional research will be performed if data is unclear. Until that time, operation of the fish facility during the spring at these flows will consist of bypassing only.

6. PROPOSED MID-LOW TO HIGH OPERATION

When average seasonal flows in the Snake River are projected to be above 80 kcfs (~72 percent of all water years), spill would be provided beginning April 3 at Lower Granite, April 5 at Little Goose, and April 7 at Lower Monumental. Spring spill operations would be provided through June 1, but the spill level would be reduced to the extent possible later in the season to facilitate higher transportation ratios. The Action Agencies would plan to initiate transportation on April 21, April 29, and May 2 at Lower Granite, Little Goose, and Lower Monumental, respectively. Adaptive management of a start date would be considered through the regional forum, with Lower Granite transportation starting no later than May 1.

The Action Agencies will continue to be conservative regarding the start dates of transport. The Action Agencies believe that leaving a large proportion of steelhead in river late into the season, as would occur with a May 1 start date (Table 3), would significantly reduce the returning number of steelhead, which typically see strong benefits of transport across the season.

Table 3. Percentages of the Yearling Chinook and Steelhead Runs at Lower Granite Dam that would have been Expected to have been Left in River Without the Opportunity to Transport using an April 20 and May 1 Transport Start Criteria

At Lower Granite Dam		Percent of Fish Collected before April 20	Percent of Fish Collected before May 1
2001	YR Chin	3.0	30.8
	STHD	0.4	17.8
2002	YR Chin	14.6	30.2
	STHD	10.3	31.4
2003	YR Chin	8.7	36.5
	STHD	4.8	27.1
2004	YR Chin	7.5	32.0
	STHD	1.8	17.2
2005	YR Chin	4.4	34.4
	STHD	2.9	22.5
2006	YR Chin	9.1	28.9
	STHD	8.2	36.3

While proposing an increase in transportation during May, the Action Agencies realize that maximization of transportation will likely mean that some level of spill would be required. May is typically a peak runoff month regardless of water year and, while spilling, spill would be optimized towards the operation that best meets the dam survival performance standards.

6.1 LOWER GRANITE DAM

Under these flow conditions, voluntary spill would begin on April 3 at Lower Granite Dam and would continue through June 1. All fish collected would be bypassed back to the river through the juvenile fish facility until April 20, when fish collection for transport would be initiated. Spill would continue in May and June in accordance with the initial spill operations (Table 3) until more information is available to inform future decisions on spill and transport operations.

Twenty-four hour monitoring of the smolt migration would continue at Lower Granite Dam. The discussion on the importance of this monitoring in the early season after a new juvenile bypass facility is constructed will be coordinated through the FPOM.

6.2 LITTLE GOOSE DAM

Under these flow conditions, voluntary spill would begin on April 5 at Little Goose Dam and would continue through June 30. Transportation would be initiated April 29. Spill would be reduced in May and June to 30-percent maximum spill, or removable spillway weir (RSW) and training flow (after implementation) to the extent possible, in order to transport more fish during the time period that has consistently shown the most benefit. Seasonal transport and spill evaluation will inform future decisions on operations at higher river flows. Sampling at the juvenile facility would be performed in a limited manner, on an as needed basis, to determine facility condition and to facilitate research until required for transport.

6.3 LOWER MONUMENTAL DAM

Under these flow conditions, voluntary spill would begin on April 7 at Lower Monumental Dam and would continue through May 9. Collection for transport would be initiated on May 1. Spill would continue in May and June to RSW and training flow. As more information becomes available on seasonal spill and transport benefits from Lower Monumental Dam, the project operation may be changed. Sampling at the juvenile facility would be performed in a limited manner, on an as-needed basis, to determine facility condition and facilitate research until required for transport.

6.4 COMPASS RESULTS

A preliminary COMPASS analysis (Figure 8), using an average water year, indicated that in order to maximize adult returns for yearling Chinook, the optimum transport initiation date was April 27, with 99 percent of the benefits to adult returns realized between April 20 and May 2 (i.e., if transport were started between those dates, overall adult returns would likely be within 1 percent of maximum potential). For Snake River steelhead, the optimum time to begin transporting would be March 31, with 99 percent of the benefits realized if transportation began up to 8 April. To balance the maximization of adult returns for each species, and considering a 95 to 100 percent maximization of adult return threshold for both species, the start dates of transport would range from March 31 to April 19 for steelhead, and March 31 to May 9 for yearling Chinook. April 20 was chosen as a planning date, because it appeared to have minimal risk to both steelhead and yearling Chinook.

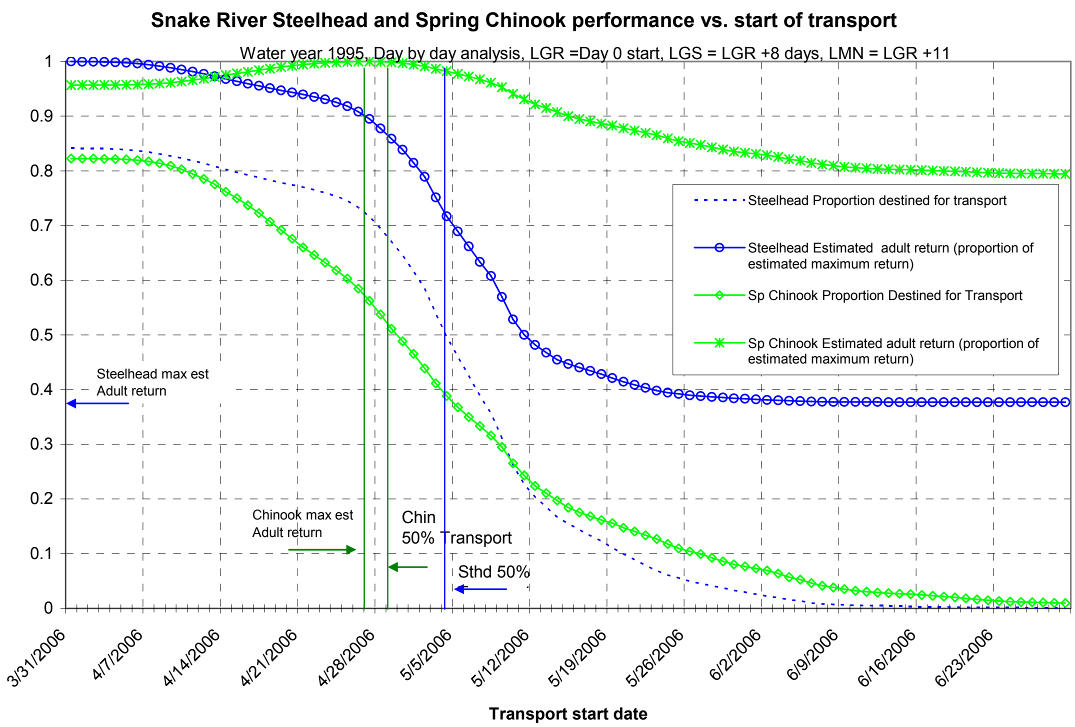

Figure 8. Preliminary COMPASS Analysis for Optimum Transport Initiation Date

Between 28 April and 5 May, modeled benefits for yearling Chinook adult returns dropped a small amount, from 99 to 98 percent of maximum adult returns. However, for steelhead, the modeled benefits dropped from 87 to 69 percent of the benefit during the same time period. This led the Action Agencies to be extremely cautious regarding the modification of the start date to May 1, as requested by many managers in the region, when only 81 percent of the modeled benefit for steelhead was realized.

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Annex 1

Data from Bill Muir Regarding Seasonal Transport to Bypass SARs
Wild and Hatchery Chinook and Wild and Hatchery Steelhead

Table 1. Weekly and yearly estimates of percent migrant survival (S_M) from Lower Granite Dam to Bonneville Dam, percent smolt-to-adult return for fish transported (SAR_T) or returned to the river (SAR_M) at Lower Granite Dam, transport migrant ratio ($T{:}M$), and post-hydropower system differential mortality (D) **for hatchery Chinook salmon** PIT-tagged upstream of Lower Granite Dam, 1997-2002. A value of 0.98 was used for survival during transport (S_T).

	April 2	April 9	April 16	April 23	April 30	May 7	May 14	May 21	May 28	Year
					1997					
S_M	-	55.5	48.0	71.9	46.0	35.8	49.2	-	-	48.5
SAR_T	-	-	0.10	0.81	1.09	0.86	1.09	0.30	0.76	0.89
SAR_M	-	-	0.00	1.36	0.81	1.10	0.42	0.21	-	0.69
$T{:}M$	-	-	-	0.60	1.35	0.78	2.60	1.43	-	1.29
D	-	-	-	0.44	0.63	0.28	1.31	-	-	0.64
					1998					
S_M	-	50.2	51.5	55.0	54.0	56.2	57.1	60.9	45.7	53.3
SAR_T	0.43	0.59	0.77	0.98	2.22	2.37	2.39	1.74	-	1.73
SAR_M	1.84	2.27	1.25	0.88	0.51	0.54	0.82	1.88	-	0.73
$T{:}M$	0.23	0.26	0.62	1.11	4.35	4.39	2.91	0.93	-	2.37
D	-	0.13	0.33	0.62	2.40	2.52	1.70	0.58	-	1.29
					1999					
S_M	51.5	54.1	45.4	54.7	56.0	56.5	57.5	56.7	49.5	55.7
SAR_T	-	-	0.00	0.76	2.32	3.20	4.01	3.86	4.61	2.75
SAR_M	-	-	0.80	0.82	1.33	1.60	1.57	1.70	2.93	1.47
$T{:}M$	-	-	-	0.93	1.74	2.00	2.55	2.27	1.57	1.87
D	-	-	-	0.52	1.00	1.15	1.50	1.31	0.79	1.06
					2000					
S_M	-	-	58.2	45.6	48.6	46.8	45.5	45.6	52.0	48.8
SAR_T	-	-	1.61	1.97	2.71	3.34	3.99	4.27	1.71	3.07
SAR_M	-	-	1.12	1.48	1.80	1.95	1.08	0.50	0.91	1.56
$T{:}M$	-	-	1.44	1.33	1.51	1.71	3.69	8.54	2.21	1.97
D	-	-	0.85	0.62	0.75	0.82	1.71	3.97	1.17	0.98
					2001					
S_M	-	15.4	28.8	29.5	29.6	25.9	22.8	17.5	8.3	27.8
SAR_T	0.00	0.68	0.91	0.66	1.02	1.64	1.17	1.02	1.02	1.09
SAR_M	0.00	0.00	0.00	0.05	0.05	0.04	0.03	0.00	0.11	0.04
$T{:}M$	-	-	-	13.20	20.40	41.00	39.00	-	9.27	27.25
D	-	-	-	3.97	6.16	10.84	9.07	-	0.78	7.73
					2002					
S_M	44.9	55.0	56.5	58.4	59.1	58.0	59.3	60.0	-	57.9
SAR_T	0.98	1.08	0.35	0.67	0.85	1.00	1.96	2.08	-	1.20
SAR_M	-	0.38	0.75	0.66	0.63	0.76	0.86	0.89	0.41	0.76
$T{:}M$	-	2.84	0.47	1.01	1.35	1.32	2.28	2.34	-	1.58
D	-	1.59	0.27	0.60	0.81	0.78	1.38	1.43	-	0.93

Table 2. Weekly and yearly estimates of percent migrant survival (SM) from Lower Granite Dam to Bonneville Dam, percent smolt-to-adult return for fish transported (SART) or returned to the river (SARM) at Lower Granite Dam, transport migrant ratio (T:M), and post-hydropower system differential mortality (D) for wild Chinook salmon PIT-tagged at Lower Granite Dam, 1998, 1999, and 2002. A value of 0.98 was used for survival during transport (ST).

	April 2	April 9	April 16	April 23	April 30	May 7	May 14	May 21	May 28	Year
					1998					
S_M	-	51.9	53.8	52.2	61.6	53.8	54.9	45.9	42.7	53.2
SAR_T	-	1.41	0.65	0.31	0.60	0.41	0.00	-	-	0.60
SAR_M	-	1.58	0.90	0.13	0.37	0.27	0.31	-	-	0.63
T:M	-	0.89	0.72	2.38	1.62	1.52	-	-	-	0.95
D		0.47	0.40	1.27	1.02	0.83	-	-	-	0.52
					1999					
S_M	52.7	57.7	57.6	55.9	56.5	53.0	50.4	53.5	-	55.7
SAR_T	1.04	0.78	1.26	1.33	2.72	2.30	4.53	-	-	2.11
SAR_M	1.27	1.53	0.24	0.91	1.82	1.53	0.55	-	-	1.22
T:M	0.82	0.51	5.25	1.46	1.49	1.50	8.24	-	-	1.73
D	0.44	0.30	3.09	0.83	0.86	0.81	4.24	-	-	0.98
					2002					
S_M	-	56.5	56.3	67.8	53.7	58.0	48.8	65.9	83.9	58.6
SAR_T	-	0.89	0.38	1.31	1.02	0.57	0.47	2.42	1.69	1.25
SAR_M	-	1.41	0.97	0.55	0.48	0.65	0.92	0.62	0.59	0.69
T:M	-	0.63	0.39	2.38	2.13	0.88	0.51	3.90	2.86	1.81
D	-	0.36	0.22	1.65	1.17	0.52	0.25	2.62	2.45	1.08

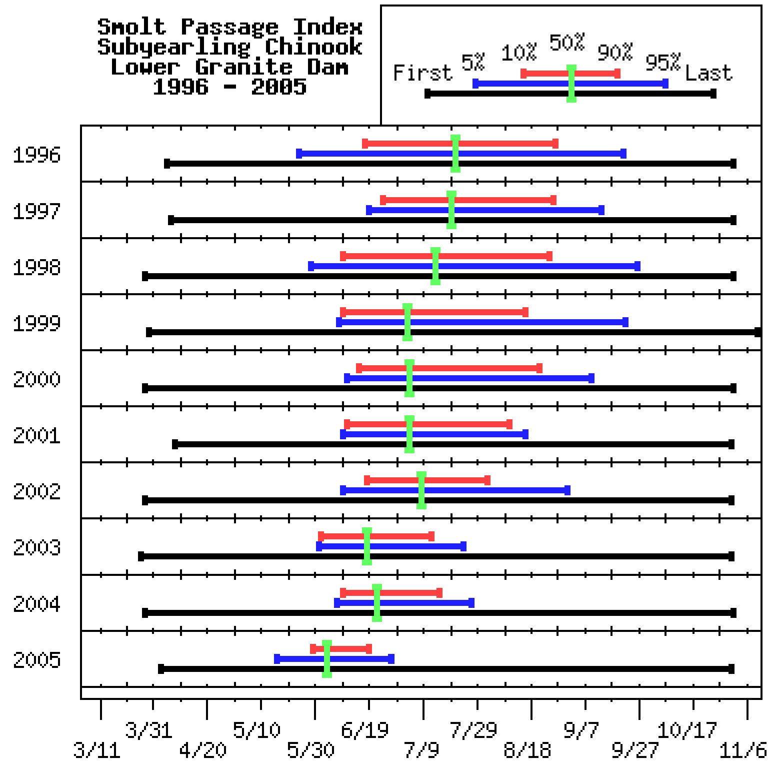
Table 3. Weekly and yearly estimates of percent migrant survival (SM) from Lower Granite Dam to Bonneville Dam, percent smolt-to-adult return for fish transported (SART) or returned to the river (SARM) at Lower Granite Dam, transport migrant ratio (T:M), and post-hydropower system differential mortality (D) for wild and hatchery steelhead PIT-tagged at Lower Granite Dam, 1999-2002. A value of 0.98 was used for survival during transport (ST).

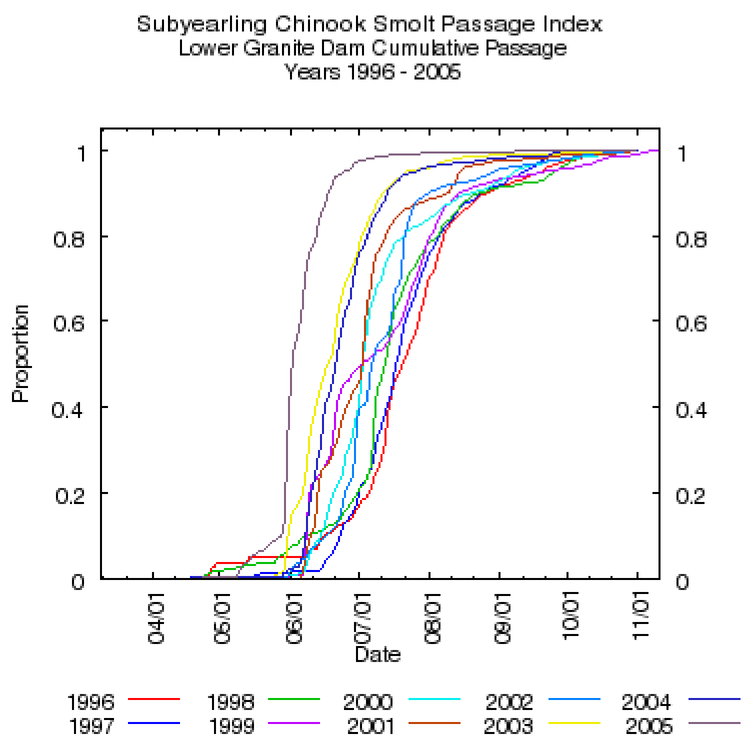
	April 2	April 9	April 16	April 23	April 30	May 7	May 14	May 21	May 28	Year
					1999 (hatchery)					
S_M	48.1	44.7	45.4	44.2	42.7	37.8	39.8	49.1	46.9	43.1
SAR_T	0.00	0.17	0.21	0.73	1.06	1.25	1.19	1.39	0.90	1.08
SAR_M	0.81	0.29	0.79	0.72	0.71	0.77	0.57	0.44	0.37	0.60
T:M	0.00	0.60	0.26	1.01	1.51	1.61	2.08	3.16	2.45	1.79
D	-	0.27	0.12	0.46	0.66	0.62	0.84	1.58	1.17	0.79
					1999 (wild)					
S_M	45.4	53.0	57.6	49.3	49.9	40.3	43.3	47.6	50.4	47.7
SAR_T	-	-	-	1.13	1.14	1.29	2.40	3.14	1.07	1.42
SAR_M	-	-	0.78	0.96	0.38	0.48	0.96	0.61	0.81	0.68
T:M	-	-	-	1.18	2.95	2.70	2.49	5.16	1.33	2.08
D	-	-	-	0.59	1.50	1.11	1.10	2.51	0.68	1.01
					2002 (wild)					
S_M	-	-	32.3	30.6	19.3	23.1	22.5	28.6	-	28.9
SAR_T	-	-	4.49	1.80	3.15	1.44	-	1.44	3.27	2.60
SAR_M	-	2.40	1.52	0.57	0.17	0.35	0.35	0.23	0.40	0.61
T:M	-	-	2.95	3.16	18.87	4.12	-	6.27	8.13	4.29
D	-	-	0.97	0.99	3.72	0.97	-	1.83	-	1.26

Annex 2

Data from DART Regarding Run Timing of Smolts at Lower Granite Dam
Steelhead, SpringSummer Chinook, Sockeye and Subyearling Chinook

* * Columbia River DART * *
10 Year Historical Run Timing Smolt Passage Index Subyearling Chinook at Lower Granite Dam
Data Courtesy of Fish Passage Center

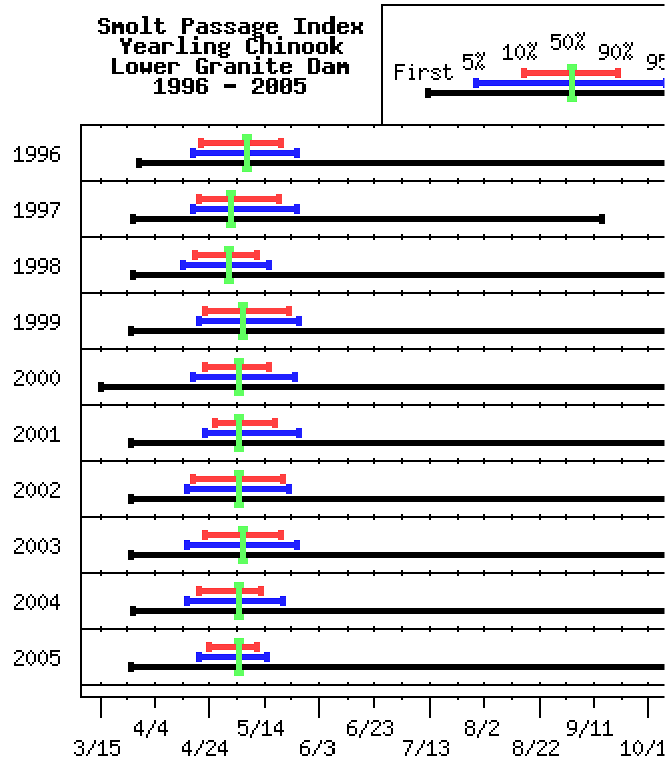


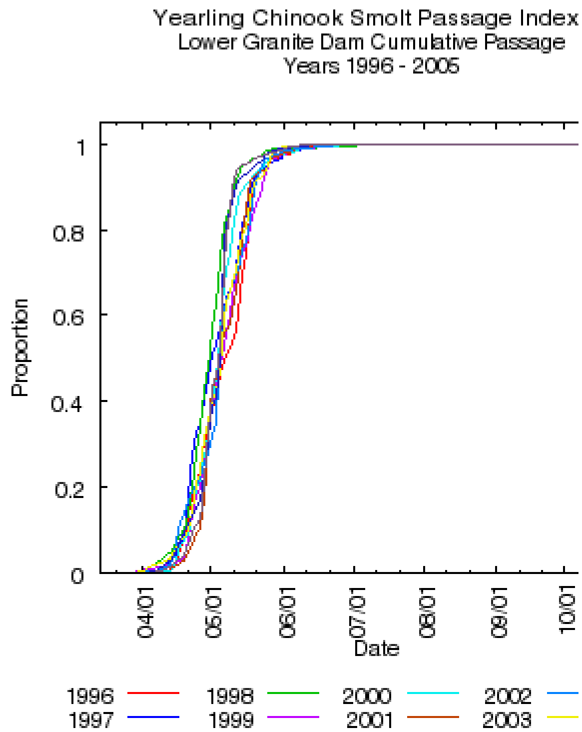


Migration Timing Characteristics

Year	First	1%	5%	10%	50%	90%	95%	Last	Middle 80% Days
	Passage Dates								
1996	04/04	04/27	05/23	06/16	07/20	08/26	09/20	10/31	72
1997	04/06	05/17	06/19	06/24	07/19	08/26	09/13	11/01	64
1998	03/28	04/29	05/28	06/09	07/13	08/25	09/26	11/01	78
1999	03/29	06/07	06/08	06/09	07/03	08/16	09/22	11/10	69
2000	03/27	06/04	06/10	06/14	07/03	08/20	09/08	10/31	68
2001	04/08	06/07	06/09	06/11	07/04	08/10	08/16	10/31	61
2002	03/28	06/02	06/09	06/18	07/08	08/02	08/31	10/31	46
2003	03/26	05/27	05/31	06/01	06/18	07/12	07/24	10/31	42
2004	03/27	05/29	06/06	06/08	06/21	07/14	07/26	10/31	37
2005	04/03	05/10	05/16	05/29	06/03	06/19	06/27	10/31	22

* * Columbia River DART * *
10 Year Historical Run Timing Smolt Passage Index Yearling Chinook at Lower Granite Dam
Data Courtesy of Fish Passage Center

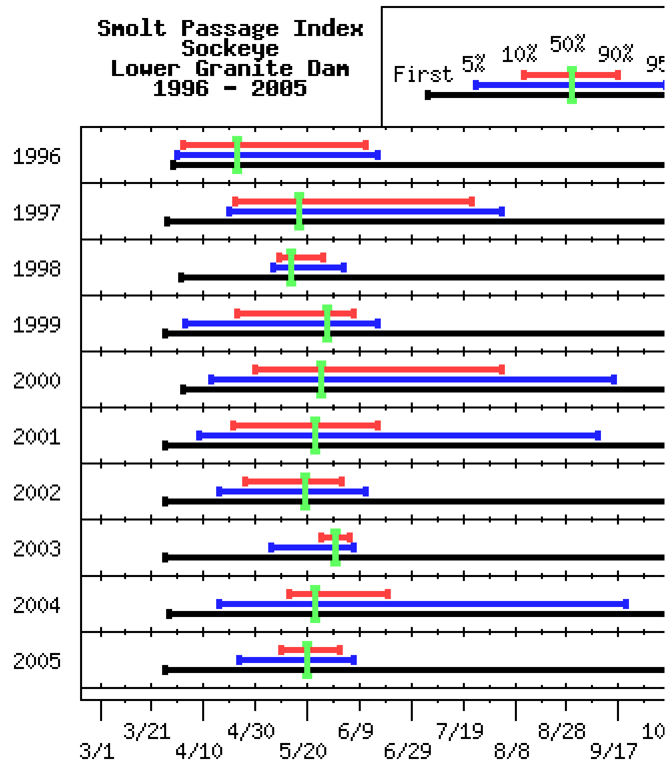


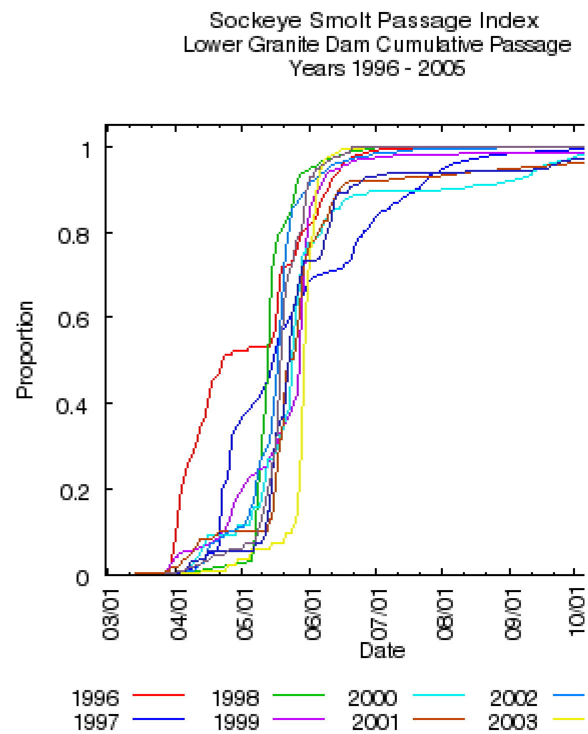


Migration Timing Characteristics

Year	First	1%	5%	10%	50%	90%	95%	Last	Middle 80% Days
	Passage Dates								
1996	03/28	04/13	04/17	04/20	05/07	05/19	05/25	10/31	30
1997	03/27	04/10	04/18	04/20	05/02	05/19	05/26	09/14	30
1998	03/27	04/05	04/14	04/19	05/01	05/11	05/16	11/01	23
1999	03/26	04/05	04/20	04/22	05/06	05/23	05/27	11/10	32
2000	03/14	04/13	04/17	04/21	05/04	05/15	05/24	10/31	25
2001	03/26	04/12	04/22	04/26	05/05	05/18	05/27	10/31	23
2002	03/26	04/11	04/16	04/18	05/05	05/21	05/23	10/31	34
2003	03/26	04/04	04/16	04/22	05/06	05/20	05/26	10/31	29
2004	03/26	04/08	04/15	04/19	05/04	05/12	05/20	10/31	24
2005	03/26	04/12	04/20	04/24	05/05	05/11	05/15	10/31	18

* * Columbia River DART * * 10 Year Historical Run Timing Smolt Passage Index Sockeye at Lower Granite Dam Data Courtesy of Fish Passage Center

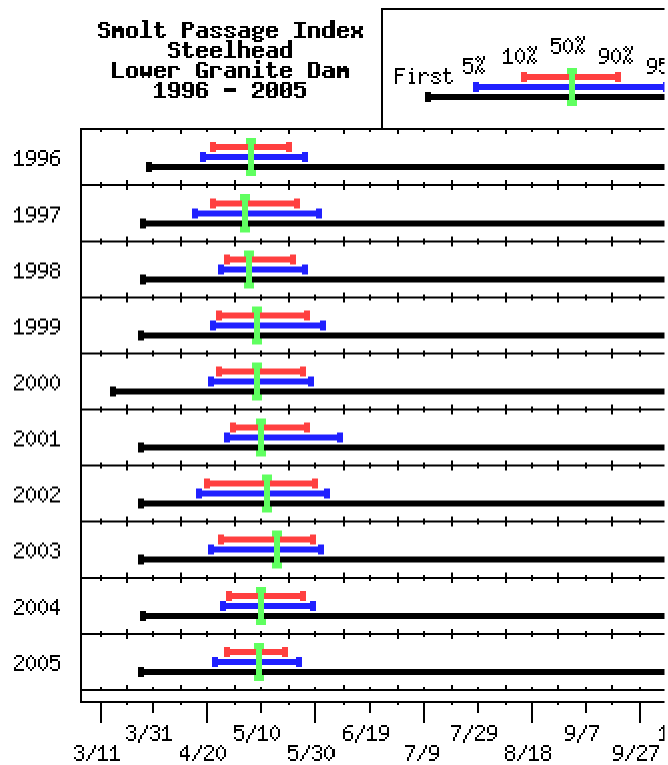


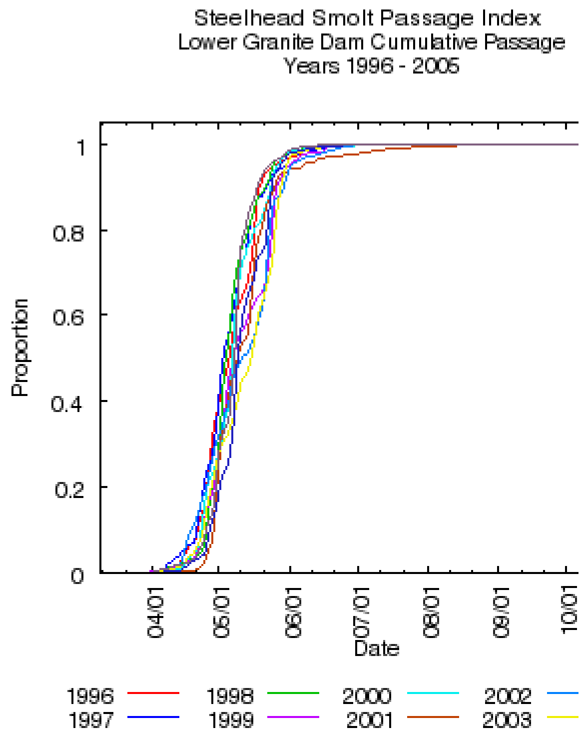


Migration Timing Characteristics

Year	First	1%	5%	10%	50%	90%	95%	Last	Middle 80% Days
	Passage Dates								
1996	03/28	03/28	03/30	04/01	04/22	06/10	06/15	10/30	71
1997	03/27	04/02	04/20	04/22	05/17	07/22	08/03	11/01	92
1998	04/01	05/06	05/07	05/09	05/14	05/26	06/03	11/01	18
1999	03/26	03/28	04/03	04/23	05/28	06/07	06/16	11/10	46
2000	04/01	04/05	04/12	04/29	05/24	08/02	09/14	10/31	96
2001	03/26	03/29	04/08	04/21	05/23	06/16	09/09	10/31	57
2002	03/26	04/09	04/16	04/26	05/19	06/02	06/11	10/31	38
2003	03/26	04/13	05/06	05/25	05/31	06/05	06/07	10/31	12
2004	03/27	04/05	04/15	05/12	05/22	06/19	09/19	10/31	39
2005	03/26	04/04	04/24	05/10	05/20	06/01	06/07	10/31	23

* * Columbia River DART * *
10 Year Historical Run Timing Smolt Passage Index Steelhead at Lower Granite Dam
Data Courtesy of Fish Passage Center





Migration Timing Characteristics

	Passage Dates								Middle 80%
Year	First	1%	5%	10%	50%	90%	95%	Last	Days
1996	03/28	04/11	04/17	04/21	05/05	05/19	05/25	10/31	29
1997	03/27	04/08	04/15	04/22	05/04	05/23	05/31	11/01	32
1998	03/27	04/08	04/25	04/27	05/05	05/22	05/26	11/01	26
1999	03/26	04/10	04/22	04/24	05/08	05/27	06/02	11/10	34
2000	03/15	04/13	04/20	04/23	05/07	05/24	05/27	10/31	32
2001	03/26	04/22	04/27	04/29	05/10	05/27	06/08	10/31	29
2002	03/26	04/12	04/17	04/20	05/12	05/30	06/03	10/31	41
2003	03/26	04/11	04/21	04/25	05/16	05/29	06/01	10/31	35
2004	03/26	04/15	04/25	04/27	05/09	05/24	05/28	10/31	28
2005	03/26	04/08	04/23	04/27	05/09	05/19	05/24	10/22	23

Annex 3
Excerpts from the Williams 2005 NOAA Tech Memo Regarding Sockeye Transportation and Percentages of Fish Transported

"We have little specific information about Snake River sockeye salmon. Between 1990 and 2001, 478 PIT-tagged sockeye salmon arriving at lower Snake River dams were transported, while 3,925 migrated in-river. Of these, two transported fish (0.4% SAR) and one in-river fish returned (0.03% SAR). Adult returns of sockeye salmon to Lower Granite Dam between 1990 and 2003 ranged from 3 to 282 fish (annual median was 13 fish). Snake River sockeye salmon have not demonstrated increased SARs in the last several years, similar to what occurred for Snake River Chinook salmon and steelhead."

"We note that transportation apparently has not provided any benefit to Snake River Sockeye salmon."

The following data represents the percentage of yearling Chinook and steelhead transported from 1993-2003 and it is anticipated that approximately this percentage of sockeye had also been transported.

Table 6. Estimated combined annual percentage of the nontagged yearling Chinook salmon population transported from Lower Granite, Little Goose, Lower Monumental, and McNary dams.

Year	Wild	Hatchery
1993	88.5	88.1
1994	87.7	84.0
1995	86.4	79.6
1996	71.0	68.7
1997	71.1	71.5
1998	82.5	81.4
1999	85.9	77.3
2000	70.4	61.9
2001	99.0	97.3
2002	72.1	64.2
2003	70.4	61.5

Table 12. Estimated combined annual percentage of the nontagged steelhead population transported from Lower Granite, Little Goose, Lower Monumental, and McNary dams.

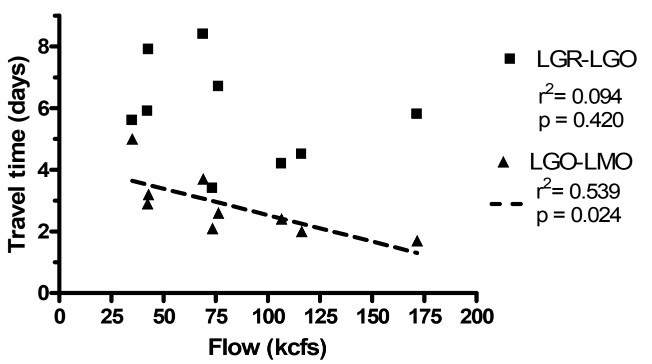
Year	Wild	Hatchery
1993	93.2	94.7
1994	91.3	82.2
1995	91.8	94.3
1996	79.8	82.9
1997	87.5	84.5
1998	88.2	87.3
1999	87.6	88.5
2000	83.9	81.5
2001	99.3	96.7
2002	75.2	70.4
2003	72.9	68.4

Annex 4
Data Provided by Bill Muir Regarding Early Season Travel Times

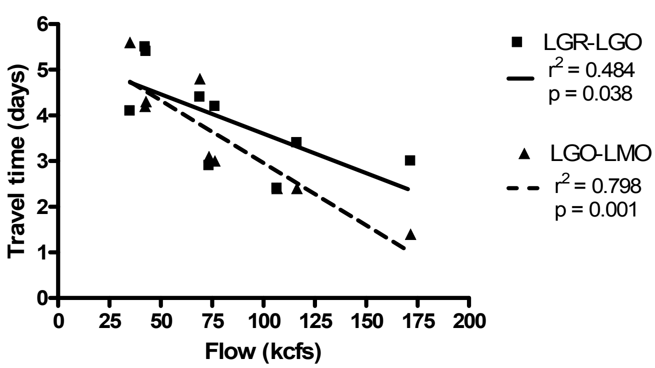
Average flow (KCFS) measured at Lower Granite Dam (LGR) and travel time (days) between LGR and Little Goose Dam (LGO), and LGO and Lower Monumental Dam (LMO) for yearling Chinook salmon and steelhead (hatchery and wild combined) between 20 – 26 April, 1997-2005.

	Yearling Chinook salmon				Steelhead				
	LGR-LGO		LGO-LMO		LGR-LGO		LGO-LMO		Flow
Year	**Med.**	**80%**	**Med.**	**80%**	**Med.**	**80%**	**Med.**	**80%**	**(KCFS)**
1997	5.8	8.9	1.7	2.5	3.0	5.0	1.4	3.0	171.6
1998	6.7	9.1	2.6	3.5	4.2	5.8	3.0	5.2	76.4
1999	4.5	6.1	2.0	2.8	3.4	4.8	2.4	4.7	116.3
2000	4.2	6.4	2.4	3.3	2.4	3.3	2.4	4.0	106.6
2001	5.6	8.0	5.0	12.4	4.1	6.4	5.6	13.8	35.1
2002	8.4	11.4	3.7	6.6	4.4	6.8	4.8	8.9	69.0
2003	3.4	5.0	2.1	2.8	2.9	4.1	3.1	7.9	73.5
2004	5.9	8.9	2.9	4.8	5.5	8.7	4.2	7.4	42.4
2005	7.9	12.1	3.2	4.7	5.4	9.9	4.3	7.9	42.8
Ave	**5.8**	**8.4**	**2.8**	**4.8**	**3.9**	**6.1**	**3.5**	**7.0**	

Yearling Chinook salmon



Steelhead



Average Release Date	Average Travel Time to LGS	Average Travel Time to LMN
1995		
4/22	6.8 (709)	8.6 (810)
4/28	4.3 (985)	6.1 (935)
5/1	4.3 (843)	5.8 (824)
5/4	4.1 (968)	5.4 (1068)
5/7	3.5 (656)	5.2 (607)
1996		
4/20	5.2 (377)	6.6 (327)
4/21	4.4 (303)	5.5 (371)
4/22	3.6 (323)	4.6 (368)
4/25	2.6 (337)	4.7 (242)

Data Courtesy of DART

Attachment B.2.1-2
Transport Permit

This attachment includes the following two documents:

1. Application for a Permit to Enhance the Survival of Listed Species Under the Endangered Species Act of 1973. Dated February 15, 2006

2. Extension of Permit No. 1237. Letter from National Marine Fisheries Service (NMFS, also called National Oceanic and Atmospheric Administration [NOAA] Fisheries), dated March 27, 2007

A. Title: Application for a Permit to Enhance the Survival of Listed Species Under the Endangered Species Act of 1973.

B. Species: Snake River sockeye salmon
Snake River spring/summer Chinook salmon
Snake River fall Chinook salmon
Snake River steelhead
Upper Columbia River spring Chinook
Upper Columbia River steelhead
Mid Columbia River steelhead

C. Date of application: February 15, 2006

D. Applicant identity:

LTC Randy L. Glaeser, District Engineer
Walla Walla District
U.S. Army Corps of Engineers
201 N. 3rd Avenue
Walla Walla, Washington 99362-1876

Phone: 509-527-7700

Point of contact: David Hurson
U.S. Army Corps of Engineers
201 N. 3rd Avenue
Walla Walla, Washington 99362-1876

Phone: 509-527-7125
FAX: 509-527-7820
E-mail address: dave.f.hurson@usace.army.mil

E. Information on personnel, cooperators and sponsors. The Corps of Engineers' (Corps) Juvenile Fish Transportation Program is carried out on a day-to-day basis from late March through October in coordination with state fishery agencies. The Washington Department of Fish and Wildlife (Lower Granite, Lower Monumental, and McNary dams) and Oregon Department of Fish and Wildlife (Little Goose Dam) provide fishery biologists under contract for quality control and oversight of fish handling activities. Within the Corps, the program is supervised by a GS-13 Fishery Biologist (26 years experience with fish passage at dams and juvenile fish transportation), managed by a GS-12 Fishery Biologist (11 years fish passage experience), and operated at the projects by GS-11 Fishery Biologists with 10 to 25 years of fishery experience. Each Project Biologist has an assistant at the GS-07/09 level. Fish barge and facility Biological Technicians are either seasonal or temporary personnel at the GS-05/06 level who have degrees in fishery biology or closely related biological fields and are trained in operating project fish passage facilities and barge equipment. Truck drivers and maintenance personnel meet Government qualification standards as appropriate for their positions.

1. **Program oversight**:

   Mr. David Hurson, Fishery Biologist
   Fish Passage Team Leader
   Walla Walla District
   U.S. Army Corps of Engineers
   201 N. 3rd Avenue
   Walla Walla, Washington 99362-1876
   Phone: 509-527-7125

   Mr. John Bailey
   Juvenile Fish Transportation Program Coordinator
   U.S. Army Corps of Engineers
   201 N. 3rd Avenue
   Walla Walla, Washington 99362-1876
   Phone: 509-527-7123

2. **Field supervisory personnel**:

   Mr. Mike Halter,
   Lower Granite Project Fishery Biologist
   Lower Granite Project
   U.S. Army Corps of Engineers
   825 Almota Ferry Road
   Pomeroy, Washington 99347-9758
   Phone: 509-843-1493 Ext. 263

   Mr. Greg Moody
   Little Goose Project Fishery Biologist
   Little Goose Project
   U.S. Army Corps of Engineers
   1001 Little Goose Dam Road
   Dayton, Washington 99328-9753
   Phone: 509-399-2233 Ext. 263

   Mr. Bill Spurgeon
   Lower Monumental Project Fishery Biologist
   Lower Monumental Project
   U.S. Army Corps of Engineers
   5520 Devils Canyon Road
   Kahlotus, Washington 99335
   Phone: 590-282-7211

   Mr. Brad Eby,

McNary Project Fishery Biologist
McNary Project
U.S. Army Corps of Engineers
82925 De Vore Road
Umatilla, Oregon 97882-1441
Phone: 541-922-2263

3. **Funding source**: Funding for the Juvenile Fish Transportation Program is part of the routine Operations and Maintenance budget for the Walla Walla and Portland Districts.

4. **Contractor qualifications:** As stated above, State agencies provide biological oversight for collection and transportation at the dams under contract to the Corps. State provided biologists also sample fish for the Smolt Monitoring Program, funded by Bonneville Power Administration and conducted under a separate Section 10 Permit (formerly issued to the Fish Passage Center). Corps project biologists supervise the collection and transportation of fish at the dams. The Corps contracts for towboats to transport fish barges from collector dams to the release points below Bonneville Dam. Towboat personnel meet Coast Guard requirements for their respective job positions. A Corps Biological Technician is assigned to each barge/towboat combination to operate fish barge equipment and to monitor fish and water quality during transit.

5. **Disposition of mortalities:** Typically, a small number of mortalities are associated with the collection and holding of fish for the Juvenile Fish Transportation Program. Mortalities are counted, and then passed through the facility drains back to the river. Mortalities are sometimes frozen and held for approved fishery agency or tribal fishery programs, such as dam angling programs to remove northern pikeminnow, which use dead juvenile fish for bait, or for other research needs. Some of the mortalities used by these parties may be listed fish, however, State or tribal programs are required to have the relevant ESA or state permits and interagency coordination completed in order to obtain mortalities from the facilities.

6. **Personnel qualifications and experience:** See paragraph G. 3.

F. Project description, purpose, and significance: The purpose of the Juvenile Fish Transportation Program is to protect sockeye (Oncorhynchus nerka), Chinook (O. tshawytscha), and coho (O. kisutch) salmon, and steelhead (O. mykiss) from adverse environmental conditions created by Corps dams and reservoirs on the lower Snake and Columbia rivers. Juvenile salmon and steelhead will be collected and transported between Lower Granite

Dam, located at river mile (RM) 107.5 on the Snake River 30 miles downstream from Clarkston, Washington, to the Columbia River below Bonneville Dam, located at RM 146.1 about 40 miles upstream from Portland, Oregon, a distance of roughly 285 river miles. Endangered Snake River sockeye, threatened Snake River Chinook, and threatened Snake River steelhead will be collected along with unlisted hatchery and wild salmon and unlisted hatchery steelhead at Lower Granite, Little Goose, and Lower Monumental dams on the Snake River, and McNary Dam on the Columbia River. Endangered hatchery and wild Upper Columbia River steelhead and spring Chinook and threatened Middle Columbia River steelhead may also be collected and transported from McNary Dam. Listed and unlisted hatchery and wild salmon and steelhead will be transported by truck and barge past three to seven downstream reservoirs and dams.

Survival of endangered and threatened species will be enhanced because they will be transported around reservoirs and dams where higher levels of mortality would occur than in the transportation process. Williams et al (2005) reported that during early April for most years, little to no benefit occurred for transported spring/summer Chinook, however, after about April 20; transport nearly always returned a higher proportion of fish over in-river migrating stocks. However, steelhead has shown a consistent benefit to transport across the entire time period. Fall Chinook data has been limited, however, neither harm nor benefit can be proven for transportation and research is continuing.

If numbers of fish collected exceed holding or transport vehicle capacities, those in excess of capacity will be bypassed back to the river below the dam where they are collected. Subsets of collected salmon and steelhead will be handled by Corps and fishery agency personnel to obtain species composition, fish condition, fish size, and other information necessary to carry out the transportation program. Fishery agency personnel (under a separate ESA permit previously held by the Fish Passage Center, now Pacific States Marine Fisheries Commission) will handle sampled fish as part of the Smolt Monitoring Program at all collector dams, and may mark subsets of collected fish for monitoring progress of the outmigration. Researchers (also under separate ESA permits) may handle, mark, obtain scale, blood, or other tissue samples, or sacrifice fish obtained from subsets of fish collected at the transport facilities.

From 2001 through 2005, the Juvenile Fish Transportation Program was carried out in accordance with the December 21, 2000 National Marine Fisheries Service (NMFS) Endangered Species Act Section 7 Biological Opinion (2000 Bi-Op) "Reinitiation of Consultation on Operation of the Federal Columbia River Power

System, Including the Juvenile Fish Transportation Program, and 19 Bureau of Reclamation Projects in the Columbia Basin", the November 30, 2004 Biological Opinion (2004 Bi-Op) "Consultation on Remand for Operation of the Columbia river Power System and 19 Bureau of Reclamation Projects in the Columbia Basin", ESA Section 10 Permit No. 1237, and operating criteria contained in the Corps' annual Fish Passage Plan (FPP). It is anticipated that future biological opinions will require juvenile fish transportation, at least as an interim program, until final configurations of the FCRPS are determined and implemented.

G. **Project methodology**: The Juvenile Fish Transportation Program is a regionally coordinated program with defined operating criteria. The Juvenile Fish Transportation Program will be carried out in compliance with a biological opinion, a Section 10 permit, and facility and program operating criteria included in the Corps of Engineers' Juvenile Fish Transportation Plan, Appendix B of the Corps' annual FPP. Any new requirements of a biological opinion or Section 10 permit will be incorporated into the FPP criteria.

1. **Period of time:** The Juvenile Fish Transportation Program is an annual program with beginning and ending dates varying depending on river flow forecasts and fish collection numbers. These criteria are defined in the FPP. During a low flow year, the program would begin on March 25 at Lower Granite Dam and continue through October 31. During years of moderate and higher river flows (currently defined as average spring flows expected to be higher than 70 kcfs), transport would not begin until April 20. During low flow years, transport at Little Goose and Lower Monumental dams would begin on April 1 and continues through October 31 at Little Goose, and September 30 at Lower Monumental. During moderate and higher flow years, the programs would begin at the same time as Lower Granite Dam.

Juvenile fish are presently not transported during the spring at McNary Dam except during extremely low flow years. Juvenile fish transportation normally begins in mid to late June when river conditions are no longer "spring like" as defined in the FPP. Once transportation begins at McNary, it continues through September 30. It is anticipated that this schedule for the Juvenile Fish Transportation Program will continue in the future, unless research results indicate that a change in the program is warranted.

This application is a request for an extension of existing Section 10 Permit 1237 to cover the Juvenile Fish Transportation program during the 2006 migration season and extending through the remand of the 2004 Biological Opinion. Additionally, this is a request for a new permit for the 5-year period initiated once a new FCRPS biological opinion is issued.

2. **Collection, holding, and transportation process**: Juvenile fish are collected and transported in the following manner:

a. 1) **Collection**: Juvenile salmon and steelhead approaching one of the collector dams generally travel near the surface of the reservoir. As they approach the powerhouse, juvenile fish sound and enter turbine intakes through the trashracks (typically gratings with 6-inch spacing between bars intended to keep larger debris from going through turbines). Traveling near the ceiling of the turbine intake, the fish encounter screens that divert them upward into vertical slots (bulkhead slots), which lead up toward the powerhouse intake deck. The fish swim upward to within 3 to 7 feet of the water surface where they pass through an orifice into a collection channel within the dam. Fish collected in the collection channel move with the flow of water toward a pipeline, or flume (with a dewatering structure) that carries them from the powerhouse to a collection facility below the dam. At the collection facility, most of the water is removed at a separator where adult fish and debris are bypassed back to the river and juvenile fish swim downward between horizontal bars. They then exit the separator through orifices into distribution flumes, which route them to raceways, sample tanks, directly into barges, or at times, back to the river.

2) **Size separation**: At Little Goose, Lower Monumental, and McNary dams, smaller fish (predominantly subyearling and yearling salmon) are separated from larger fish (predominantly larger juvenile salmon and steelhead) by separator bars that are spaced closer together (about 5/8-inch) on the first half of the separator, or further apart (about 1 1/4-inch) on the second half of the separator. Smaller juvenile fish are diverted to raceways, sample tanks, or into barges separate from larger juvenile fish and when loaded trucks or barges after holding,, the fish are kept separated by size.

3) **Holding of a Listed Species:** Fish are held in water continuously throughout the collection facilities except when sample fish are handled in the sample rooms. From the separator, collected fish pass through flumes or non-pressurized pipes to raceways, into sample holding tanks, or in some cases directly into barges or back to the river.

a) **Raceways**: Lower Granite and Little Goose dams each have 10 raceways that are 4 feet wide, 5 feet deep, and 80 feet long. Each raceway can hold 6,000 lbs. (pounds) of juvenile salmonids at 0.5 lbs. of fish/gallon of water (lb./gal). At an average size of 10 fish per lb., 6,000 lbs. would be 60,000 fish per raceway, or a total facility holding capacity of 600,000 fish. Lower Monumental and McNary dams have 4 and 8 raceways respectively, that are 8 feet wide, 5 feet deep, 80 feet long and can hold 12,000 lbs. of fish at 0.5 lbs./gal. At 10 per lb., 120,000 fish could be held in each raceway at Lower Monumental Dam for a total of about 480,000 fish and McNary Dam for a total of 960,000 fish. Spring/summer Chinook, sockeye, and steelhead are typically yearling fish (larger), while fall Chinook are typically subyearlings and migrate at a much smaller size. The actual maximum number of fish to be loaded into any raceway is determined by the project biologists on a daily basis based on information from the daily sampling process. At all projects, fish are distributed among the raceways to limit loading in individual raceways to below the loading criterion. The criterion of 0.5 lbs./gal is only met when facilities are reaching capacity. When the capacity is reached, any additional fish collected are bypassed back to the river until fish in the raceways can be loaded onto barges.

b) **Water supply**: River water enters the juvenile fish collection systems through orifices from the bulkhead slots within the turbine intakes of each dam. A 12-inch orifice typically passes 11 to 15 cfs at up to 25 fps. The cumulative total in the collection channel ranges from about 240 cfs at Lower Granite Dam to over 700 cfs at McNary Dam. It takes about 60 cfs to run the distribution system, holding tanks, and raceways at each facility. Excess water is returned to the river at Lower Granite Dam, or used in the adult fish collection systems at Little Goose, Lower Monumental, and McNary dams. Holding capacities for fish are based on 0.5 lb./gal of water and 5 pounds of fish/gal/minute flow through the raceways or sample holding tanks. With 10 raceways, 60,000 lbs. of fish can be held at both Lower Granite and Little Goose dams. At Lower Monumental Dam with four raceways, and McNary Dam with eight raceways, 48,000 and 96,000 lbs. of fish can be held with the designed water supplies. Facility operators maintain raceway depths and water flow through them to meet both operating criteria for holding fish. Water used in the facilities is returned to the river.

4) **Transportation of fish**: Both trucks and barges are utilized for transporting juvenile fish. Transitioning from trucks to barges for transporting fish collected at Snake River projects was formerly based on fish numbers. Transport normally switched from trucks to barges when daily collection numbers at Lower Granite Dam approached 20,000 fish per day. During ESA consultation for the 1998 Supplemental Biological Opinion, dates were established for switching to and from barge transport in

order to increase the length of the barging season for wild steelhead. The 2000 Bi-Op emphasized extending the barging season during summer months, to provide increased barging for subyearling Chinook salmon. Presently, juvenile fish are barged from April 22 (April 8 in a low flow year) through August 16. Fish collected at McNary Dam during the spring are normally bypassed back to the river, except during an extreme low flow year. Transport of fish at McNary Dam begins sometime in mid to late June, when river conditions are no longer spring like as defined in the FPP. When transport begins at McNary, juvenile fish are typically barged through mid-August when transport operations change to trucking.

During low flow year, prior to initiating barging, and when trucking resumes in mid-August, 3,500 gallon fish trailers may be used to transport fish. Four semi-tractors and eight fish trailers are available for operation. Normally, two large fish tractor/trailers operate from Lower Granite Dam and one each from Little Goose and Lower Monumental dams. When transportation at McNary Dam switches to trucking in mid-August, one of the tractor/trailers from the Snake River projects will be moved to McNary and used there. Four trailers are available as spares and used when needed. The fish trailers are insulated and equipped with refrigeration, aeration, oxygenation, and recirculation equipment. At a maximum density of 0.5 lbs./gal, each truck can haul up to 1,750 lbs. of fish.

During the main fish passage periods, when fish numbers are higher, barges will be used. Eight barges are available, two at 85,000 gallons, two at 100,000 gallons, and four at 150,000 gallons water capacity. Fish poundage capacity of the barges is calculated at 5.0 lbs./gal/minute of inflow, with space in fish holds equivalent to 0.5 lbs./gal of water. Respective carrying capacities for the small, medium, and large barges are 23,000, 50,000, and 75,000 pounds of fish. Diesel engine powered pumps circulate river water through aeration chambers to ensure that there is adequate dissolved oxygen in the water, and, in the event that river waters are supersaturated with total dissolved gas due to spill, to strip out excess gas to bring levels back to normal. Tests on barges conducted in 1993 showed that with gas supersaturation levels at 135 to 140 percent in the river, levels in the barges were reduced to 100 to 102 percent. The medium and larger barges are also equipped with recirculation systems so inflow can be shut off, and water within the barge recirculated and aerated in the event of chemical spills or other water quality problems in the river.

Late in the season when fish numbers are very low, three 1-ton trucks with 300-gallon mini-tanks are available, one at each Snake River collector dam. Mini-tankers are not be used at McNary Dam because, even though salmon and steelhead numbers reach low levels, large numbers of juvenile American shad, Alosa sapidissima, are mixed with the salmonids and requires using the larger fish trailer.

5) **Transport release areas/methods**: During low flow years, from the beginning of transport until April 7, fish will be trucked from Snake River projects to below Bonneville Dam and released at the Dalton Point, Oregon, boat ramp. Fish collected and transported from April 8 through approximately August 16, will be barged from Lower Granite, Little Goose, and Lower Monumental dams to random release sites between lighted buoy No. 92 (RM 144) and Warrendale, Oregon (RM 141). Barging will normally begin in mid to late June from McNary Dam and continue through mid-August, depending on fish numbers. When trucking resumes at Snake River projects and at McNary Dam in mid-August, large fish trucks or mini-tankers will be used for transporting fish. Large and small trucks will be loaded onto a barge at a site near Troutdale, Oregon and transported to mid-river so fish can be released away from concentrations of predators along the shore.

b. **Description of tags**: No tags are used as part of the transportation program.

c. **Description of drugs**: A small percentage of the juvenile fish collected at the juvenile fish transportation facilities are sampled under a Section 10 permit for the Smolt Monitoring Program utilizing Smolt Monitoring Program sampling guidelines. This program uses MS-222 for anesthetizing the sample fish to assess fish numbers, condition, and species composition. MS-222 is administered to fish held in preanesthetic tanks before routing them into the sample rooms. MS-222 is also administered in the sorting trough in the sample rooms. Over the season, 1 to 10 percent of the spring/summer Chinook, 2 to 30 percent of the fall Chinook, and 1 to 11 percent of the steelhead collected are sampled. Higher percentages of late season migrants are sampled; with up to 100 percent sampled when numbers get very low. Sample rates may also be increased periodically to obtain sufficient numbers of fish to tag as part of approved research projects. During late summer when mini-tankers are in use, sea salt may be added to the water in the tanks to provide a 5 parts per thousand saline solutions to combat columnaris (Flexibacter columnaris) infections on subyearling fall Chinook salmon.

d. **Holding time**: Operating criteria in the Corps' FPP requires juvenile fish to be transported within 48 hours of being collected. If collected fish cannot be transported within this time period, they are returned to the river. During the peak of the barging season in the spring, most juvenile fish are loaded onto barges and transported within 24 hours of collection.

e. **Sampling of fish**: Fish are sampled at the juvenile fish transportation facilities as part of the BPA funded Smolt Monitoring Program utilizing Smolt Monitoring Program sampling guidelines, under a Section 10 permit issued for that purpose. Fish related information required for managing the Juvenile Fish Transportation Program is obtained from this sampling effort. All fish are handled according to criteria established cooperatively with regional fishery agencies and Indian tribes through the Fish Passage Operations and Maintenance Coordination Team and contained in the FPP. The 24-hour cumulative samples of fish are anesthetized and routed through the sampling rooms daily at each collector dam for gathering data on species, size, and condition for the operation of the transport program.

While exiting the separator, automatic sampling systems divert approximately 1 to 5 percent of the spring migrants collected into sample tanks. These automatic sampling systems divert sub-samples several times an hour, 24-hours per day. Approximately 95 to 99 percent of the collected fish are routed to raceways or directly into barges without being sampled or handled. During the summer and fall when the numbers of collected fish are very low, 100 percent may be routed into covered holding tanks where they can be held in shaded, cooler conditions. When this happens, all collected fish are handled. As a result, 2 to 60 percent of the fall Chinook may be sampled at the different dams over the course of the season.

Sampled fish are preanesthetized with MS-222 before they are routed into the sample rooms where they are maintained in a recirculating MS-222 solution. Juvenile fish are inspected for marks, and some may be used for other purposes in the Smolt Monitoring Program. As permitted by other ESA permits, some of the sampled fish may be handled or sacrificed for research purposes. After sampling and being allowed to recover, fish are transported with non-sampled fish.

3. **Potential for injury or mortality**: Juvenile fish transportation facilities normally have very low injury and mortality rates. Each project has Standard Operating Procedures and operating criteria that they follow to operate the facilities correctly and to provide the best fish passage and collection conditions. Project personnel continually monitor the fish passage facilities to detect and correct any conditions that may injure fish passing through them. Descaling and other injuries are monitored daily at the collection facilities as part of the daily sampling program. Some of the juvenile fish migrating downstream through the reservoirs have pre-existing conditions including being diseased with external fungal infections, parasites, or internal or external bacterial or viral infections

as well as having injuries from predators. These fish, if they die within the collection or transportation facilities, are counted as part of the collection/transportation mortality although pre-dam injuries and disease are noted in project reports. Because of environmental factors upstream of the dams, juvenile fish may also experience some descaling. In high flow years when there are large amounts of debris in the river, descaling before fish reach Lower Granite Dam may exceed 10 percent. In low flow years when water temperatures are higher than normal, fish entering the collection facilities may have decreased mucus layers and may be descaled from prolonged passage through reservoirs and predator interaction. Efforts to reduce the effects of the fish facilities and areas of the fish passage facilities that may cause fish injuries and mortalities are detailed below.

a. **Collection facility personnel**: At each collector dam, a crew of trained biological technicians (often with degrees in fishery biology) staff the collection facilities 24-hours per day, 7-days per week during the transport season.

b. **Transport personnel**: Truck drivers are trained to monitor fish health and conditions during transport to assure that no problems occur. Each towboat has a trained biological technician (often with a degree in fishery biology) assigned to ensure that the barges are operated correctly and that water quality and fish health are maintained during barge transport.

c. **Biological oversight**: During the day shift, in addition to the Corps' project biologist and/or the assistant project biologist, state provided biologist(s), under contract to the Corps, monitor fish condition and facility operations. In the Walla Walla District office of the Corps, a senior fishery biologist or an alternate biologist coordinates daily operations. As required, transport operations are coordinated with fishery agency and tribal representatives through NMFS, the TMT, FPCBPA or its successor funded data organizations, or FPAC. In the event of emergencies, the Corps District biologists, the project biologists, or dam project management personnel are available 24-hours per day, 7-days per week to assist juvenile fish facility and transport personnel. Fishery agency biologists representing NMFS and the BPA funded data organizations will also be identified for emergency notification.

d. **Trashrack maintenance**: Debris that accumulates on the trashracks can cause injury and mortality to fish entering the turbine intakes. To minimize the amount of trash reaching the trash racks at Little Goose and Lower Granite dams, debris booms were installed. The other collector dams do not have debris booms. At Lower Granite Dam and the other dams, debris which floats against the upstream face of the powerhouse is removed and hauled away or passes through spill. All turbine unit trashracks are raked at the beginning of the juvenile bypass season when fish screens are installed. Project personnel measure gatewell drawdown at least once per week during the fish passage season to determine if trash is collecting on the trashracks. Trashracks are raked again if gatewell drawdown exceeds criteria in the FPP. To monitor the effect of debris that sinks and collects on the trash rack, orifices, or other locations in the collection system, descaling is evaluated in the sample rooms each day. If descaling increases in the daily samples, project biologists and operators begin looking for causes upstream in the collection facility. If trash on the trashracks is a suspected cause, project operators rake the trash to clean the trashracks. This is done on an "as-needed" basis throughout the transportation season.

e. **Gatewell debris**: Debris which goes through the trash racks and rises in the bulkhead slots can accumulate at the surface of the water. When this happens, project maintenance personnel dip the debris out of the gatewells. Criteria in the FPP require dipping before the gatewells are half covered with debris. This is in compliance with the NMFS Bi-Ops for operation of the dams.

f. **Oil in gatewells**: Fish screen drive mechanisms and operating gate hydraulic cylinders contain oil. When seals fail, oil can accumulate in gatewells. Oil can come from other sources above the dams, and be drawn from the reservoir into turbine intakes. When oil appears on the water surface in gatewells, project operators remove it using absorbent pads or oil skimmers.

g. **Debris in orifices**: Sticks or other debris that block orifices can cause serious injury or mortality to fish. Orifices are inspected several times per day, and are cycled open and closed to dislodge any debris. When a blockage is suspected, orifices are equipped with airlines so the orifice valve can be closed and air can be injected behind the valve to flush debris from the orifice.

h. **Fish screen inspections**: Several types of screens are included in the juvenile bypass systems.

1) **Turbine intake screens**: Two different types of fish screens are utilized to divert migrating juvenile fish from turbine intakes up into bulkhead slots. Submersible traveling screens (STS) with flexible mesh move like conveyer belts to carry debris that accumulates on the screen over to the back side where it is flushed off by flow through the screen. Extended-length bar screens (ESBS) have a static screen with a mechanized brush that

sweeps debris off the screen so it can be flushed through the turbine. When small fish that are weaker swimmers are present, STS's are run continuously to keep them clean. When larger fish are present, the screens are typically run 20 minutes off and 4 minutes on to save wear and tear on screen equipment. STS's and debris brushes on ESBS's are driven by electric motors. A warning system is provided from the screens to the control room in the dam, as well as to screen control boxes in the gallery above the fish bypass. If a screen or trash brush fails electronically, a warning signal alerts the project operator. Fish screens are inspected when they are removed for the season, maintained and repaired over the winter, and inspected again before they are installed in the spring. Fish screens are also inspected with underwater video cameras once per month while they are in use. Any tears, lost fasteners, or other damage are usually detected during these inspections. According to criteria established in the FPP, turbine units with a known damaged fish screen are shut down until the screen can be repaired or replaced.

2) **Vertical barrier screens**: Vertical barrier screens (VBS) prevent fish that are guided into the bulkhead slots from swimming back down through the operating gate slots into the turbines. The VBS's are visually inspected whenever the turbine unit gatewell slots are dewatered. VBS's are also inspected at least once per year with underwater video cameras. Worn or damaged vertical barrier screens are repaired. This requires taking the generating unit out of service while the unit is dewatered and repairs are made. At McNary Dam, VBS's may be pulled out in one piece with a crane for inspection, cleaning, and repair. This is done periodically during the season as needed to clean impinged debris off of the VBS's.

i. **Dewatering screens, pipelines, and flumes**: Although debris, which passes through the orifices is generally too small to block collection channels or transport flumes or pipes, fine debris can block dewatering screens. Such screens are typically equipped with debris removal brushes that are operated automatically or manually to keep screens functioning properly. Some dewatering screens also have air burst systems to help maintain clean screens. Screens and flumes are typically inspected at least once per day. Water level sensing devices are installed at critical locations with automatic alarm signals in the dam control rooms.

j. **Wet separators, distribution flumes, raceways, and pipes**: From the beginning to the end of the transportation season, collection facilities are staffed 24-hours per day, 7-days per week. Facility personnel inspect the separators at least four times per hour, and inspect distribution flumes, raceways, and pipes at least hourly. Where raceway covers or other structures impede visual inspection from the separator control building, closed circuit television is used to provide adequate inspection. Dead fish collected in the systems are removed from the separators, from raceways, sample tanks, or in the sample rooms. These mortalities are used to estimate daily and seasonal mortality in the systems. Daily mortality rates for a species can be as high as 100 percent if one fish is collected and it is dead. Seasonal mortality, the accumulation of daily mortality, however, has been quite low. In 2004, seasonal mortality at Lower Granite, Little Goose, Lower Monumental, and McNary juvenile fish facilities was less than 1 percent.

k. **Fish handling and loading**: Fish handling and loading procedures are overseen by project biologists, state agency provided biologists, and personnel trained in facility and equipment operation.

l. **Fish transportation activities**:

1) Trucking - All truck drivers have CDLs, are trained on the operation of environmental control equipment on the fish trucks, and on the care and problems of fish in transportation. During a typical truck trip, the drivers stop several times to inspect fish and to remove dead fish that may have been loaded with live fish when raceways were emptied into the truck. Trucks are equipped with redundant systems (e.g. liquid oxygen, aeration, and compressed air systems). In case of equipment failure, truck drivers are trained to go to alternate release sites so fish can be returned to the river.

2) Barging - On the barges, each barge has at least one backup pump system. When fully loaded, three pumps out of four on the large barges, or two pumps out of three on the medium and small barges, are required. If a pump fails, the backup pump is started. When the barge is less than fully loaded, only one or two pumps are needed to maintain oxygen and flow levels. Then, additional backup pumps are available. Each barge is equipped with a warning system to alert the barge rider or towboat crew if a pump fails. Each barge is equipped with an oxygen sensing system that monitors gas levels within the barge continuously when the barge is filled with water. When fish are loaded on board, the barge rider typically monitors fish condition, temperature, and oxygen levels for the first hour or two after leaving the collector dam. As the trip progresses, the fish are monitored every other hour, then every four hours until release. Each barge is also equipped with gas stripping equipment (see paragraph G. 2.a.4. The medium and large size barges are also equipped with recirculation equipment so that if a chemical spill, or other pollution is encountered in the river, the barge intakes can be

closed, and water recirculated and aerated in the barge until the barge is past the problem.

m. **Estimates of mortality**: There is some mortality associated with the collection and transportation of juvenile salmonids. From the time juvenile fish enter the juvenile fish collection system until they are loaded on barges or trucks, any mortalities found by facility workers are collected and counted. Mortality levels will vary some by species, by project, and by time of year that fish are collected. In general, mortality levels observed in the juvenile fish transportation facilities are very low. Spring migrant collection and holding mortality is normally less than 0.5 percent and frequently much less than this. Collection of subyearling Chinook salmon normally has a higher facility mortality rate due to warmer water temperatures during the summer and resultant disease problems of fish. The tables below detail seasonal mortality for the years of 2000-2004 by species for each juvenile fish collection facility. In the trucks and barges, seasonal mortality typically is less than 1 percent. Separate estimates of mortalities caused by Smolt Monitoring Program activities or research will be described under separate ESA Section 10 Permit applications.

Annual facility mortality in percent at Lower Granite Dam, 2000-2004.

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	
Year	Clipped	Unclipped	Clipped	Unclipped	Clipped	Unclipped	Clipped	Unclipped	All	Total
2000	0.1	0.2	---	0.5	0.1	0.1	0.1	2.3	0.1	0.1
2001	0.2	0.2	0.4	0.5	0.1	0.1	0.0	3.1	0.3	0.1
2002	0.2	0.2	1.4	1.2	0.1	0.1	1.6	3.1	0.2	0.3
2003	0.2	0.2	2.9	1.4	0.1	0.1	1.2	1.3	0.7	0.4
2004	0.5	0.5	0.7	0.5	0.1	0.1	0.4	3.6	0.1	0.3

Annual facility mortality in percent at Little Goose Dam, 2000-2004.

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	
Year	Clipped	Unclipped	Clipped	Unclipped	Clipped	Unclipped	Clipped	Unclipped	All	Total
2000	0.4	0.4	---	0.7	0.1	0.1	0.6	2.7	0.2	0.3
2001	0.5	0.6	6.3	2.9	0.7	0.4	1.1	0.1	1.3	0.8
2002	0.1	0.1	0.3	0.5	0.1	0.1	0.8	1.5	0.7	0.2
2003	0.2	0.2	1.9	1.1	0.2	0.2	0.7	0.7	0.5	0.3
2004	0.1	0.1	0.1	0.2	0.1	0.1	0.0	0.6	0.1	0.1

Annual facility mortality in percent at Lower Monumental Dam, 2000-2004.

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	
Year	Clipped	Unclipped	Clipped	Unclipped	Clipped	Unclipped	Clipped	Unclipped	All	Total

2000	0.3	0.2	0.7	0.5	0.1	0.1	0.0	0.3	0.2	0.2
2001	0.3	0.3	10.1	1.3	0.9	0.4	0.8	0.6	0.3	0.5
2002	0.2	0.2	1.3	0.7	0.3	0.3	2.3	2.3	0.1	0.3
2003	0.2	0.2	0.5	0.6	0.1	0.2	0.1	0.3	0.1	0.2
2004	0.2	0.2	1.0	0.4	0.2	0.3	0.2	0.0	0.0	0.2

Annual facility mortality in percent at McNary Dam, 2000-2004.

Year	Yearling Chinook	Subyearling Chinook	Steelhead Clipped	Steelhead Unclipped	Sockeye Clipped	Sockeye Unclipped	Coho All	Total
2000	0.1	0.6	0.2	0.1	0.5	0.8	0.5	0.6
2001	0.3	0.8	0.8	0.6	0.5	0.2	0.6	0.7
2002	<0.1	0.7	<0.1	<0.1	0.1	0.1	<0.1	0.5
2003	0.1	1.0	0.2	0.2	0.1	0.1	0.5	0.8
2004	0.4	0.9	0.5	0.3	0.5	0.6	0.3	0.9

H. Description and estimate of take: The juvenile fish transportation facilities are operated in compliance with biological opinions issued by NMFS. The biological opinions detail how the projects will be operated, including how the Juvenile Fish Transportation Program will fit in with other project operations such as spill or development of surface bypass collectors, for improving juvenile fish passage and survival within the FCRPS. These project operations specify when juvenile fish will be collected, how many of the collected fish will be transported, and when water will be spilled for maintaining fish in river for their migration. The number of fish collected and transported each year varies depending on the size of the juvenile fish outmigration for each of the listed ESA species, fish survival to Lower Granite Dam, efficiency of the bypass system at each project, and river flow and spill conditions within the FCRPS. Based on operations required by previous biological opinions, two different project operating scenarios were evaluated for the Juvenile Fish Transportation Program with all juvenile fish collected being transported, appendix 1. These options included maximizing transportation with no spill (low flow year), and a spread the risk operation (high flow year) with spill to the gas cap or other spill programs in place at each collector project and all juvenile fish collected transported. The percent of each ESA listed species arriving at the upper most Corps project (Lower Granite Dam or McNary Dam) that would be transported under each scenario was then calculated. Transportation of juvenile fish at McNary Dam during the spring is included in the request in the event of an extreme low flow year similar to 2001, or in case ongoing research supports changing the spring operation at McNary to include transportation.

1. **Requested take:** The following level of take for listed stocks is requested based on low flow operations with no spill and transportation of all juvenile fish collected at transportation projects. This estimate is considered the maximum percentage of each stock that would be transported each year

under this permit and is the percentage of all fish arriving at Lower Granite Dam (McNary Dam for Columbia River stocks), although fish may be transported from any of the collector sites. Depending on the requirements of future biological opinions and actual river flow and spill conditions, the percent of each stock that may be transported will probably be less than the amount listed.

a. **Snake River sockeye salmon (O. nerka) naturally and artificially produced:**

Collect and transport: 93.2 percent of the juvenile fish that arrive at Lower Granite Dam.
Mortality: 2 percent of collection.

Adult sockeye naturally and artificially produced.
Fallback: 12
Mortality: 2

b. **Snake River spring/summer Chinook salmon (O. tshawytscha) naturally and artificially produced:**

Collect and transport: 93.2 percent of the juvenile fish that arrive at Lower Granite Dam.
Mortality: 2 percent of collection.

Adult Chinook naturally and artificially produced.
Fallback: 1,800
Mortality: 36

c. **Snake River fall Chinook salmon (O. tshawytscha naturally produced:**

Collect and transport: 79.5 percent of the juvenile fish that arrive at Lower Granite Dam.
Mortality: 3 percent of collection.

Adult Chinook naturally produced.
Fallback: 600
Mortality: 12

d. **Snake River steelhead (O. mykiss) naturally produced:**

Collect and transport: 95.3 percent of the juvenile fish that arrive at Lower Granite Dam.
Mortality: 2 percent of collection.

Adult steelhead naturally produced.

Fallback: 15,000
Mortality: 500

e. **Upper Columbia River spring Chinook (*O. tshawytscha*) naturally and artificially produced:**

Collect and transport: 70.6 percent of the juvenile fish that arrive at McNary Dam.
Mortality: 2 percent of collection.

Adult Chinook naturally produced.
Fallback: 400
Mortality: 10

Adult Chinook artificially produced.
Fallback: 150
Mortality: 8

f. **Upper Columbia River steelhead (O. mykiss) naturally and artificially produced:**

Collect and transport: 75.7percent of the juvenile fish that arrive at McNary Dam.
Mortality: 2 percent of collection.

Adult steelhead naturally produced.
Fallback: 300
Mortality: 30

Adult steelhead artificially produced.
Fallback: 650
Mortality: 50

g. **Middle Columbia River Steelhead (O. mykiss) naturally produced.**

Collect and transport: 75.7 percent of the juvenile fish that arrive at McNary Dam.
Mortality: 2 percent of collection.

Adult steelhead naturally produced.
Fallback: 1800
Mortality: 50

2. **Period of take**: This application is for the 5-year period of 2006 through 2010. Annual programs may be from March 25 through October 31 at Lower Granite Dam, April 1 through October 31 at Little Goose Dam, and from April 1 through September 30 at Lower Monumental and McNary dams. McNary Dam is

located on the Columbia River at river mile 293, and Lower Monumental, Little Goose, and Lower Granite dams are on the Snake River at river miles 41.5, 70, and 107.5 respectively.

3. **Status of species**: Snake River sockeye and Upper Columbia River spring Chinook and steelhead are listed as endangered under the ESA. Snake River spring/summer Chinook, Snake River fall Chinook, Snake River Steelhead, and Middle Columbia River steelhead are listed as threatened under the ESA.

I. Transportation and holding: Juvenile fish are held and transported according to criteria contained in the Corps' FPP. Additional information is provided below.

1. **Transportation of a listed species**

a. **Mode of transportation:** A detailed description of the juvenile fish transportation equipment and process is included in paragraph G.2. Transportation of juvenile fish is accomplished with Government-owned, leased, and/or contracted equipment.

b. **Length of time in transit:** Truck transport from Lower Granite Dam takes 8 to 9 hours, from Little Goose takes 6 to 7 hours, Lower Monumental takes Dam 5 to 6 hours, and from McNary Dam it takes 3 to 4 hours. Barge transport from Lower Granite Dam takes about 36 hours to reach the release site with stops at the other projects to load additional fish onto the barges. From Little Goose it takes about 30 hours, from Lower Monumental about 24 hours, and from McNary about 17 hours.

c. **Length of time in transit for future moves:** N/A.

d. **Common carriers:** N/A.

e. 1) **Transport trucks**: Up to eight 3,500 gallon fish tractor trailers will be used, two at Lower Granite, one at Little Goose, one at Lower Monumental Dam, one at McNary Dam, and four spares. The trailers have painted steel or stainless steel tanks divided into three compartments. The floors of the tanks slope toward a central unloading trough, which is equipped with a hydraulically operated knife valve for unloading. Hand operated knife gates are available to separate the compartments. The tanks are equipped with air stones and a recirculation system. Liquid oxygen and compressed air cylinders are carried for maintaining oxygen levels. A refrigeration unit is included in the recirculation system for maintaining water temperature. The tanks are surrounded by insulation, which in turn is covered with a metal skin plate. Three 150-gallon and three 300-gallon mini-tankers (pickup mounted units) will be used for transport operations from Lower Granite, Little Goose, and Lower Monumental Dams in late summer and fall when fish numbers are very low. These are fiberglass tanks, insulated, equipped with agitators and oxygen supplies and can be divided into two compartments.

e. 2) **Transport barges**: All barges are painted-steel construction with compartments varying from 4 feet deep around the perimeter to over 6 feet deep at the release orifice. Two barges are Army surplus barges acquired in 1978. Three fish compartments were constructed in-line bow to stern. The compartments are separated by partitions, and each compartment slopes toward a central release hole. This hole serves a dual function as an overflow drain as pumped water flows through screens and is discharged to the river during loading and transport. For release, the screen mechanism and a stopper are lifted vertically to allow water and fish to exit from each compartment through a 17-inch orifice. These barges are equipped with three pumps capable of providing 4,600 gals/min of inflow. Water is pumped upward against a baffle and allowed to fall back into the fish compartments to aerate or degas the water. Each barge holds 85,000 gallons of water, with loading capacity rated at 5 lbs. of fish/gallon/minute inflow, so these barges are capable of transporting up to 23,000 pounds of fish under the Corps' FPP operating criteria. The two medium-sized barges were constructed in 1981 and 1982. They have four compartments, two forward and two aft on either side of the centerline. These barges each hold 100,000 gallons of water. Like the small barges, they have three pumps but these are capable of providing 10,000 gals/min inflow. At 5 lbs. of fish/gallon/minute, they can hold up to 50,000 pounds of fish. Each compartment slopes toward a stopper near the centerline through which fish are released. The screened water overflow system is separate from the fish release system. Water is pumped through packed columns to provide aeration and degasification. Two large barges were constructed in 1989 and two more were constructed in 1997. They are similar to the medium sized barges in design, but have two additional compartments. Therefore, they hold 150,000 gals of water, and the pumps are sized to provide 15,000 gals/min of inflow. They can hold up to 75,000 lbs. of fish at 5 lbs. of fish/gallon/minute inflow. The medium and large sized barges are also equipped with recirculation systems so inflow can be shut off and water within the barge recirculated in the event of an oil or chemical spill, or poor water quality along the transport route.

f. **Special care before and during transport**: Sample fish are anesthetized (see section G.2.c.) before handling. They are allowed to recover from the anesthetic before being loaded into transport vehicles. Oxygen and temperature levels are monitored and regulated in transport trucks. In the barges, oxygen and temperature levels are monitored, but temperatures are ambient river temperatures. Oxygen levels are regulated by varying pumped inflow and adjusting flow through individual packed columns. All transportation is conducted in-water, with loading densities carefully regulated to stay within the Corps' FPP criteria. Where fish are separated by size, they are kept separated by size within raceways and transport vehicles. Barge releases are made at randomized locations over a 4 mile stretch of river to reduce interactions with predatory fish. Truck releases in the early spring are made from a boat ramp when good river conditions exist. Water temperatures at that time are cool enough to limit the activity of predatory fish. Later in the summer, trucks are loaded onto a barge and transported to mid-river to avoid concentrations of predators. Like the fish barges, the barged trucks are emptied at randomized locations to avoid predatory fish. Trucked fish are usually released during daylight hours for personnel safety reasons. During late summer when mini-tankers are in use, sea salt may be added to the water in the tanks to provide a 5 parts per thousand saline solution to combat columnaris (Flexibacter columnaris) bacterial infections on subyearling fall Chinook salmon.

2. **Holding of a listed species**. Fish are held in flowing water continuously throughout the collection facilities except when sample fish are handled in the sample rooms. From the separator, collected fish pass through flumes or non-pressurized pipes to raceways, or into sample holding tanks, or in some cases directly into barges.

a. **Raceways**: A detailed description of project raceways can be found at paragraph G.2.a.3.a).

b. **Water supply**: River water enters the juvenile fish collection systems through orifices from the bulkhead slots within the turbine intakes of each dam. A 12-inch orifice typically passes 11 to 15 cfs at up to 25 fps. The cumulative total in the collection channel ranges from about 240 cfs at Lower Granite Dam to over 700 cfs at McNary Dam. It takes about 60 cfs to run the distribution system, holding tanks, and raceways at each facility. Excess water is wasted back to the river at Lower Granite Dam, or used in the adult fish collection system at Little Goose, Lower Monumental, and McNary dams. Holding capacities are based on 1/2 lb./gal of water. With 10 raceways (see section VIII. A), 60,000 lbs. of fish can be held at Lower Granite and Little Goose dams. At Lower Monumental Dam with four raceways, and McNary Dam with eight raceways, 48,000 and 96,000 pounds of fish can be held with designed water supplies. Water used in the facilities is returned to the river.

c. **Diet of fish held/transported**: Fish are not fed in collection or holding facilities, or in transport vehicles.

d. **Sanitation practices**: Facilities and transport equipment are drained when not in use. Trucks are rinsed and flushed after each trip. A chlorine solution is used as needed for rinsing truck tanks. Barges are filled with river water and flushed prior to loading of fish. Large fish including northern pikeminnow, smallmouth bass, and other potential predators are removed at the fish separator. Avian predators are deterred at holding facilities by bird wires, netting, roofs, or by proximity of facility personnel.

3. **Emergency contingencies**: Facility operators have facility operation plans which include emergency procedures. They are also instructed by project biologists on measures to take if emergencies occur. A detailed emergency telephone list is provided to each facility operator, truck driver, or barge rider. This list includes Corps biologists, CBFWA FPAC members, dam managers, state agency biologists, and research personnel involved at the juvenile fish facilities. In the event of an emergency, personnel are instructed to notify appropriate persons on that list. Key personnel on the list are available 24-hours per day, 7-days per week during the transport season to deal with emergencies. Truck drivers are provided with the locations of emergency release sites between collector dams and release sites. Barge riders are instructed to release fish if major equipment failures occur that they and the towboat crew cannot correct.

J. **Cooperative breeding program:** The Corps, within its authorities and responsibilities, is willing to cooperate in any reasonable effort that will increase survival of listed species.

K. **Previous ESA permits**: The Walla Walla District has held the following five Section 10 permits for the Juvenile Fish Transportation Program: No. 792, No. 795, No. 828, No. 895, and No. 1237. The numbers of listed fish transported under these permits are listed below.

1. **Number of listed species taken**: From 1993 through 2004, an estimated 27,511,174 ESA listed fish were transported under Section 10 permits. Listed below are the numbers of fish transported under these permits and the mortality (0.24 percent) associated with the collection and transportation of the fish. Adult salmonids periodically fallback through the juvenile fish facilities and are handled as incidental fish under the transport Section 10 permits. This includes both adult fish that are migrating upstream on their spawning migrations and steelhead kelts migrating back downstream to the Pacific Ocean. From 1993

through 2004, an estimated 5,614 listed adult Snake River spring/summer Chinook, 2,602 adult Snake River fall Chinook, 11 adult Snake River sockeye, 50,246 adult Snake River steelhead, 691 adult Upper Columbia River spring Chinook, 2,274 adult Upper Columbia River steelhead, and 3,319 adult Middle Columbia River steelhead passed over the juvenile fish separators and were routed back to the river below the projects.

ESA listed juvenile fish transported from 1993 - 2004:
Snake River wild spring/summer Chinook: 10,871,280
Snake River hatchery spring/summer Chinook: 7,408,781
Snake River wild fall Chinook: 4,052,744
Snake River sockeye: 171,216
Snake River steelhead: 4,757,901
Upper Columbia River wild spring Chinook: 72,975
Upper Columbia River hatchery spring Chinook: 19,719
Upper Columbia River wild steelhead: 33,479
Upper Columbia River hatchery steelhead: 109,594
Middle Columbia River wild steelhead: 13,485

ESA listed juvenile fish transport facility mortalities from 1993-2004:
Snake River wild spring/summer Chinook: 30,135
Snake River hatchery spring/summer Chinook: 25,584
Snake River wild fall Chinook: 10,423
Snake River wild sockeye: 149
Snake River hatchery sockeye: 98

Upper Columbia River wild steelhead: 58
Upper Columbia River hatchery steelhead: 190

2. **Steps taken to avoid or decrease mortality:** Each year, the function and operation of collection and transport facilities and equipment at each collector dam are reviewed by Corps and State agency provided biologists working at the collection facilities. They recommend improvements to the Corps that are implemented during the winter maintenance period or, if they are major facility changes, are budgeted and then designed and coordinated with fishery agency and tribal representatives through the Corps Fish Facility Design Review Work Group. Improvements range from removing sharp curves in pipes or flumes to major facility reconstruction such as constructing new outfall pipes to constructing entirely new facilities. From 1987 through 1994, new collection and transportation facilities were constructed at Little Goose, Lower Monumental, and McNary dams. Modifications have been made to these new facilities to improve fish passage conditions through them. The Corps also funds research to evaluate fish passage conditions at the projects and to find new methods of improving fish guiding equipment and fish collection and transportation facilities. Section G.3. contains

additional information on steps taken as part of the Juvenile Fish Transportation Program to minimize mortality in the day-to-day operation of the program.

L. **Certification**: "I hereby certify that the foregoing information is complete, true and correct to the best of my knowledge and belief. I understand that this information is submitted for the purpose of obtaining a permit under the Endangered Species Act of 1973 (ESA) and regulations promulgated thereunder, and that any false statement may subject me to the criminal penalties of 18 U.S.C. 1001, or to penalties under the ESA"

Randy L. Glaeser Date
Lieutenant Colonel, Corps of Engineers
District Engineer

References:

Williams, J.G., S.G. Smith, R.W. Zabel, W.D. Muir, M.D. Scheuerell, B.P. Sanford, S.M. March, R.a. McNatt, and S.Achord. 2005. Effects of the Federal Columbia River Power System on Salmonid Populations. U.S. Dept. Commerce, NOAA Tech memo. NMFS-NWFSC-62.

Corps of Engineers. 2005. Fish Passage Plan. U.S. Army Corps of Engineers, Northwestern Division.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
1201 NE Lloyd Boulevard, Suite 1100
PORTLAND, OREGON 97232-1274

F/NWR5

March 27, 2007

Lieutenant Colonel Anthony J. Hofmann
Walla Walla District, US Army Corps of Engineers
201 North Third Avenue
Walla Walla, WA 99362-1876

RE: Extension of Permit No. 1237

Dear Lieutenant Hofmann:

We have reviewed your application for an Endangered Species Act (ESA) Section 10 permit for the operation of the Juvenile Fish Transportation Program. In lieu of approving your application for a one-year period, the National Marine Fisheries Service (NMFS) instead is granting by way of this letter an extension of Permit No. 1237 through March 31, 2008, during which time this permit will remain in full force and effect.

In support of our decision to extend Permit No. 1237 for another year, we have reviewed the relevant science developed since that permit was originally issued. We find no new information that is materially inconsistent with the basis for the original issuance of this permit and therefore conclude that the criteria for issuance of Permit No. 1237 continue to be satisfied.

Our intent to grant this one-year extension was communicated to our regional fisheries co-managers and the public at the February 14 Technical Management Team meeting and the March 1 Implementation Team meeting. No objections were expressed to the planned permit extension.

NMFS plans to process your application for a new five-year permit over the next year, in coordination with our consultation on Federal Columbia River Power System (FCRPS) operations pursuant to the court-ordered remand, with the intent of issuing such a permit at the time a new FCRPS biological opinion can be issued. As was done for Permit 1237, the consultation for the operation of the FCRPS will also cover NMFS' proposed issuance of a new permit.

NMFS is holding your application in abeyance without finally determining its adequacy pending the development of your new proposed action for operating the FCRPS in the future. Once this proposed action is ready for consultation and issuance of a biological opinion, NMFS will confirm the sufficiency of this application and publish the required Federal Register notice pursuant to our regulations at 50 C.F.R. §222.303(b).

If you have any questions on this issue please contact Paul Wagner 503-231-2316.

Sincerely,

Bruce K. Suzumoto
Assistant Regional Administrator
Hydropower Division

cc: Dave Hurson
Rock Peters

Section B.2.2—Habitat Action

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ACRONYMS AND ABBREVIATIONS

BA	Biological Assessment
BiOp	Biological Opinion
BPA	Bonneville Power Administration
CBWPT	Columbia Basin Water Transactions Program
CHW	Collaboration Habitat Work Group
Corps	U.S. Army Corps of Engineers
Council	Northwest Power and Conservation Council
DPS	Distinct Population Segment
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
ESU	Evolutionarily Significant Unit
FCRPS	Federal Columbia River Power System
LCFRB	Lower Columbia Fish Recovery Board
MPG	Major Population Group
LCREP	Lower Columbia River Estuary Partnership
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
PCRSF	Pacific Coast Salmon Recovery Fund
PDR	Pile Dike Removal Program
PNAMP	Pacific Northwest Aquatic Monitoring Partnership
PWG	Policy Work Group
Reclamation	U.S. Bureau of Reclamation
RM&E	research, monitoring, and evaluation
RPA	Reasonable and Prudent Alternative
UPA	Updated Proposed Action
VSP	Viable Salmonid Population

B.2.2 HABITAT ACTION

B.2.2.1 Introduction

The Action Agencies remain committed in their efforts to support improving the trend in recovery of Endangered Species Act (ESA)-listed salmonid species in the Columbia River Basin. Tributary and estuarine habitat in the Columbia River Basin is a major component of the lifecycle of these fish. Therefore, the objective of the Action Agencies' overall habitat strategy is to protect and improve habitat based on biological needs and prioritized actions that address limiting factors identified for each salmon Evolutionarily Significant Unit (ESU) (another equivalent term—Distinct Population Segment (DPS)—is often used to denote steelhead).

Habitat protection and improvement has been an ongoing component of the recovery process. This has involved completion of multiple projects throughout the Columbia River Basin. Planning for continuing and future efforts for habitat can generally be divided into the following strategies and underlying actions (Figure B.2.2-1).

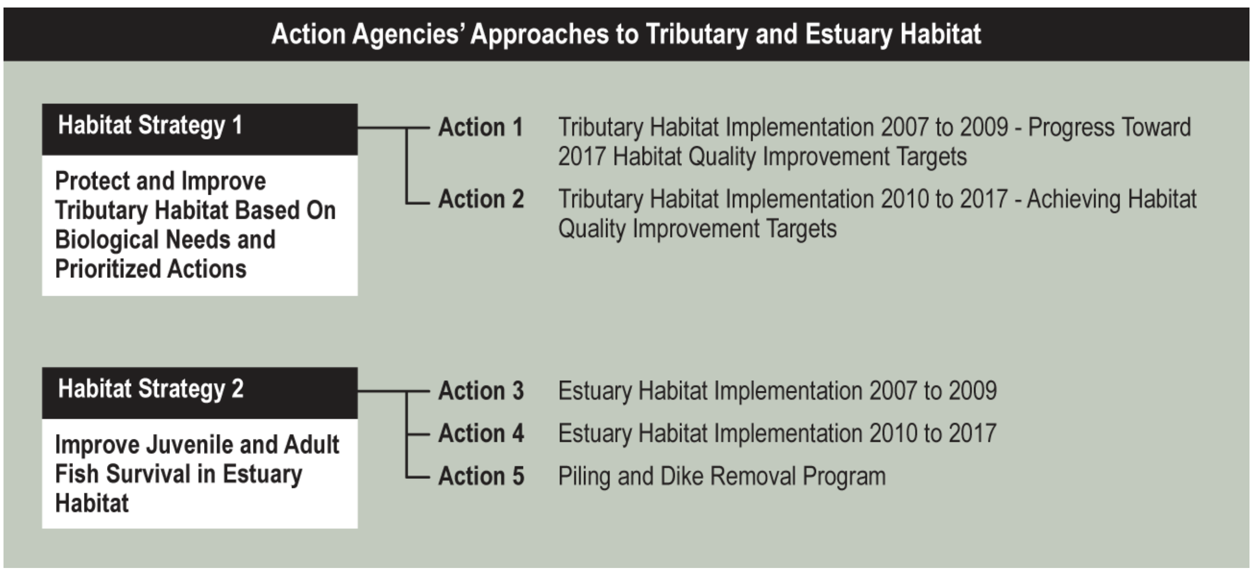

Figure B.2.2-1. Action to Protect and Improve Tributary and Estuary Habitat

Habitat Strategy 1 – Protect and improve tributary habitat based on biological needs and prioritized actions that effectively address limiting factors identified for specified ESUs. This includes the following:

- Increase streamflow through water acquisition
- Address entrainment through screening
- Provide fish passage and access
- Improve mainstem and side channel habitat conditions
- Protect and enhance riparian conditions
- Improve water quality

Habitat Strategy 2 – Improve juvenile and adult fish survival in estuary habitat for all ESUs. This includes the following:

- Acquire, protect and restore off-channel habitat
- Restore tidal influence and improve hydrologic flushing
- Restore floodplain reconnection by removing or breaching dikes or installing fish friendly tide gates
- Remove invasive plants and weeds; replant native vegetation
- Protect and restore emergent wetland habitat and riparian forest habitat
- Restore channel structure and function

The following section discusses these strategies and actions.

B.2.2.2 Habitat Strategy 1 – Protect and Improve Tributary Habitat Based on Biological Needs and Prioritized Actions

The overall objective of the Tributary Habitat Action is to protect and improve mainstem tributary and side-channel tributary habitat for ESA-listed fish migration, spawning and rearing, and to restore floodplain function. The main overall strategy will be to protect and improve tributary habitat based on biological needs and prioritized actions that address primary limiting factors identified for specified ESUs and DPSs.

The Tributary Habitat Action will be implemented by expanding the existing tributary habitat program with particular (but not exclusive) focus on ESA-listed fish populations with greatest biological need (productivity less than 1 or significant deficiencies in other Viable Salmonid Population [VSP] characteristics) and where there is potential for improvement in tributary habitat.

The Tributary Habitat Action uses the products (assembly of tables of potential recovery actions and methods for assessing their benefits) developed by the BiOp Remand Collaboration Habitat Workgroup (CHW). The action draws from and is consistent with Northwest Power Planning and Conservation Council (Council) Subbasin Plans and National Marine Fisheries Service (NMFS, also known as National Oceanic and Atmospheric Administration [NOAA] Fisheries) and State Recovery Planning efforts, and builds on the progress made under the 2000/2004 Federal Columbia River Power System (FCRPS) biological opinions (BiOps). These actions have been, and will continue to be, implemented in partnership with States, Tribes, and others with funding and/or technical assistance from the Action Agencies.

Experts agree that implementation of actions to improve conditions for survival in tributary habitats is one important element of salmon and steelhead recovery efforts (for examples, see National Research Council (NRC) 1996; Stouder et al. 1997; Lichatowich 1999; Knudsen et al. 2000; Lynch et al. 2002; Montgomery et al. 2003; Wissmar and Bisson 2003; and MacDonald et al. 2006). Although measuring the biological benefits of these efforts is difficult to quantify, it is generally accepted that protecting and restoring natural migration, spawning, and rearing habitat conditions in tributary subbasins is important to salmon recovery. Methods for assessing biological benefits from habitat actions to improve habitat quality have been developed by a variety of experts and have been a particular focus of the BiOp Remand CHW. The Action Agencies are using a method for associating change in overall habitat quality with change in survival developed in the CHW. This method is described in Appendix C, Attachment C-1 of the Comprehensive Analysis. This appendix also documents how the habitat quality benefits were determined for the Tributary Habitat Action.

Between 2000 and 2005, the Action Agencies spent over $100 million to protect and restore more than 1,000 miles of riparian habitat, screen 85 diversions, restore passage to 1,280 miles of stream, and acquire 530 cubic feet per second (cfs) of water for instream flow (Corps et al. 2005). The Bonneville Power Administration (BPA) also budgeted an additional $15 million to support development of subbasin assessments and plans. These accomplishments have been implemented through partnerships and cost-sharing with States, Tribes, and local parties. The Action Agencies have learned from experience that Tributary Habitat Actions require the cooperation of local stakeholders and take 1 to 4 years to progress from planning to construction and implementation.

In this Tributary Habitat Action BPA proposes to increase the level of effort to implement actions to benefit listed ESUs compared to that in 2000 to 2006. Figure B.2.2-2 shows the geographic scope of the current action, which is consistent with, but considerably broader than, the scope of the 2000 BiOp Reasonable and Prudent Alternative (RPA) and the 2004 BiOp.

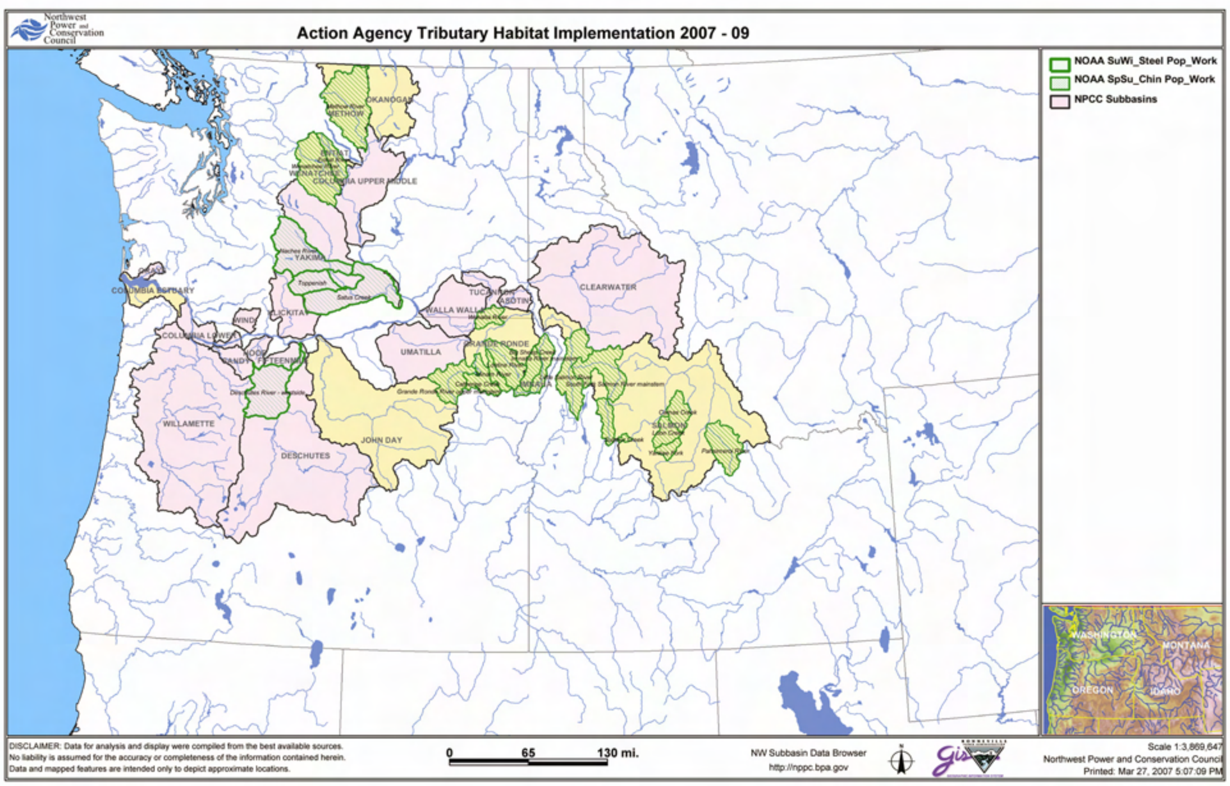

Figure B.2.2-2. Geographic Area of Action Agency Tributary Habitat Program

The BPA funding commitments increased from approximately $20 million per year (average between 2000 and 2006) to approximately $31.5 million per year for tributary habitat actions to benefit anadromous fish during 2007 to 2009, about a 58 percent increase over the 2000 and 2004 BiOp programs in the recently issued BPA decision on 2007 to 2009 Fish and Wildlife Program funding.[1] This increase is largely directed toward areas where listed populations are experiencing low productivity or significant deficiencies in other VSP characteristics. In addition, the Columbia Basin Water Transactions Program (CBWTP—a water and land brokerage established under the 2000 BiOp and the Council's 2000 Fish and Wildlife Program) have been effective in acquiring instream flows and riparian easements to benefit ESA-listed and other anadromous and resident fish species affected by the FCRPS. BPA will direct 70 percent of the funding for the CBWTP ($3.5 million annually) to areas used by anadromous fish.

[1] The $31.5 million annual tributary habitat budget includes 70 percent of the $5 million annual budget of the Columbia Basin Water Transactions Program targeted toward ESA-listed salmon and steelhead.

In addition, in response to draft biological analyses prepared by the Action Agencies subsequent to BPA's 2007 to 2009 funding decision and to input from the Collaboration Process, actions have been added for 2008 and 2009 to address populations with the greatest biological need. The estimated annual average increase for these additional Tributary Habitat Actions in 2008 and 2009 is up to $5.8 million. Combined with the commitments above, BPA funding in 2008 and 2009 will total approximately $37.3 million annually.

BPA will increase its funding commitment to $45 million per year for 2010 to 2017 to support implementation of a further expansion of the habitat program to achieve the habitat quality improvements specified in Attachment B.2.2-1, Table 1; to fund implementation of a broad habitat program based on biological need and addressing limiting factors from recovery and subbasin plans; and to fund actions to benefit ESUs in the estuary and lower river. This increase will be allocated according to "gaps" in biological performance of populations where tributary or estuary habitat is a limiting factor and potential for habitat quality improvement exists. Reclamation's funding commitments are approximately $4 to 6 million per year and are subject to annual Congressional appropriations.

B.2.2.2.1 Description of the Tributary Habitat Action

The Action Agencies commit to provide funding and/or technical assistance to implement "on-the-ground" actions to address biological priorities and key limiting factors identified for tributary habitat for Columbia and Snake River ESUs. These actions are designed to address streamflow, entrainment, passage and access, channel complexity, riparian condition, and water quality limiting factors and improve habitat quality. Habitat quality improvement targets (percent change) for specific populations are presented in Attachment B.2.2-1, Table 1.

This habitat program will be implemented in 3-year increments. For the 2007 to 2009 timeframe, specific locations and actions are identified. These actions represent a substantial expansion from the 2000 to 2006 implementation of the 2000 and 2004 BiOps. For the 2010 to 2017 period, the Action Agencies have committed increased funding and specific project selection on a 3-year basis based on biological priorities, analysis of limiting factors, and achieving the targeted habitat quality improvements.

Projects funded to implement this action will be consistent with Recovery Plans and subbasin plans. The Tributary Habitat Action contains the following:

1. **Overall Commitments**: specific funding commitments, as well as a commitment to implement projects to achieve habitat quality improvements for populations within specific ESUs or DPSs by 2017;
2. **Initial Projects**: specific habitat projects identified by population will be funded and implemented from 2007 to 2009 (Attachment B.2.2-2, Tables 1-5) and will contribute to achieving identified habitat quality improvements (Attachment B.2.2-1, Table 1);
3. **Additional Project Selection**: specific habitat projects will be identified and implemented in 2010-2017 based on:
   - prioritization of projects based on populations with greatest biological need;
   - project selection from the menu of projects developed in the collaboration;
   - experts' determination of anticipated habitat quality improvements toward 2017 commitments for target populations;
   - all projects will specify populations to be benefited, treatment of limiting factors and estimates of biological benefits;
   - selection will be coordinated with recovery planners and the Council;

4. **Accountability for Results**: a specific review process to ensure implementation compliance in 3-year intervals and
   - commitment to implement substitute projects of equal habitat value in the event planned projects become infeasible in order to ensure satisfactory progress toward meeting specific 2017 habitat quality improvement;
   - commitment to research, monitoring, and evaluation (RM&E) during implementation that will inform project selection;
   - commitment to apply new scientific information to estimate benefits for future implementation.; and
   - commitment to reassess specific projects implemented in a previous cycle, if new scientific information suggests that their benefit estimates were significantly in error and implement replacement projects, if needed.

B.2.2.2.2 Initial Actions: Tributary Habitat Implementation 2007 to 2009

Habitat Action 1—Tributary Habitat Implementation 2007 to 2009 – Progress Toward 2017 Habitat Quality Improvement Targets.

The Action Agencies will provide funding and technical assistance for specific actions identified for implementation in 2007 to 2009 (Attachment B.2.2-2, Tables 1-5a) based on biological need and limiting factors.

If actions identified for implementation in 2007-2009 prove infeasible, the Action Agencies will implement comparable replacement projects in 2010-2013 to maintain estimated habitat quality improvements at the population level, or alternatively at the major population group (MPG) or ESU/DPS level.

The first phase of implementation of these commitments is 2007 to 2009. The Action Agencies will complete the habitat actions initiated under the 2000 and 2004 BiOps and will substantially expand the level of implementation with particular focus on areas with greatest biological need. For this period, specific projects were identified and funding decisions made by BPA through the Fish and Wildlife Program 2007 to 2009 project selection process (Attachment B.2.2-2, Tables 1 through 3). Selection of actions was initially based on priority for populations with low productivity and in subbasins identified as priority areas in the 2000 and 2004 BiOps. These priority areas included the Entiat, Okanogan, Methow, Wenatchee, Grande Ronde, Salmon and John Day subbasins. In addition, based on biological needs identified in the Action Agencies' draft lifecycle biological analyses and input from the remand collaboration process, a suite of further actions beyond those funded in the 2007 to 2009 Fish and Wildlife Program decision were identified for implementation in 2008 and 2009 in the Clearwater, Grande Ronde, Imnaha, Salmon, and Okanogan subbasins (Attachment B.2.2-2, Table 4).

In addition to these areas, the Action Agencies are also implementing a broad habitat program to benefit all ESUs based on recommendations from the Council.[2] Habitat quality improvements have been estimated for each population resulting from implementation of 2007 to 2009 projects (Attachment B.2.2-1). These estimates constitute the first phase of progress toward meeting the 2017 habitat quality commitments.

This suite of actions for 2007 to 2009 includes a number of enhancements to the 2000 to 2006 program.

Highlights include:

- **Better Biological Focus**: Refined identification of ESUs with greatest biological needs to allow for more effective implementation of habitat actions that address key limiting factors.
- **Expanded Actions**: Expanded actions specifically identified through the Council's Fish and Wildlife Program process, with a significant increase in funding for habitat actions to benefit listed salmon and steelhead above the 2000 to 2006 period. The selected projects have also successfully undergone independent science review.
- **Further Action Expansion in Response to Biological Analysis and Collaboration Process Policy Work Group (PWG) input**: Another approximately $11.6 million in funding provided for additional actions in 2008 and 2009 (estimated $5.8 million per year) beyond the 2007 to 2009 Fish and Wildlife Program decision. Projects will proceed to implementation following issuance of a FCRPS BiOp and will undergo independent science review (if they have not already received review) and coordination with the BPA/Council process.[3] Reclamation will shift resources to assign a full time liaison to the Grande Ronde area and extend delivery of technical assistance to the Pahsimeroi River subbasin.
- **Additional Opportunity**: Additional water acquisitions and riparian easements to address key limiting factors as opportunities arise using the funds earmarked for the CBWTP ($3.5 million annually).

More detail on specific proposed Tributary Habitat Actions can be found in Attachment B.2.2-2, Tables 1 through 4. These tables include project descriptions, limiting factors, reporting metrics, and budgets.

- Attachment B.2.2-2, Table 1 addresses Upper Columbia ESUs;
- Attachment B.2.2-2, Table 2 addresses Mid-Columbia ESUs;
- Attachment B.2.2-2, Table 3 addresses Snake River ESUs; and
- Attachment B.2.2-2, Table 4 contains available information on the additional projects identified for BPA funding in 2008 and 2009.

Reclamation contributes technical assistance for numerous Tributary Habitat Actions listed in Attachment B.2.2-2, Tables 1 through 3. Table 5 in Attachment B.2.2-2 displays Reclamation's technical assistance for Tributary Habitat Actions that complement (Table 5a) and supplement (Table 5b) those identified in

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[2] In the 2007 to 2009 Fish and Wildlife Program solicitation process, BPA made a decision to fund implementation of all proposed "high priority" projects (with on-the-ground habitat benefits and positive independent scientific review for the identified low productivity populations) in addition to maintaining a significant habitat program for other populations within listed ESUs throughout the Columbia River Basin. Priority subbasins were identified in the 2000 and 2004 BiOps based on ESUs with biological need and habitat potential where addressing flow, passage and screening problems could produce immediate or short-term benefits. It was in those areas where all proposed projects with on-the-ground habitat benefits were selected for funding.

[3] Future project review and selection will involve a broader group of entities as described below in the Process to Identify Future Projects section in this appendix.

Tables 1 through 3. Habitat actions listed in Table 5b were not identified in time to be included in the evaluation of the changes in habitat quality improvements listed in Attachment B.2.2-1. Consequently, implementation of the habitat actions in Table 5b from 2007 through 2009 is expected to contribute an additional change to habitat quality improvement beyond the amounts shown in Attachment B.2.2-1. This benefit will be evaluated in the future.

The habitat program described above is weighted toward listed ESUs in upriver and middle river areas because these incur the greatest impact from the FCRPS. However, lower river ESUs are also included in the Tributary Habitat Action. The estuary habitat program (Estuary Habitat Action) described in Section B.2.2.3 would benefit all ESUs and address Lower Columbia River/Willamette River ESUs (Chinook salmon, steelhead, coho salmon, and chum salmon). Tributary habitat projects selected for implementation in 2007 to 2009 to benefit Lower Columbia River ESUs are presented in Attachment B.2.2-2, Table 6.[4]

Snake River Fall Chinook and Sockeye are not included in the Tributary Habitat Action because Fall Chinook are mainstem spawners and Sockeye are currently maintained entirely through a safety-net hatchery program. However, as the significant increase in Sockeye smolt production (see Hatchery Action, Appendix B.2.3) is implemented, the safety net program will become a conservation program and complementary habitat actions will be developed to support the conservation function of the production increase to assist in recovery.

B.2.2.2.3 Tributary Habitat Implementation 2010 to 2017

Habitat Action 2—Tributary Habitat Implementation 2010-2017 – Achieving Habitat Quality Improvement Targets.

On 3-year cycles, the Action Agencies will identify additional habitat projects for implementation based on biological need and limiting factors from the recovery/subbasin plan inventory where habitat potential exists. Projects will identify location, treatment of limiting factor, targeted population or populations, appropriate reporting metrics, and estimated biological benefits.

a) During 2010 to 2017, the Action Agencies will provide funding and/or technical assistance to implement specific habitat projects to achieve the specified habitat quality improvement for populations with greatest biological need (bolded populations in Table 1 in Attachment B.2.2-1). Habitat quality improvements associated with projects will be estimated in advance of project selection by expert panels. The Action Agencies will convene expert panels to estimate changes in habitat limiting factors from the implementation of habitat actions in coordination with recovery planning groups and the Council:
    - The expert panel will use methods consistent with the *NWF v NMFS* Remand Collaboration habitat workgroup process to estimate benefits.
    - If actions from the previous cycle prove infeasible for the bolded populations, the Action Agencies will implement comparable replacement projects in the next 3-year cycle to maintain estimated habitat quality improvements at the population level. If infeasible at the population level, then alternatively at the MPG or ESU/DPS level. Selection of replacement projects will be made based on input from expert panels, regional recovery planning groups, the Council, and NMFS.
    - Research, monitoring, and evaluation (RM&E) will inform the determination of habitat quality improvements and new scientific information will be applied to estimate benefits for future implementation.

[4] The annual average 2007 to 2009 budget for habitat actions in the lower river is $1.5 million.

- If new scientific or other information suggests that habitat quality improvement estimates for projects from the previous cycle were significantly in error, the Action Agencies will examine the information and review the project or projects in question and their estimated benefits. This review will occur as part of the Comprehensive RPA Evaluations in 2012 and 2015 and will be performed in conjunction with NMFS. In the event such review finds that habitat quality improvement benefits were significantly overstated, the Action Agencies will implement replacement projects to provide benefits sufficient to achieve the habitat quality improvement estimated for the original project of projects.

b) During 2010-2017, for those populations not within category a) above (non-bolded populations in Table 1 in Attachment B.2.2-1), the Action Agencies will provide funding and/or technical assistance to maintain a broad habitat program based on biological need and addressing limiting factors from the recovery/subbasin plan inventory.

The Action Agencies will fund implementation and provide technical assistance for habitat actions to achieve the target habitat quality improvements specified in Attachment B.2.2-1, Table 1 by 2017.

For 2010 to 2017, the Action Agencies will:

- Specify an expanded funding commitment for habitat actions during the BiOp period
- Commit to implement projects to achieve population-specific habitat quality improvements for targeted populations and to implement a broad habitat program to address limiting factors for listed ESUs based on biological need and habitat potential
- Specify the process by which specific future projects will be chosen
  - Potential projects will be selected from the menu of projects developed based on recovery plans and compiled in the collaboration process
  - Biological need will drive specific project selections
  - Experts will determine associated habitat benefits for targeted populations and all projects will specify populations benefited, treatment of limiting factor/s, and estimated biological benefits
  - Projects will receive independent science review
- Specify a 3-year review process
  - Project completion and effectiveness is reviewed
  - Future projects are identified and linked to habitat quality by local experts
- Commit to a habitat RM&E program that informs future project selection

Specify the Funding Commitment. The Action Agencies will expand the level of implementation from the 2007 to 2009 period for specific targeted populations, while maintaining a broad-based program for other ESUs. To support this expansion, BPA will increase its funding commitment to $45 million per year for 2010 to 2017 for its habitat program to achieve the remaining portion of the habitat quality improvements specified in Attachment B.2.2-1, Table 1 after implementation in the 2007 to 2009 period.[5] Reclamation will continue to allocate $4 to $6 million per year for technical assistance for habitat projects, contingent on Congressional appropriations.

[5] As noted above, BPA's habitat program includes actions in the estuary to benefit all ESUs and actions in the lower river.

Projects to Achieve Population-specific Improvements in Habitat Quality. The Action Agencies commit to fund and/or provide technical assistance to implement habitat actions identified in coordination with Council and recovery planning processes to meet population-level habitat quality improvement targets specified in Attachment B.2.2-1, Table 1. If insufficient feasible actions are identified through these processes to reach the specific population-level habitat quality targets, the Action Agencies will fund implementation of substitute actions also identified through these processes to achieve a comparable habitat quality improvement for other populations within the MPG or for other populations within the ESU, in that order, with no reduction in funding commitment.

In the event planned projects become infeasible, the Action Agencies will fund implementation of replacement projects in order to ensure satisfactory progress toward meeting specific 2017 habitat quality improvement commitment.

Specify Process to Identify Future Projects. For each subsequent 3-year increment during 2010 to 2017, the Action Agencies will solicit projects based on biological priorities, key limiting factors, and habitat quality improvements to make progress toward meeting the targeted habitat quality improvements specified in Attachment B.2.2-1, Table 1. Future projects will be selected by the Action Agencies based on the following criteria, which will be applied in coordination with local recovery plan and Council processes. The Action Agencies will coordinate with NMFS, Council, States, Tribes, project sponsors, and others to further refine and advance these criteria for use in developing and implementing projects for 2010 to 2017.

- Projects must address limiting factors identified in recovery plans (the CHW tables have assembled the current information from recovery plans and subbasin plans);
- Priority will be given to actions for populations with low productivity or significant deficiencies in other VSP characteristics;
- Priority will also be given to:
  - projects that benefit more than one population or more than one ESU/DPS;
  - projects that address more than one limiting factor; and
  - projects with more immediate benefits
- Projects should consider VSP characteristics in addition to productivity (abundance, spatial structure, and genetic diversity)
- Projects will identify location, treatment of limiting factor, population or populations benefited, appropriate reporting metrics, and estimated biological benefits.

All VSP parameters will be considered when selecting projects to treat limiting factors in this broad program of actions.

3-Year Review Process. Before future projects are selected for implementation, the Action Agencies will coordinate with the Council and recovery planning processes to estimate change in habitat quality associated with project proposals. For targeted populations, the Action Agencies will convene an expert panel to evaluate the percentage change in habitat quality from projects proposed for implementation in the next cycle. The expert panel will use the approach originally applied for selection and implementation of the 2007 to 2009 projects and all subsequent information on the relationship between actions, habitat quality, and salmon productivity developed through the FCRPS RM&E to estimate the percentage change in habitat quality. All proposals considered for funding will be evaluated for estimated change in habitat quality resulting from implementation. The amount of habitat quality change associated with different projects will be a criterion in project selection. New scientific information will be applied to estimate benefits for future implementation. In the event new scientific information suggests that habitat quality improvement estimates for projects from the previous implementation cycle were significantly in error, the Action Agencies will examine the information and review the project or projects in question and their estimated benefits. This review will occur as part of each 3-year review process and will be performed in conjunction with NMFS. If such review finds that habitat quality improvement benefits were significantly overstated, the Action Agencies will implement replacement projects to provide benefits sufficient to achieve the habitat quality improvement estimated for the original projects.

The Action Agencies will prepare annual progress reports and complete comprehensive reviews of implementation compliance in 2012 and 2015. Adjustments to implementation will be made where needed to ensure satisfactory progress is maintained to meet specified 2017 habitat quality improvements.

B.2.2.2.4 Biological Benefits of the Tributary Habitat Action

Methods associated with determining the biological benefits for the Tributary Habitat Action are described in Appendix C of the Comprehensive Analysis.

In addition, many of the habitat actions (such as floodplain reconnections, channel complexity improvements, and riparian protection and enhancement) accrue sometimes significantly greater habitat quality and associated survival improvements after 2017 than before 2017. Participants in the collaboration process have, in some cases, provided estimates of 25-year benefits associated with implementing actions in the 2007 to 2017 period. The additional post-2017 improvement estimates are displayed in Attachment B.2.2-1, Table 2. These estimates are conservative because they only represent effects of actions implemented from 2007 through 2009. Habitat quality improvements after 2017 are expected to grow larger than indicated in Attachment B.2.2-1, Table 2 as actions are identified and implemented from 2010 to 2017. Benefits continuing to occur from actions taken in 2007 to 2017 will be carried forward to subsequent FCRPS consultations.

B.2.2.2.5 Research, Monitoring, and Evaluation (RM&E)

The RM&E program results will inform both future project selection and the assignment of benefits associated with future projects. Tributary habitat actions will be coordinated with RM&E efforts consistent with broader regional RM&E goals that are currently being developed. The Action Agencies will continue to use results from RM&E activities to validate or reaffirm habitat quality improvement estimates and adjust tributary habitat program priorities if warranted with a goal of attaining the greatest biological effectiveness from implementing Tributary Habitat Actions. Specific actions for RM&E are presented in Appendix B.2.6, Attachment B.2.6-3

B.2.2.2.6 Performance Target and Performance Standard

Performance Target. The Action Agencies' performance target for the Tributary Habitat Action is the habitat quality improvement specified in Attachment B.2.2-1, Table 1.

Performance Standard. The Action Agencies performance standard for the Tributary Habitat Action is the implementation of projects selected to achieve the habitat quality improvement specified in Attachment B.2.2-1, Table 1.

Performance Metrics. The Action Agencies will use the following performance metrics to track their progress in implementation over the term of the BiOp (Table B.2.2-1). These metrics are consistent with those developed by the Federal Habitat Team and Pacific Northwest Aquatic Monitoring Partnership (PNAMP) and used to track implementation of the Pacific Coast Salmon Recovery Fund (PCSRF) program.

Table B.2.2-1. Performance Metrics

Action	Performance Measure
Flow	Cubic feet per second or acre-feet of increased instream flow acquired (months of year/duration (e.g. permanent, annual, seasonal)
Screen	Number of screens
Access	Miles of access
Complexity	Miles of complexity restored
Riparian Protection and Enhancement	Miles or acres of riparian habitat protected or enhanced

For 2010 to 2017 these performance metrics will be tracked in timeframes that coincide with 3-year implementation cycles. Successful implementation will be determined by completion or initiation of suites of projects.

B.2.2.2.7 Accomplishment Reporting

The Action Agencies will produce an annual report of the completed population specific performance metrics listed in Table B.2.2-1.

B.2.2.3 Habitat Strategy 2 – Improve Juvenile and Adult Fish Survival in Estuary Habitat

The overall objective of the Estuary Habitat Action is to protect and increase the distribution of high-quality habitat for all ESUs.

The estuary habitat action uses the products developed by the CHW. For 2007 to 2009, the Action Agencies will implement an expanded estuary habitat program to benefit all listed ESUs affected by the FCRPS. The Action Agencies will:

- Implement 35 specific habitat projects identified in Appendix D, Attachment D-1 in the Comprehensive Analysis.

For 2010 to 2017, the Action Agencies will continue to implement (approximately $5.5 million per year with Corps funding subject to Congressional appropriations) estuary habitat projects:

- specific projects will be selected based on biological effectiveness criteria consistent with the Willamette/Lower River Recovery Plan (Recovery Plan) in coordination with the Lower Columbia River Estuary Partnership (LCREP), the Lower Columbia Fish Recovery Board (LCFRB), and other regional participants;
- the Recovery Plan and LCREP and other local resources will be used to help identify projects.

A key step in conserving and rebuilding ESA-listed salmon and steelhead is determining the potential benefits that could accrue from actions implemented to conserve and improve estuary habitats and their effects on the status of salmon and steelhead ESUs. The FCRPS Hydropower BiOp Remand Collaboration Estuary Subgroup of the CHW developed approaches to determine the potential to improve and protect ESA-listed salmon and steelhead viability through estuary habitat actions.

The Estuary Subgroup has produced several products that have been used in developing and assessing the following estuary habitat actions. These products include several estuary habitat tables that list limiting factors affecting anadromous fish survival, actions and locations that address those limiting factors, estimated implementation benefits and estimated percent of survival improvement targets (PC Trask & Associates 2007; see Appendix D, Attachment D-1 in the Comprehensive Analysis). The subgroup relied heavily on the September 27, 2006, draft *Columbia River Estuary Recovery Plan Module* (Estuary Module, NMFS 2006) and worked closely with local experts to develop and populate the tables and estimate benefits attributable to potential projects. The estuary tables provide information about the implementation of actions on a geographic basis addressing ESUs by life history type (stream-type or ocean-type). At this time, information does not allow for finer distinctions down to the ESU or population level for salmonid use in the estuary.

For purposes of this action, the estuary is defined as the area from the mouth of the Columbia River upstream to the limit of tidal influence at Bonneville Dam. This is consistent with the 2004 Updated Proposed Action (UPA), the limits for the national estuary program, Fresh et al. 2005, and the NMFS Fisheries Recovery Plan Estuary Module.

NMFS and the Action Agencies organized estuary habitat actions using specific reaches or segments. The estuary tables use eight reaches (A through H) to differentiate the lower Columbia River and estuary. The estuary reaches were developed for the LCREP, in conjunction with the University of Washington and the U.S. Geological Survey as part of the development of ecosystem classification for the lower Columbia River and estuary and were used in the estuary module.

BPA funding commitments were increased from approximately $600,000 per year (average between 2000 and 2006) to approximately $2 million per year for habitat actions to benefit listed ESUs during 2007 to 2009, more than doubling efforts over the 2000 and 2004 BiOp programs in the recently issued BPA decision on 2007 to 2009 Fish and Wildlife Program funding.

In addition, in response to draft biological analyses prepared by the Action Agencies subsequent to BPA's 2007 to 2009 funding decision and input from the Collaboration Process Policy Work Group (PWG), additional actions have been added for 2008 and 2009 to address listed ESUs. An additional $1.5 million each year for 2008 and 2009 was provided to expand acquisition and restoration efforts and to fund BPA's new Pile and Dike Removal Program. Project prioritization and selection will be done in coordination with LCREP's Science Workgroup and other local resources, and will be consistent with recovery plans. Projects will proceed to implementation following issuance of FCRPS BiOp and in coordination with the BPA/ Council process. The Corps funding commitments are approximately $2 million per year and are subject to annual Congressional appropriations.

Benefits are estimated for specific projects identified. If these projects are not implemented for some reason, such as local sponsorship or real estate issues, the Action Agencies will fund alternative projects to provide the same or greater benefits. Projects will be selected using the process identified below for future project implementation.

Background

The 2000 FCRPS BiOp included RPA actions calling for habitat work and RM&E efforts in the estuary to help offset impacts of the FCRPS. The Action Agencies and others in the region developed a comprehensive estuary restoration program to inventory, protect and restore key habitats. The program includes a major monitoring, analysis and research program to better understand habitat use and needs in the estuary (to focus actions) and to evaluate progress toward rebuilding the productivity of the system over the long term. This program is outlined in more detail in the Action Agencies' restoration plan, entitled *An Ecosystem-Based Approach to Habitat Restoration Projects with Emphasis on Salmonids in the Columbia River Estuary* (Estuary Habitat Plan)(Johnson et al. 2003). This restoration plan identifies five elements for the implementation of scientifically sound habitat projects to address the potential limiting factors identified for the estuary–protection, conservation, enhancement, restoration, and creation. The Action Agencies also prepared an estuary action plan (Estuary Action Plan 2003). The

Action Agencies will continue to implement actions based on these plans directed at providing biological benefit to ESA-listed fish.

From 2000 to 2006 the Action Agencies have implemented multiple actions in the estuary (for a complete list of 2000 to 2006 implemented projects see: *Estimated Benefits of Federal Agency Habitat Projects in the Lower Columbia River and Estuary*, PC Trask & Associates 2007; see Appendix D, Attachment D-1 of the Comprehensive Analysis).

Method

The estuary habitat table draws most of its information from the Estuary Module (see Appendix D, Attachment D-2 in the Comprehensive Analysis). The Estuary Module identifies and evaluates management actions that, if implemented, would likely reduce threats to salmon and steelhead in the Columbia River estuary and plume. This was accomplished in the Estuary Module by reviewing and synthesizing current literature such as the *Mainstem Lower Columbia River and Columbia River Estuary Subbasin Plan and Supplement* and two NMFS Northwest Fisheries Science Center technical memoranda for the estuary: *Salmon at River's End* (Bottom et al. 2005) and *Role of the Estuary in the Recovery of Columbia River Basin Salmon and Steelhead* (Fresh et al. 2005). Technical input was also garnered from area experts, including staff at NMFS' Northwest Fisheries Science Center, the LCREP, and the LCFRB. The estuary habitat table also builds upon Appendix E of the 2004 FCRPS Hydropower BiOp, especially as it related to limiting factors.

Relation to Recovery Plans and LCREP

Recovery Plans: The Action Agencies' will continue to work with NMFS, the States, and other local groups such as the LCREP and the LCFRB utilizing the Recovery Plans to help identify future projects.

LCREP: The Action Agencies are working closely with the LCREP in their acquisition and restoration efforts in the Columbia River estuary. The LCREP, one of 28 programs in the National Estuary Program, is a two-state, public-private initiative. Using a watershed approach, the Estuary Partnership integrates 28 cities, 9 counties, and the States of Oregon and Washington over an area that stretches 146 miles from Bonneville Dam to the Pacific Ocean. The Estuary Partnership provides a regional framework to support and enhance local efforts. That support includes providing funds to local entities. Many public and private partners help the LCREP accomplish its work. Funding from the States of Oregon and Washington and Congress – through the National Estuary Program – supports base operations and help secure matching public and private dollars. According to LCREP, every dollar invested by the Action Agencies in the Estuary Partnership currently leverages 16 additional dollars.

B.2.2.3.1 Description of Estuary Habitat Action

The Action Agencies will provide funding to implement actions to provide the survival benefits for ocean and stream-type ESUs of 97 percent and 3 percent, respectively. The Action Agencies are committing to implement "on-the-ground" actions to address biological priorities and key limiting factors identified for estuary habitat for Columbia and Snake River ESUs. These actions are designed to improve function of the limiting factors. This habitat program will be implemented in 3-year increments. For the 2007 to 2009 timeframe, specific locations and actions are identified or are undergoing scoping. These actions represent a substantial expansion and a commitment from the Action Agencies for increased funding from the 2000 to 2006 implementation of the 2000 and 2004 BiOps. For the 2010 to 2017 period, the Action Agencies have committed to continue the same level of increased funding from the previous timeframe of 2007 to 2009. Specific BPA projects will be selected on a 3-year basis based on biological priorities, analysis of limiting factors, and improvements in habitat quality. Projects funded to implement this action will be consistent with Recovery Plans.

Initial Actions

The first phase of implementation of these commitments is 2007 to 2009. The Action Agencies will complete the habitat actions initiated under the 2000 and 2004 BiOps and will substantially expand the level of implementation with particular focus on projects with greatest biological value.

Rationale

Habitat actions for the estuary are being accomplished by the Corps and BPA. Corps projects will be funded under Section 536 of the Water Resources Development Act 2000 or other authorities, as appropriate. Estuary habitat projects are also covered in the programmatic Lower Columbia River/Estuary Project (2003-011-00) sponsored through the LCREP and other proposals under review through the Fish and Wildlife Program. Although habitat-related RM&E will not provide direct survival benefits, the Action Agencies will be monitoring action effectiveness for certain habitat projects and will be supporting RM&E work to improve our understanding of habitat needs and benefits in the estuary. This improved understanding will help shape future project development and success.

For years 2007 to 2009, we have identified specific projects the Action Agencies will implement based on collaborative efforts with LCREP, the Council, and local partners. After that time, additional projects will be identified based on research and regional coordination and developed following the Action Agencies Restoration Plan criteria, providing greater benefits in the future. For these future estuary habitat projects, the Action Agencies will provide funding of approximately an average of $5 million each year for fiscal year (FY) 2007 to 2009. For future estuary habitat projects, BPA will provide funding of approximately $2.0 million for FY 2007 and 3.5 million per year for FY 2008 and FY 2009, an increase of approximately $2.4 million annually above 2000 to 2006 average. The Corps expects to continue funding estuary habitat projects at a similar level to current levels (approximately $2 million per year) subject to Congressional appropriations. The Corps is seeking funding for a general investigation study to identify further ecosystem opportunities in the lower Columbia River estuary. If funded, this study could lead to additional authorities and funding for habitat work in the estuary.

In the Columbia River estuary, both ocean- (smaller subyearling fish) and stream-type (somewhat larger yearling fish) salmonids experience significant mortality. However, because the two types typically spend different amounts of time in the estuary and plume environments, they are subject to somewhat different combinations of threats and opportunities. For ocean-type juveniles (Columbia River Chum Salmon, Snake River Fall Chinook Salmon, Upper Willamette Chinook Salmon, Lower Columbia River Fall Chinook Salmon), mortality in the estuary is believed to be related most closely to lack of habitat, changes in food availability, and the presence of contaminants. Stream types (Snake River Sockeye Salmon, Lower Columbia River Coho Salmon, Upper Columbia River Steelhead, Snake River Steelhead, Lower Columbia River Steelhead, Middle Columbia River Steelhead, Upper Willamette River Steelhead, Upper Columbia River Spring Chinook Salmon, and Snake River Spring/Summer Chinook Salmon) are affected by these same factors, although presumably to a lesser degree because of their shorter residency times in the estuary. However, stream-type salmonids are thought to use the low-salinity gradients of the plume to achieve growth and gradually acclimate to saltwater. Stream-type fish, especially steelhead, are also impacted to a greater extent by avian predation in the estuary.

The estuary habitat restoration projects proposed by the Action Agencies will provide estuary habitat improvements expected to in turn improve juvenile and adult fish survival. These projects will provide an increase in juvenile salmonid shallow water habitat that would benefit all listed ESUs, with the greatest habitat benefit to those ESUs expressing ocean type life histories that use the estuarine environment for longer periods of time. Finally, as the habitat restoration projects listed are intended to expand and improve juvenile salmonid off-channel habitat and wetlands habitat, this increase and improvement in rearing habitat is believed to provide refuge for many of the ESUs, thereby increasing survival and decreasing predation. More specific estimated benefits are described in the Survival Benefits section below. Some of the projects will especially benefit lower Columbia River ESUs such as Columbia River Chum Salmon, Lower Columbia River Fall Chinook Salmon, Lower Columbia River Coho Salmon, and Lower Columbia River Steelhead by restoring access to or improving habitat in lower Columbia River tributaries.

Future Implementation

For each subsequent phase of implementation of the estuary habitat proposed action, the Action Agencies will work with LCREP and others to identify projects based on research and regional coordination, providing greater benefits in the future. The Action Agencies will use the Recovery Planning products to adjust the direction and location for implementing future estuary habitat projects.

As the estuary studies continue to improve our understanding, the Action Agencies will be better able to target the amount and types of habitat that would help increase survival and better quantify the biological benefits of these actions. Ultimately, the Action Agencies' goal is to implement actions that provide the greatest and most efficient biological benefit to listed ESUs.

In addition to undertaking actions to protect and restore habitats in the estuary, the Action Agencies can have a role in affecting actions of others in the estuary. The Action Agencies do not directly regulate land use or development, such as large industrial projects, agriculture, or residential development. Through the Corps' Regulatory Program authorities (Section 404 of the Clean Water Act, Section 10 of the Rivers and Harbors Act), development proposals that affect Waters of the United States and navigable waters sponsored by individuals, organizations, or other Federal agencies are evaluated to determine the potential impacts of the activity on relevant public interest factors. These factors include general environmental concerns, fish and wildlife values, water quality, energy needs, safety, and navigation. Proposals for development are also evaluated under the ESA, National Historic Properties Act, and other appropriate laws and regulations to ensure consistency (compliance). Those projects that could affect listed species or their critical habitat undergo Section 7 consultation under the ESA. This public review process will ensure that impacts to listed salmon and steelhead, and their critical habitat, are minimized.

Description of Estuary Habitat Elements

Protection. This includes estuary projects that would secure a property interest through land acquisition, lease, or easement. Metrics tracked for these types of projects include: 1) the number and location of acres protected, 2) the term of protection, and 3) the riparian miles protected.

The Action Agencies are attempting to acquire ownership or development (protection) rights to intact patches of habitat or critical areas in need of further restoration treatments.

Conservation. Habitat conservation is geared toward the goal of increasing the potential for natural processes to work for the benefit of multiple species and can be a critical component of a larger restoration plan, limiting harmful impacts of conventional management practices and complementing other measures to help boost the site's potential for self maintenance. Examples of habitat conservation incentives include financial support for the implementation of riparian setbacks, the addition of riparian buffer strips, integrated pest management, and off-stream livestock watering techniques. The Action Agencies' restoration plan includes additional discussion of protection and conservation strategies and applications.

Enhancement. Habitat enhancement entails the improvement of a targeted ecological attribute and/or process. Several groups are implementing enhancement projects to improve different elements of the ecosystem including riparian plantings and fencing, tide gate or culvert replacement, invasive species removal, and streambank stabilization.

Restoration. Like habitat enhancement projects, restoration projects can take place in a variety of ways. According to the working definition, restoration means the return to a previously existing ecological condition. This can involve more intense modification and manipulation of site conditions than enhancement. As a result, restoration projects typically require more careful planning, design, and maintenance than enhancement projects. For example, miles of habitat can be gained by reconnecting tidal channels that have been cut off by tide gates, dike construction, and placement of fill material for land-use activities. Reconnecting these areas through the removal of tide gate structures, dike breaching, and or culvert installation into a roadbed, however, can increase the risk of flooding landowners that were previously protected by these structures. Therefore, reconnecting tidal channels may require a combination of strategies, such as acquisition and enhancement. At sites where dike breaching or tide gate removal is not possible, self-regulating tide gates that allow fish passage will be considered.

Creation. Habitat creation involves constructing or placing habitat features that did not exist previously, but which attempt to mimic conditions of an intact, functioning ecosystem. Tidal channel excavation is an example of a habitat creation strategy intended to replicate the natural structure and function of an intact channel in proximity to the project site. Another is the placement of dredged material intended to create marsh, shallow water, or other habitat. Because of the uncertainty about the potential ecological gain from a habitat creation strategy, it needs to be accompanied by a stronger effectiveness-monitoring component.

The Estuary Habitat Actions 2007 to 2009

Habitat Action 3—Estuary Habitat Implementation 2007 to 2009

The Action Agencies will provide funding to implement specific actions identified for implementation in 2007-2009 (see below). If actions identified for implementation in 2007-2009 prove infeasible, the Action Agencies will implement comparable replacement projects in 2010 -2013 to provide equivalent benefits.

For 2007 to 2009, BPA will implement specific projects to provide survival benefits to listed ESUs. Much of this funding will be channeled through LCREP, and BPA will work closely with the LCREP and others in further project selection, identification and prioritization. LCREP's Strategic Habitat Restoration Prioritization Framework identifies the most ecologically beneficial locations for restoration and describes the most appropriate types of restoration strategies for those locations. Projects are prioritized based on which provide the greatest benefit to the lower Columbia River estuary and its resources. Placing potential projects through a scientifically rigorous framework allows decisions to be made on what projects to implement within the context of opportunity and help prioritize use of available funds. Taken together, projects selected through this framework provide greater ecological benefit compared to projects implemented in a simple ad-hoc manner.

The Corps will also implement habitat restoration or enhancement projects in the estuary under available authorizes including Section 536 of the Water Resources Development Act of 2000 and the Corps continuing authorities programs for ecosystem restoration.

For the near term, the Action Agencies plan to implement approximately 35 key habitat restoration projects listed below. Additional projects will be identified based on research and regional coordination and developed following the Action Agencies' Restoration Plan and Estuary Habitat and Action Plans over the near term.

Further Action Expansion in Response to Biological Analysis and PWG Input. Based on biological needs identified in the Action Agencies' draft lifecycle biological analyses and input from the remand collaboration process, a suite of further actions beyond those funded in BPA's 2007 to 2009 Fish and Wildlife Program decision have been selected or are undergoing preliminary scoping for implementation during 2008 to 2009. The estimated annual average budget for these additional actions is $1.5 million each year (total of $3 million for 2008 and 2009) beyond the 2007 to 2009 Fish and Wildlife Program decision. Actions will benefit all listed ESUs in the estuary.

LCREP's Habitat Project. BPA's LCREP project is funded in FY 2007 for $1.5 million; FY 2008 for $3 million, and FY 2009 for $3 million. The following projects, or projects similar in nature, will be implemented in FY 2007 to 2009. Specific project details are currently confidential in light of ongoing negotiations.

- Acquisition in Reach D. This acquisition will provide permanent conservation protection, and allow for restoration work to commence. Conservation ownership provides an opportunity to rehabilitate approximately 380 acres of off-channel rearing habitat for a variety of salmonid populations, and manage the riparian habitat to enhance its value for salmon as well as watershed function.
- Project #1 (Reach A). This is a 45-acre floodplain reconnection project (tide gate removal).
- Project #2 (Reach A). This is a 45-acre acquisition of floodplain intended for future restoration activities (dike breach).
- Project #3 (Reach A). This is a 50-acre floodplain reconnection project (dike breach).
- Project #4 (Reach A). This project is the acquisition of 320 acres of tidelands and 119 acres of riparian/upland forest.
- Project #5 (Reach F). Restoration of 30 acres of riparian area, including 2 linear miles of fencing.
- Approximately 15 to 20 Bonneville unscoped FY 2007 to 2009 projects. These are FY 2007 to 2009 projects that are undergoing preliminary scoping and sponsor development.
- Pile Dike Removal. Preliminary scoping ongoing. Implementation in FY 2008 and FY 2009. The Action Agencies are currently working with the LCREP in developing a strategy for assessing pile dikes and identifying structures that may be candidates for removal.

Additional near-term projects will be identified through LCREP's Strategic Habitat Restoration Prioritization Framework and the Recovery Plan. LCREP's Framework identifies the most ecologically beneficial locations for restoration and describes the most appropriate types of restoration strategies for those locations. All projects implemented through the LCREP will be ranked within a competitive review process by its Science Workgroup, utilizing the LCREP's *Criteria for Identifying and Prioritizing Habitat Protection and Restoration Projects on the Lower Columbia River and Estuary* include ecosystem, implementation and monitoring criteria (Attachment B.2.2-3)[1]. These criteria can also be located on LCREP's Web site. The Action Agencies participate in LCREP's Science Workgroup. For additional information see BPA project 2003-011-00.

Grays River Restoration Project. The project proposal species for this project is Lower Columbia River Chum Salmon. The Grays River is located between river mile 19 and 23 along the Columbia River in Wahkiakum County, Washington. This project will aid in restoring habitat-forming processes to enhance salmon and steelhead populations in the Grays River. This project will be the first step in

[1] These are LCREP's criteria and not the Action Agencies' criteria, though they are used by LCREP in selecting projects under the Action Agencies' Proposed RPA.

restoring channel structure and function that will increase in-stream habitat diversity, channel stability, and riparian integrity in the critical response reach upstream and adjacent to critical salmon spawning areas of the Grays River. The major component of this strategy is the planning, design, installation, and monitoring of engineered logjams that will rejuvenate historic channel and floodplain processes. Additional restoration measures include reforesting the riparian corridor to enhance future large woody debris recruitment and investigation of conservation activities within ecologically critical areas. These activities include land acquisition and levee removal to protect critical areas and reconnect floodplain areas. This project will be implemented from 2007 to 2009. For additional information see BPA project 2003-013-00.

Chinook River. The proposed project is located near Chinook, Washington. The intent of the project is to restore partial tidal influence and access to several acres of the Chinook River Estuary. To accomplish this goal, a tide gate will be retrofitted. At this time, the number of acres (or lineal miles of channel access) influenced by the project are unknown. This project is likely to benefit chum salmon.

Julia Butler Hanson. The proposed project is located on the Julia Butler Hanson National Wildlife Refuge near Cathlamet, Washington. The intent of the project is to install fish friendly tide gates to increase tidal flushing and fisheries access to approximately 110 acres. Riparian plantings of up to 210 acres will likely be included as well.

Vancouver Lake. This project is a tide gate retrofit project located in Reach F (in the City of Vancouver area). The number of acres affected by this project is currently uncertain.

Ramsey Lake. This project, located at river mile 2 on the Columbia Slough, will re-establish hydrologic connectivity to the Lower Columbia Slough to reclaim and improve floodplain wetland functions (forested wetland and soft bottom, mud backwater sloughs) and to increase the amount and quality of off-channel rearing and refuge habitat for juvenile salmonids. This project will return approximately 5.0 acres of isolated habitat. Native vegetation will be planted along shorelines and within the wetland restoration site. Reconstructed slough channels will provide approximately 2.5 acres of annually inundated off-channel habitat.

Dairy Creek. This project is intended to improve hydrologic flushing and salmonid access to Sturgeon Lake on Sauvie Island, Oregon. Sturgeon Lake is approximately 3,200 acres in size.

Sandy River. This project is located at the confluence of the Sandy and Columbia rivers just north of I-84, and east of the Troutdale airport. This project is part of a long-term effort to restore 1,500 acres of the Sandy River delta. Near-term future restoration includes breaching the dike and re-establishing flow to a portion of the original Sandy River channel, planting vegetation on 50 acres, removing invasive weeds on 180 acres, planting wetland scrub shrub on 45 acres, and controlling and removing invasive wetland plants on 45 acres.

Vancouver Water Resources. This proposed project is intended to protect and restore approximately 5 to 10 acres of emergent wetland and riparian forest habitat.

The Corps expects to complete additional projects that will provide similar benefits that will be identified during the FY 2007 to 2009 period. These are FY 2007 to 2009 projects that are undergoing preliminary scoping and sponsor development.

The Estuary Habitat Action 2010 to 2017

Habitat Action 4—Estuary Habitat Implementation 2010-2017

The Action Agencies will provide funding to implement specific projects to achieve additional estuary survival benefits.

- Projects will be selected in coordination with LCREP and other regional experts, using recovery planning products and the modified LCREP project selection criteria (Attachment B.2.2-3) to identify projects that will benefit salmon.
- To support project selection, the Action Agencies will convene an expert regional technical group to determine the estimated change in survival that would result from implementation of each project proposed for implementation.
- The expert regional technical group will use the approach originally applied in this Biological Assessment (BA) (see Appendix D, Attachment D-1 in the Comprehensive Analysis – *Estimated Benefits of Federal Agency Habitat Projects in the Lower Columbia River Estuary*) and all subsequent information on the relationship between actions, habitat and salmon productivity models developed through the FCRPS RM&E to estimate the change in overall estuary habitat and resultant change in population survival

Additional projects for longer-term implementation will be identified based on research and regional coordination, providing greater benefits in the future. The Action Agencies will use the Estuary Plan and draw on priorities identified through LCREP's Science Work Group utilizing their *Criteria for Identifying and Prioritizing Habitat Protection and Restoration Projects on the Lower Columbia River and Estuary* (Attachment B.2.2-3), the collaboration process and Recovery Plan products to adjust the direction and location for implementing future estuary habitat projects.

From 2010 to 2017, BPA will commit approximately $3.5 million every year for these priority habitat projects, working through the LCREP program. The Corps expects to continue to fund estuary habitat projects at a similar level to current funding (approximately $2 million per year), but actual funding will be dependant on Congressional appropriations.

Piling and Dike Removal Program

Habitat Action 5—Piling and Dike Removal Program

To increase access to productive habitat and to reduce avian predation, the Action Agencies will develop and implement a piling and dike removal program.

- In 2008, the Action Agencies will work with Lower Columbia River Estuary Program to develop a plan for strategic removal of structures that have low value to navigation channel maintenance, present low-risk to adjacent land use, support increased ecosystem function, and are cost-effective.
- Beginning in 2008 and 2009, the Action Agencies will begin implementation. Implementation will continue through 2017.

Implementation of this new program will begin in FY 2008. The program consists of a study to evaluate pilings and pile dikes that can be removed without negative effects on the navigation channel operations or private property, several demonstration projects to test methodologies, and limited monitoring to learn which techniques are best suited for future funding years.

The Action Agencies have committed to fund a new Pile Dike Removal Program (PDR Program) in the lower Columbia River and Estuary for improved ecosystem health. The Action Agencies PDR Program is being developed in cooperation with the LCREP. PDR Program on-the-ground implementation will begin in 2008 and will be funded at the $1 million level per year.

The Action Agencies are currently working with the LCREP in developing a strategy for assessing pile dikes and identifying structures that may eventually be candidates for removal. The strategy is expected to help guide the strategic removal of structures that have low value for navigation channel maintenance, present low-risk to adjacent land use, support increased ecosystem function, and are cost effective.

Draft criteria have been developed by LCREP to help identify potential projects beginning in 2008. The draft criteria include project support, ecosystem function, long-term management, and cost effectiveness categories.

The emerging strategy is intended to identify a suite of pile dike (or pile structure) projects that meets the checklist criteria, are geographically related to reduce mobilization/demobilization costs, and follow a critical pathway toward reducing the number of derelict pile dikes in the lower river and estuary.

B.2.2.3.2 Action Criteria Linked to ESA Limiting Factors

The Action Agencies' estuary program is designed to address ESA limiting factors in the estuary for all listed fish affected by the FCRPS. The Action Agencies' adopted the limiting factors in the Estuary Module. The Estuary Module identified and prioritized limited factors based on a thorough review and synthesis of pertinent literature, supplemented by input from area experts that included staff from NMFS' Northwest Fisheries Science Center and Portland office, the LCREP, and the LCFRB. Several key documents provided consistent guidance. These documents included the following:

- *Salmon at River's End: The Role of the Estuary in the Decline and Recovery of Columbia River* (Bottom et al. 2005)
- *Role of the Estuary in the Recovery of Columbia River Basin Salmon and Steelhead: An Evaluation of the Effects of Selected Factors on Salmonid Population Viability* (Fresh et al. 2005)—NMFS technical memorandum
- *Mainstem Lower Columbia River and Columbia River Estuary Subbasin Plan* and its supplement—Lower Columbia River Estuary Partnership (2004)

Following are key limiting factors identified for the estuary and the criteria from the Recovery Module for actions that the Action Agencies' will be implementing to address these limiting factors. The Action Agencies are not able to address all of the limiting factors and criteria under their authorities. For example, the Action Agencies have no regulatory authority over toxics or exotic invertebrates and have limited ability to address this factor under existing authorities and programs.

Ocean-Type Habitat-Related Limiting Factors

These factors are habitat, flow, toxics, temperature, sediment, predation, exotic invertebrates, and stranding. Ocean-type life histories include Columbia River Chum Salmon, Snake River Fall Chinook Salmon, Upper Willamette River Chinook Salmon, and Lower Columbia River Fall Chinook Salmon.

Related Habitat Action Criteria:

- Protect remaining high-quality off-channel habitat;
- Reduce noxious weeds;
- Breach or lower dikes or levees;

- Adjust the timing, magnitude, and frequency of flows within the estuary;
- Restore contaminated sites;
- Protect and restore riparian areas;
- Remove pile dikes;
- Use dredge materials beneficially; and
- Reduce over-water structures.

Stream-Type Habitat-Related Limiting Factors

These are: habitat, flow, toxics, temperature, sediment, predation, and exotic invertebrates. Stream type life histories include Snake River Sockeye Salmon, Lower Columbia River Coho Salmon, Upper Columbia River Steelhead, Snake River Steelhead, Lower Columbia River Steelhead, Middle Columbia River Steelhead, Upper Willamette River Steelhead, Upper Columbia River Spring Chinook Salmon and Snake River Spring/Summer Chinook Salmon.

Related Habitat Action Criteria:

- Protect remaining high-quality off-channel habitat;
- Reduce noxious weeds;
- Breach or lower dikes or levees;
- Adjust the timing, magnitude, and frequency of flows within the estuary;
- Restore contaminated sites;
- Protect and restore riparian areas;
- Remove pile dikes;
- Use dredge materials beneficially;
- Reduce entrainment from dredging; and
- Reduce over-water structures.

In addition to these limiting factors and criteria, we will also be using more detailed criteria for project selection based on the Estuary Plan, Recovery Plans, and coordination with LCREP and the region to identify future projects.

B.2.2.3.3 Research, Monitoring, and Evaluation (RM&E)

The research, monitoring, and evaluation for the Columbia River Estuary will involve four main actions:

- Monitor and Evaluate Fish Performance in the Estuary and Plume
- Monitor and Evaluate Migration Characteristics and Estuary/Ocean Conditions
- Monitor and Evaluate Habitat Actions in the Estuary
- Investigate Estuary/Ocean Critical Uncertainties

The information obtained from these actions will be used to address the following primary management questions:

- Are aquatic, riparian, and upland estuary habitat actions achieving the expected biological and environmental performance targets?
- Are the offsite habitat actions in the estuary improving juvenile salmonid performance and which actions are most effective at addressing the limiting factors?
- What are the limiting factors or threats in the estuary/ocean preventing the achievement of desired habitat or fish performance objectives?

Additional details about the RM&E for estuary actions are provided in Appendix B.2.6.

B.2.2.3.4 Performance Targets

Performance measures for the Columbia River Estuary include reach survival, life history diversity, growth rates, and predation rates of juvenile salmonids and the bathymetry, topography, connectivity, and hydrology of estuary habitats. Survival benefits for actions implemented in periods FY 2010 to FY 2017 for Estuary Habitat Actions have been estimated for stream and ocean-type life histories and used within the biological assessment based on methods discussed and developed in the Collaboration Process. These estimated benefits provide the long-term performance targets (see Appendix B.2.6 for additional details).

B.2.2.3.5 Accomplishment Reporting

The Action Agencies will produce an annual report to provide performance metrics for completed Estuary Habitat Actions.

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Attachment B.2.2-1
Estimated Tributary Habitat Quality Improvement for Actions to be Funded from 2007 to 2017

TABLE OF CONTENTS

LIST OF TABLES

1. INTRODUCTION

This section includes two tables that display habitat quality improvements estimated to occur from actions implemented under the Tributary Habitat Action described in Appendix B, Section B.2.2.

Table 1 displays the Action Agency commitments to achieve population specific habitat quality improvements as described in Appendix B, Section B.2.2. These improvements would occur over the 10-year life of the Biological Opinion (BiOp). Bolded populations in this table indicate specific habitat quality improvements for populations with greatest biological need. During 2010 to 2017, for those populations not bolded, the Action Agencies will provide funding and/or technical assistance to maintain a broad habitat program based on biological need and addressing limiting factors from the recovery/subbasin plan inventory.

Table 2 displays the population specific habitat quality improvements estimated to occur over a 25-year time frame from Tributary Habitat Actions implemented from 2007 to 2009. These 25-year habitat quality improvements were developed by local biologists and, while not included in the Action Agencies' quantitative biological analysis, demonstrate the ongoing benefits of habitat actions.

See Appendix C of the Comprehensive Analysis for a full description of the methodologies used to estimate habitat quality improvement.

Table 1. Estimated Habitat Quality Improvements

ESA Listed ESU	Major Population Group	Population	Estimated Percentage Habitat Quality Improvement of 2007-2009 Actions	Total Estimated Percentage Habitat Quality Improvement of 2007-2017 Actions
Snake River Spring/Summer Chinook	Grand Ronde/Imnaha	**Catherine Creek**	**4**	**23**
		Lostine/Wallowa River	2	*
		Grand Ronde River upper mainstem	**2**	**23**
		Imnaha River mainstem	1	*
	Middle Fork Salmon River	Big Creek	1	*
	South Fork Salmon River	Secesh River	1	*
		South Fork Salmon River Mainstem	<1	*
	Lower Snake	Tucannon River	7	17
	Upper Salmon River	East Fork Salmon River	1	*
		Lemhi River	7	*
		Pahsimeroi River	41	*
		Salmon River lower mainstem below Redfish Lake	1	*
		Salmon River upper mainstem above Redfish Lake	14	*
		Valley Creek	1	*
		Yankee Fork	**10**	**30**
Upper Columbia Spring Chinook	Upper Columbia – Below Chief Joseph	**Entiat River**	**10**	**22**
		Methow River	**2**	**6**
		Wenatchee River	**1**	**3**
Middle Columbia Steelhead	Cascades Eastern Slope Tributaries	Deschutes River – eastside	1	*
		Deschutes River – westside	<1	*
		Fifteen mile Creek (winter run)	<1	*
		Klickitat River	4	*
	John Day River	John Day River lower mainstem tributaries	<1	*
		John Day River upper mainstem	<1	*
		Middle Fork John Day River	<1	*
		North Fork John Day River	<1	*
		South Fork John Day River	1	*
	Umatilla and Walla Walla River	Touchet River	4	*
		Umatilla River	4	*
		Walla Walla River	4	*
	Yakima River	Naches River	4	*

Table 1. Estimated Habitat Quality Improvements

ESA Listed ESU	Major Population Group	Population	Estimated Percentage Habitat Quality Improvement of 2007-2009 Actions	Total Estimated Percentage Habitat Quality Improvement of 2007-2017 Actions
	Group	Satus Creek	4	*
		Toppenish	4	*
		Yakima River upper mainstem	4	*
Snake River Steelhead	Clearwater River	**Lochsa River**	**8**	**17**
		Lolo Creek	**5**	**8**
		Selway River	**<1**	**<1**
		South Fork Clearwater River	**5**	**14**
	Grand Ronde River	Grand Ronde River lower mainstem tributaries	<1	*
		Grand Ronde River upper mainstem	4	*
		Joseph Creek (OR)	<1	*
		Joseph Creek (WA)	4	*
		Wallowa River	<1	*
	Hells Canyon	Hells Canyon		
	Imnaha River	Imnaha River		*
	Lower Snake	Asotin Creek	4	*
		Tucannon River	5	*
	Salmon River	**Lower Middle Fork mainstem and tribs (Big, Camas, and Loon Creeks)**	**1**	**7**
		East Fork Salmon River	2	*
		Lemhi River	3	*
		Pahsimeroi River	9	*
		Salmon River upper mainstem	6	*
		Secesh River	**1**	**6**
		South Fork Salmon River	**<1**	**1**
Upper Columbia Steelhead	Upper Columbia River – below Chief Joseph	**Entiat River**	**6**	**8**
		Methow River	**2**	**4**
		Okanogan River	**12**	**14**
		Wenatchee River	**1**	**4**

*The Action Agencies will provide funding and/or technical assistance to maintain a broad habitat program in these geographic areas based on biological need and addressing limiting factors from the recovery/subbasin plan inventory.

Table 2. Estimated Habitat Quality Improvement after 2017 for Actions Implemented from 2007 to 2009

ESA-Listed ESU	Major Population Group	Population	Estimated Percentage Habitat Quality Improvement of 2007-2009 Actions accrued after 2017 (within 25 years)
Snake River Spring/Summer Chinook	Grande Ronde / Imnaha	Catherine Creek	10
		Lostine/Wallowa River	1
		Minam River	
		Grande Ronde River upper mainstem	2
		Wenaha River	
		Big Sheep Creek	
		Imnaha River mainstem	
	Middle Fork Salmon River	Bear Valley Creek	
		Big Creek	1
		Camas Creek	
		Loon Creek	
		Marsh Creek	
		Sulphur Creek	
		Middle Fork Salmon River above Indian Creek	
		Chamberlain Creek	
		Middle Fork Salmon River below Indian Creek	
	South Fork Salmon River	East Fork South Fork Salmon River	
		Little Salmon River	
		Secesh River	1
		South Fork Salmon River mainstem	<1
	Lower Snake	Asotin Creek	10
		Tucannon River	13
	Upper Salmon River	East Fork Salmon River	See Footnote[1/]
		Lemhi River	See Footnote[1/]
		North Fork Salmon River	
		Pahsimeroi River	See Footnote[1/]
		Salmon River lower mainstem below Redfish Lake	See Footnote[1/]
		Salmon River upper mainstem above Redfish Lake	See Footnote[1/]
		Valley Creek	See Footnote[1/]
		Yankee Fork	32
Upper Columbia Spring Chinook	Upper Columbia - Below Chief Joseph	Entiat River	2
		Methow River	1
		Wenatchee River	See Footnote[1/]

Table 2. Estimated Habitat Quality Improvement after 2017 for Actions Implemented from 2007 to 2009 (continued)

ESA-Listed ESU	Major Population Group	Population	Estimated Percentage Habitat Quality Improvement of 2007-2009 Actions accrued after 2017 (within 25 years)
Middle Columbia Steelhead	Cascades Eastern Slope Tributaries	Deschutes River - eastside	
		Deschutes River - westside	
		Fifteenmile Creek (winter run)	
		Klickitat River	
		Rock Creek	
	John Day River	John Day River lower mainstem tributaries	
		John Day River upper mainstem	
		Middle Fork John Day River	
		North Fork John Day River	
		South Fork John Day River	
	Umatilla and Walla Walla River	Touchet River	
		Umatilla River	
		Walla Walla River	
	Yakima River Group	Naches River	
		Satus Creek	
		Toppenish	
		Yakima River upper mainstem	
Snake River Steelhead	Clearwater River	Clearwater River lower mainstem	
		Lochsa River	5
		Lolo Creek	2
		Selway River	<1
		South Fork Clearwater River	3
	Grande Ronde River	Grande Ronde River lower mainstem tributaries	
		Grande Ronde River upper mainstem	5
		Joseph Creek (OR)	
		Joseph Creek (WA)	
		Wallowa River	<1
	Hells Canyon	Hells Canyon	
	Imnaha River	Imnaha River	
	Lower Snake	Asotin Creek	8
		Tucannon River	8

Table 2. Estimated Habitat Quality Improvement after 2017 for Actions Implemented from 2007 to 2009 (continued)

ESA-Listed ESU	Major Population Group	Population	Estimated Percentage Habitat Quality Improvement of 2007-2009 Actions accrued after 2017 (within 25 years)
Snake River Steelhead (continued)	Salmon River	Lower Middle Fork mainstem and tribs (Big, Camas, and Loon Creeks)	1
		Chamberlain Creek	
		East Fork Salmon River	1
		Lemhi River	See Footnote[1/]
		Little Salmon and Rapid River	
		Upper Middle Fork mainstem and tribs	
		North Fork Salmon River	
		Pahsimeroi River	See Footnote[1/]
		Panther Creek	
		Salmon River upper mainstem	15
		Secesh River	1
		South Fork Salmon River	<1
Upper Columbia Steelhead	Upper Columbia River - Below Chief Joseph	Entiat River	3
		Methow River	1
		Okanogan River	3
		Wenatchee River	1

Note:
1/ Estimates are not currently available but will be developed when 2010 to 2017 actions are refined.

Attachment B.2.2-2
Tributary Habitat Action Tables

ATTACHMENT B.2.2-2—TRIBUTARY HABITAT ACTION TABLES

This attachment consists of the following six tables:

Table 1. Tributary Habitat Actions, Upper Columbia River Spring Chinook Salmon and Steelhead, 2007 to 2009
- Table 1a. Upper Columbia Steelhead
- Table 1b. Upper Columbia Spring Chinook Salmon

Table 2. Tributary Habitat Actions, Mid Columbia River Steelhead, 2007 to 2009

Table 3. Tributary Habitat Actions, Snake River Spring/Summer Chinook Salmon and Steelhead, 2007 to 2009
- Table 3a. Snake River Steelhead
- Table 3b. Snake River Spring Summer Chinook Salmon

Table 4. Additional 2008 to 2009 Tributary Habitat Actions
- Table 4a. Snake River Spring Summer Chinook Salmon
- Table 4b. Snake River Steelhead
- Table 4c. Upper Columbia River Steelhead

Table 5. Reclamation Technical Assistance
- Table 5a. Complementary to BPA-Funded Tributary Habitat Actions Listed in Tables 1, 2, and 3
- Table 5b. Supplementary to BPA-Funded Tributary Habitat Actions Listed in Tables 1, 2, and 3

Table 6. Habitat Actions for Lower Columbia River ESUs

Table 1-a. Upper Columbia Steelhead 2007-2009 BPA Tributary Habitat Actions

Upper Columbia Steelhead							
MPG	**Populations**	**Tributary Habitat Limiting Factors** (FCRPS BiOp Remand Habitat Workgroup products)	**BPA Project Nbr**	**Average annual planning budget**	**Project Title & Short Description**	**Action Description**	**Reporting Metric**
Eastern Cascades	Wenatchee River	Floodplain Connectivity and Function- degraded floodplain connectivity and function Channel Structure and Complexity- habitat diversity, in-channel habitat quantity Riparian Areas and LWD Recruitment- degraded riparian function Stream Flow- low stream flow Water Quality- High stream temperature Fish Passage- barriers to passage or access	200201301	$ 3,500,000	Water Entity (RPA 151) NWPPC Fund water right transactions that restore streamflows and focused riparian easements on criticial fish-bearing Columbia Basin tributaries. Implemented as the Columbia Basin Water Transactions Program (CBWTP) in a partnership between BPA and NFWF.	Land Purchase	# of HUs protected by land purchase or easement * # of acres of new purchase/easement * # of riparian miles protected
						Install Flow Measuring Device	* Is the measuring device portable or fixed?
						Acquire Water Instream	
						Develop and Negotiate Water Right Transaction	
			200704200	$ 156,600	UPA Wenatchee Passage Program To replace 9 barrier culverts in Alder Creek, Clear Creek and Beaver Creek with fish-friendly structures to provide 4.0 miles of spawning and rearing habitat for ESA listed Upper Columbia steelhead.	Install Fish Passage Structure	
						Remove/Modify Dam	
			200708500	$ 216,667	UPA Nason Creek Oxbow Reconnection Project Project proposes to install two bottomless arch culverts in SR 207 to successfully reconnect 0.64 miles of historic oxbow habitat to the mainchannel Nason Creek. This project will increase Spring Chinook salmonid abundance by 25-50% in the Nason A.U.	Install Fish Passage Structure	* # of miles of habitat accessed
			200708600	$ 100,000	UPA Wenatchee Subbasin Riparian Enhancement Proposal The Wenatchee Riparian proposal will involve planting native vegetation and fencing to establish a properly functioning riparian buffer in the Wenatchee Assessment Units. This project will benefit Upper Columbia steelhead, spring Chinook and bull trout.	Install Fence	
						Plant Vegetation	* # of riparian miles treated
						Maintain Vegetation	
			200728300	$ 766,667	UPA Wenatchee Subbasin Access Proposal Forty-three (43) potential fish passage barrier structures are being proposed for funding to benefit Upper Columbia spring Chinook, steelhead and bull trout. Emphasis is on replacing the Mill Creek Culvert near the mouth of Peshastin Creek.	Install Fish Passage Structure	

Table 1-a. Upper Columbia Steelhead 2007-2009 BPA Tributary Habitat Actions

Upper Columbia Steelhead							
MPG	**Populations**	**Tributary Habitat Limiting Factors** (FCRPS BiOp Remand Habitat Workgroup products)	**BPA Project Nbr**	**Average annual planning budget**	**Project Title & Short Description**	**Action Description**	**Reporting Metric**
Eastern Cascades (con't)	Wenatchee River (con't)		200732500	$ 700,000	UPA Wenatchee Subbasin Complexity Proposal Five potential complexity projects are being proposed for funding to benefit Upper Columbia spring Chinook, steelhead and bull trout. Funds are also requested for unidentified potential complexity projects to assist in meeting UPA metric goals.	Realign, Connect, and/or Create Channel	
			200703400	$ 308,000	Columbia Cascade Pump Screen Correction This project proposes to start a voluntary compliance pump screen correction program in the Methow, Entiat, and Wenatchee River basins in order to reduce juvenile fish losses due to entrapment in water diversions as called for in the most recent FCRPS BiO.	Install Fish Screen	
	Entiat River	Floodplain Connectivity and Function- impaired floodplain and side-channel connectivity Channel Structure and Complexity- in-channel habitat quantity, habitat diversity Riparian Areas and LWD Recruitment- degraded riparian condition Stream Flow- Low stream flow Fish Passage- obstructions to passage and access Stream Substrate- excess fine sediment	200705500	$ 20,000	Entiat River - UPA - Lower Entiat River Off-Channel Restoration Project The Lower Entiat River Off-Channel enhancement project will provide 0.28 miles of off-channel habitat to benefit Upper Columbia ESA listed steelhead, spring Chinook, and bull trout. An irrigation channel will be enhanced for rearing and spawning habitat.	Develop Pond	
						Increase Instream Habitat Complexity	* # of stream miles treated * # of structures installed
						Plant Vegetation	
						Install Fish Passage Structure	* # of miles of habitat accessed
			200723100	$ 83,333	UPA Entiat Subbasin Riparian Enhancement Program Riparian projects are being proposed in the Entiat subbasin to benefit Upper Columbia spring Chinook, steelhead and bull trout. Funding is requested for Tillicum Creek Fence and programmatic riparian projects.	Install Fence	
						Plant Vegetation	
						Maintain Vegetation	
			200731800	$ 125,000	Entiat River - UPA - Knapp-Wham Hanan Detwiler Irrigation System Consolidation Project Consolidation of the Knapp-Wham and Hanan Detwiler irrigation systems will eliminate partial fish passage barriers associated with 2 surface water diversions, add instream habitat within the lower Entiat River, and enhance instream flows via water saved.	Develop Alternative Water Source	
						Increase Instream Habitat Complexity	* # of stream miles treated * # of structures installed
						Remove/Install Diversion	* # of miles of habitat accessed
						Install Well	* Amount of unprotected water flow returned to the stream by conservation in cfs * Estimated # of miles of primary stream reach improvement

Table 1-a. Upper Columbia Steelhead 2007-2009 BPA Tributary Habitat Actions

Upper Columbia Steelhead							
MPG	**Populations**	**Tributary Habitat Limiting Factors** (FCRPS BiOp Remand Habitat Workgroup products)	**BPA Project Nbr**	**Average annual planning budget**	**Project Title & Short Description**	**Action Description**	**Reporting Metric**
Eastern Cascades (con't)	Entiat River (con't)		200201301	$ 3,500,000	Water Entity (RPA 151) NWPPC Fund water right transactions that restore streamflows and focused riparian easements on criticial fish-bearing Columbia Basin tributaries. Implemented as the Columbia Basin Water Transactions Program (CBWTP) in a partnership between BPA and NFWF.	Land Purchase	# of HUs protected by land purchase or easement
							* # of acres of new purchase/easement
							* # of riparian miles protected
						Install Flow Measuring Device	* Is the measuring device portable or fixed?
						Acquire Water Instream	
						Develop and Negotiate Water Right Transaction	
			200703400	$ 308,000	Columbia Cascade Pump Screen Correction This project proposes to start a voluntary compliance pump screen correction program in the Methow, Entiat, and Wenatchee River basins in order to reduce juvenile fish losses due to entrapment in water diversions as called for in the most recent FCRPS BiO.	Install Fish Screen	
	Methow River	Floodplain Connectivity and Function- impaired floodplain connectivity and function, impaired side-channel connectivity Channel Structure and Complexity- habitat diversity, in-channel habitat quality Riparian Areas and LWD Recruitment- impaired riparian function Stream Flow- Low stream flow Water Quality- High stream temperature Fish Passage- passage: thermal, screens, culverts and flow barriers in lower reach Other- Ecologic conditions-disease	200703500	$ 202,880	UPA Project - Methow Basin Riparian Enhancement MSRF proposes to partner with Bureau of Reclamation and Methow Conservancy to identify and prioritize riparian enhancement projects that will add value to passage, access and conservation projects. All projects will focus on TES species and habitat.	Install Fence	* # of miles of fence
						Plant Vegetation	* # of riparian miles treated
			200717200	$ 90,193	UPA Project - MVID West Canal Diversion and Headworks Move POD 175' upstream by installing new concrete diversion headworks, realign 150' of West Canal intake and build new access road to connect new headworks, construct permanent channel-spanning natural rock roughened channel permanent diversion.	Plant Vegetation	
						Operate and Maintain Habitat/Passage	
						Install Fish Passage Structure	* # of miles of habitat accessed
						Remove/Install Diversion	* # of miles of habitat accessed
			200721400	$ 41,832	UPA Project - Fender Mill Floodplain Restoration - Phase 1 Restore natural channel process, reestablish side channel rearing habitat, restore-improve riparian forest habitat, add wood complexes in main stem, install rock structure to keep majority of flow in main stem, breach existing levee, connect side channels.	Create, Restore, and/or Enhance Wetland	* # of acres treated
						Increase Instream Habitat Complexity	* # of stream miles treated
						Plant Vegetation	* # of acres of planted
						Operate and Maintain Habitat/Passage	
			200703400	$ 308,000	Columbia Cascade Pump Screen Correction This project proposes to start a voluntary compliance pump screen correction program in the Methow, Entiat, and Wenatchee River basins in order to reduce juvenile fish losses due to entrapment in water diversions as called for in the most recent FCRPS BiO.	Install Fish Screen	

Table 1-a. Upper Columbia Steelhead 2007-2009 BPA Tributary Habitat Actions

Upper Columbia Steelhead							
MPG	**Populations**	**Tributary Habitat Limiting Factors** (FCRPS BiOp Remand Habitat Workgroup products)	**BPA Project Nbr**	**Average annual planning budget**	**Project Title & Short Description**	**Action Description**	**Reporting Metric**
Eastern Cascades (con't)	Methow River (con't)		200723700	$ 45,120	UPA Project - Elbow Coulee Floodplain Restoration This project would eliminate a dike; open an existing side channel and floodplain; reconnect a wetland; and use large woody debris and boulders to split flows. These would increase habitat complexity and create more dynamic habitats for listed salmonids.	Create, Restore, and/or Enhance Wetland	* # of acres treated
						Enhance Floodplain	* # of acres treated
						Increase Instream Habitat Complexity	* # of structures installed
						Plant Vegetation	* # of acres of planted
						Realign, Connect, and/or Create Channel	* # of stream miles treated, including off-channels, after realignment
						Upland Erosion and Sedimentation Control	* # of acres treated
						Operate and Maintain Habitat/Passage	
			200725100	$ 164,640	UPA Project - Methow Valley Irrigation District East Diversion Dam Replacement This project will remove the present channel-spanning irrigation diversion dam and replace it with a reinforced earth and rock wing dam parallel to the thalweg. This project will also re-open 1/4 mile of side channel habitat blocked by a pushup berm.	Plant Vegetation	* # of acres of planted
						Realign, Connect, and/or Create Channel	* # of stream miles treated, including off-channels, after realignment
						Operate and Maintain Habitat/Passage	
						Remove/Install Diversion	* # of miles of habitat accessed
			200726400	$ 333,333	UPA Project - Programmatic Habitat Complexity Projects in the Methow River Subbasin These projects would eliminate dikes, open side channels, and enhance floodplain connectivity at various sites in the Methow subbasin. Identification and ranking to be based on MIHRP study.	Realign, Connect, and/or Create Channel	* # of stream miles treated, including off-channels, after realignment
			200201301	$ 3,500,000	Water Entity (RPA 151) NWPPC Fund water right transactions that restore streamflows and focused riparian easements on criticial fish-bearing Columbia Basin tributaries. Implemented as the Columbia Basin Water Transactions Program (CBWTP) in a partnership between BPA and NFWF.	Land Purchase	# of HUs protected by land purchase or easement
							* # of acres of new purchase/easement
							* # of riparian miles protected
						Install Flow Measuring Device	* Is the measuring device portable or fixed?
						Acquire Water Instream	
						Develop and Negotiate Water Right Transaction	

Table 1-a. Upper Columbia Steelhead 2007-2009 BPA Tributary Habitat Actions

Upper Columbia Steelhead							
MPG	**Populations**	**Tributary Habitat Limiting Factors** (FCRPS BiOp Remand Habitat Workgroup products)	**BPA Project Nbr**	**Average annual planning budget**	**Project Title & Short Description**	**Action Description**	**Reporting Metric**
Eastern Cascades (con't)	Okanogan River	Floodplain Connectivity and Function- impaired floodplain connectivity and function, impaired side-channel connectivity Channel Structure and Complexity- habitat diversity, in-channel habitat quality Riparian Areas and LWD Recruitment- impaired riparian f	199604200	$ 621,420	Restore and Enhance Anadromous Fish Populations and Habitat in Salmon Creek This project is directed at reconnecting a productive tributary of the Okanogan River, Salmon Creek. This project involves a water lease with the Okanogan Irrigation District and construction of a low flow channel within the lower reach.	Realign, Connect, and/or Create Channel	* # of stream miles treated, including off-channels, after realignment
						Install Well	
						Acquire Water Instream	
						Develop and Negotiate Water Right Transaction	
			200000100	$ 206,999	Anadromous Fish Habitat & Passage The Tribe proposes continuing habitat rehabilitation efforts to decrease sediment loads and improve passage for anadromous steelhead and salmon. In addition, monitoring and evaluation efforts will assess effectiveness of ongoing activities.	Develop Alternative Water Source	
						Install Fence	* # of miles of fence
			200714500	$ 40,763	Okanogan Livestock and Water Provide a cost share program to assist producers in developing offsite water for livestock and provide assistanc fencing riparian areas. Allowing producers to respond to and prevent complaints.	Develop Alternative Water Source	
						Install Fence	* # of miles of fence
						Plant Vegetation	
			200722400	$ 480,453	Implementation of the Okanogan Subbasin Plan. Initiate a Programmatic and Sequenced set of Key Habitat Restoration and Protection Actions The integration of science into management, decision-making and recommended actions is an essential task for resource managers. This phased and programmatic plan is the centerpiece for mitigation, recovery and conservation in the Okanogan R & the Province.	Enhance Floodplain	* # of acres treated
						Plant Vegetation	* # of acres of planted
							* # of riparian miles treated
						Realign, Connect, and/or Create Channel	* # of stream miles treated, including off-channels, after realignment
						Upland Erosion and Sedimentation Control	* # of acres treated
						Acquire Water Instream	* # of acres treated
							* # of miles of total stream reach improvement, including primary and secondary reaches
							* Amount of water secured

Table 1-a. Upper Columbia Steelhead 2007-2009 BPA Tributary Habitat Actions

Upper Columbia Steelhead							
MPG	**Populations**	**Tributary Habitat Limiting Factors** (FCRPS BiOp Remand Habitat Workgroup products)	**BPA Project Nbr**	**Average annual planning budget**	**Project Title & Short Description**	**Action Description**	**Reporting Metric**
Eastern Cascades (con't)	Okanogan River (con't)		200201301	$ 3,500,000	Water Entity (RPA 151) NWPPC Fund water right transactions that restore streamflows and focused riparian easements on criticial fish-bearing Columbia Basin tributaries. Implemented as the Columbia Basin Water Transactions Program (CBWTP) in a partnership between BPA and NFWF.	Land Purchase	# of HUs protected by land purchase or easement
							* # of acres of new purchase/easement
							* # of riparian miles protected
						Install Flow Measuring Device	* Is the measuring device portable or fixed?
						Acquire Water Instream	
						Develop and Negotiate Water Right Transaction	

Table 1-b. Upper Columbia Spring Chinook Salmon 2007 - 2009 BPA Tributary Habitat Actions

Upper Columbia Spring Chinook Salmon							
MPG	**Populations**	**Tributary Habitat Limiting Factors** (FCRPS BiOp Remand Habitat Workgroup products)	**BPA Project Nbr**	**Average annual planning budget**	**Project Title & Short Description**	**Action Description**	**Reporting Metric**
Eastern Cascades	**Wenatchee River**	Floodplain Connectivity and Function- impaired floodplain connectivity and function Channel Structure and Complexity- reduced in-channel habitat quantity Riparian Areas and LWD Recruitment- reduced riparian function Stream Flow- low stream flow Water Quality- high stream temperature Fish Passage- barriers to passage or access	200704200	$ 156,600	UPA Wenatchee Passage Program To replace 9 barrier culverts in Alder Creek, Clear Creek and Beaver Creek with fish-friendly structures to provide 4.0 miles of spawning and rearing habitat for ESA listed Upper Columbia steelhead.	Install Fish Passage Structure	
						Remove/Modify Dam	
			200703400	$ 308,000	Columbia Cascade Pump Screen Correction This project proposes to start a voluntary compliance pump screen correction program in the Methow, Entiat, and Wenatchee River basins in order to reduce juvenile fish losses due to entrapment in water diversions as called for in the most recent FCRPS BiO.	Install Fish Screen	
			200708500	$ 216,667	UPA Nason Creek Oxbow Reconnection Project Project proposes to install two bottomless arch culverts in SR 207 to successfully reconnect 0.64 miles of historic oxbow habitat to the mainchannel Nason Creek. This project will increase Spring Chinook salmonid abundance by 25-50% in the Nason A.U.	Install Fish Passage Structure	* # of miles of habitat accessed
			200708600	$ 100,000	UPA Wenatchee Subbasin Riparian Enhancement Proposal The Wenatchee Riparian proposal will involve planting native vegetation and fencing to establish a properly functioning riparian buffer in the Wenatchee Assessment Units. This project will benefit Upper Columbia steelhead, spring Chinook and bull trout.	Install Fence	
						Plant Vegetation	* # of riparian miles treated
						Maintain Vegetation	
			200728300	$ 766,667	UPA Wenatchee Subbasin Access Proposal Forty three (43) potential fish passage barrier structures are being proposed for funding to benefit Upper Columbia spring Chinook, steelhead and bull trout. Emphasis is on replacing the Mill Creek Culvert near the mouth of Peshastin Creek.	Install Fish Passage Structure	
			200732500	$ 700,000	UPA Wenatchee Subbasin Complexity Proposal Five potential complexity projects are being proposed for funding to benefit Upper Columbia spring Chinook, steelhead and bull trout. Funds are also requested for unidentified potential complexity projects to assist in meeting UPA metric goals.	Realign, Connect, and/or Create Channel	

Table 1-b. Upper Columbia Spring Chinook Salmon 2007 - 2009 BPA Tributary Habitat Actions

Upper Columbia Spring Chinook Salmon							
MPG	**Populations**	**Tributary Habitat Limiting Factors** (FCRPS BiOp Remand Habitat Workgroup products)	**BPA Project Nbr**	**Average annual planning budget**	**Project Title & Short Description**	**Action Description**	**Reporting Metric**
Eastern Cascades (con't)	**Wenatchee River (con't)**		200201301	$ 3,500,000	Water Entity (RPA 151) NWPPC Fund water right transactions that restore streamflows and focused riparian easements on criticial fish-bearing Columbia Basin tributaries. Implemented as the Columbia Basin Water Transactions Program (CBWTP) in a partnership between BPA and NFWF.	Acquire Water Instream	
						Develop and Negotiate Water Right Transaction	
	Entiat River	Floodplain Connectivity and Function- impaired floodplain connectivity and function, impaired side-channel connectivity Channel Structure and Complexity- reduced habitat diversity, in-channel habitat quantity Riparian Areas and LWD Recruitment- impaired riparian condition and function Stream Flow- low stream flow	200705500	$ 20,000	Entiat River - UPA - Lower Entiat River Off-Channel Restoration Project The Lower Entiat River Off-Channel enhancement project will provide 0.28 miles of off-channel habitat to benefit Upper Columbia ESA listed steelhead, spring Chinook, and bull trout. An irrigation channel will be enhanced for rearing and spawning habitat.	Develop Pond	
						Increase Instream Habitat Complexity	* # of stream miles treated * # of structures installed
						Plant Vegetation	
						Install Fish Passage Structure	* # of miles of habitat accessed
			200703400	$ 308,000	Columbia Cascade Pump Screen Correction This project proposes to start a voluntary compliance pump screen correction program in the Methow, Entiat, and Wenatchee River basins in order to reduce juvenile fish losses due to entrapment in water diversions as called for in the most recent FCRPS BiO.	Install Fish Screen	
			200723100	$ 83,333	UPA Entiat Subbasin Riparian Enhancement Program Riparian projects are being proposed in the Entiat subbasin to benefit Upper Columbia spring Chinook, steelhead and bull trout. Funding is requested for Tillicum Creek Fence and programmatic riparian projects.	Install Fence	
						Plant Vegetation	
						Maintain Vegetation	
			200731800	$ 125,000	Entiat River - UPA - Knapp-Wham Hanan Detwiler Irrigation System Consolidation Project Consolidation of the Knapp-Wham and Hanan Detwiler irrigation systems will eliminate partial fish passage barriers associated with 2 surface water diversions, add instream habitat within the lower Entiat River, and enhance instream flows via water saved.	Develop Alternative Water Source	
						Increase Instream Habitat Complexity	* # of stream miles treated * # of structures installed
						Remove/Install Diversion	* # of miles of habitat accessed
						Install Well	* Amount of unprotected water flow returned to the stream by conservation in cfs * Estimated # of miles of primary stream reach improvement

Table 1-b. Upper Columbia Spring Chinook Salmon 2007 - 2009 BPA Tributary Habitat Actions

Upper Columbia Spring Chinook Salmon							
MPG	**Populations**	**Tributary Habitat Limiting Factors** (FCRPS BiOp Remand Habitat Workgroup products)	**BPA Project Nbr**	**Average annual planning budget**	**Project Title & Short Description**	**Action Description**	**Reporting Metric**
Eastern Cascades (con't)	**Entiat River (con't)**		200201301	$ 3,500,000	Water Entity (RPA 151) NWPPC Fund water right transactions that restore streamflows and focused riparian easements on criticial fish-bearing Columbia Basin tributaries. Implemented as the Columbia Basin Water Transactions Program (CBWTP) in a partnership between BPA and NFWF.	Acquire Water Instream	
						Develop and Negotiate Water Right Transaction	
	Methow River	Floodplain Connectivity and Function- impaired floodplain connectivity and function Channel Structure and Complexity- reduced habitat diversity, in-channel habitat quantity, side-channel connectivity Riparian Areas and LWD Recruitment- reduced riparian condition Stream Flow- low stream flow Water Quality- high water temperature Stream Substrate- excess fine sediment (ChewuchR., Beaver Ck) Fish Passage- obstructions to passage and access	200703500	$ 202,880	UPA Project - Methow Basin Riparian Enhancement MSRF proposes to partner with Bureau of Reclamation and Methow Conservancy to identify and prioritize riparian enhancement projects that will add value to passage, access and conservation projects. All projects will focus on TES species and habitat.	Install Fence	* # of miles of fence
						Plant Vegetation	* # of riparian miles treated
			200703400	$ 308,000	Columbia Cascade Pump Screen Correction This project proposes to start a voluntary compliance pump screen correction program in the Methow, Entiat, and Wenatchee River basins in order to reduce juvenile fish losses due to entrapment in water diversions as called for in the most recent FCRPS BiO.	Install Fish Screen	
			200717200	$ 90,193	UPA Project - MVID West Canal Diversion and Headworks Move POD 175' upstream by installing new concrete diversion headworks, realign 150' of West Canal intake and build new access road to connect new headworks, construct permanent channel-spanning natural rock roughened channel permanent diversion.	Plant Vegetation	
						Operate and Maintain Habitat/Passage	
						Install Fish Passage Structure	* # of miles of habitat accessed
						Remove/Install Diversion	* # of miles of habitat accessed
			200721400	$ 41,832	UPA Project - Fender Mill Floodplain Restoration - Phase 1 Restore natural channel process, reestablish side channel rearing habitat, restore-improve riparian forest habitat, add wood complexes in main stem, install rock structure to keep majority of flow in main stem, breach existing levee, connect side channels.	Create, Restore, and/or Enhance Wetland	* # of acres treated
						Increase Instream Habitat Complexity	* # of stream miles treated
						Plant Vegetation	* # of acres of planted
						Realign, Connect, and/or Create Channel	* # of stream miles before treatment
						Operate and Maintain Habitat/Passage	

Table 1-b. Upper Columbia Spring Chinook Salmon 2007 - 2009 BPA Tributary Habitat Actions

Upper Columbia Spring Chinook Salmon							
MPG	**Populations**	**Tributary Habitat Limiting Factors** (FCRPS BiOp Remand Habitat Workgroup products)	**BPA Project Nbr**	**Average annual planning budget**	**Project Title & Short Description**	**Action Description**	**Reporting Metric**
Eastern Cascades (con't)	**Methow River (con't)**		200723700	$ 45,120	UPA Project - Elbow Coulee Floodplain Restoration This project would eliminate a dike; open an existing side channel and floodplain; reconnect a wetland; and use large woody debris and boulders to split flows. These would increase habitat complexity and create more dynamic habitats for listed salmonids.	Create, Restore, and/or Enhance Wetland	* # of acres treated
						Enhance Floodplain	* # of acres treated
						Increase Instream Habitat Complexity	* # of structures installed
						Plant Vegetation	* # of acres of planted
						Realign, Connect, and/or Create Channel	* # of stream miles before treatment
						Realign, Connect, and/or Create Channel	* # of stream miles treated, including off-channels, after realignment
						Upland Erosion and Sedimentation Control	* # of acres treated
						Operate and Maintain Habitat/Passage	
			200725100	$ 164,640	UPA Project - Methow Valley Irrigation District East Diversion Dam Replacement This project will remove the present channel-spanning irrigation diversion dam and replace it with a reinforced earth and rock wing dam parallel to the thalweg. This project will also re-open 1/4 mile of side channel habitat blocked by a pushup berm.	Plant Vegetation	* # of acres of planted
						Realign, Connect, and/or Create Channel	* # of stream miles treated, including off-channels, after realignment
						Operate and Maintain Habitat/Passage	
						Remove/Install Diversion	* # of miles of habitat accessed
			200726400	$ 333,333	UPA Project - Programmatic Habitat Complexity Projects in the Methow River Subbasin This project will remove the present channel-spanning irrigation diversion dam and replace it with a reinforced earth and rock wing dam parallel to the thalweg. This project will also re-open 1/4 mile of side channel habitat blocked by a pushup berm.	Realign, Connect, and/or Create Channel	* # of stream miles treated, including off-channels, after realignment
			200201301	$ 3,500,000	Water Entity (RPA 151) NWPPC Fund water right transactions that restore streamflows and focused riparian easements on criticial fish-bearing Columbia Basin tributaries. Implemented as the Columbia Basin Water Transactions Program (CBWTP) in a partnership between BPA and NFWF.	Acquire Water Instream	
						Develop and Negotiate Water Right Transaction	

Table 1-b. Upper Columbia Spring Chinook Salmon 2007 - 2009 BPA Tributary Habitat Actions

Upper Columbia Spring Chinook Salmon							
MPG	**Populations**	**Tributary Habitat Limiting Factors** (FCRPS BiOp Remand Habitat Workgroup products)	**BPA Project Nbr**	**Average annual planning budget**	**Project Title & Short Description**	**Action Description**	**Reporting Metric**
Eastern Cascades (con't)	**Okanogan River (extirpated)**	Floodplain Connectivity and Function- impaired floodplain connectivity and function Channel Structure and Complexity- reduced habitat diversity, in-channel habitat quantity, side-channel connectivity Riparian Areas and LWD Recruitment- reduced riparian condition Stream Flow- low stream flow Water Quality- high water temperature Stream Substrate- excess fine sediment (ChewuchR., Beaver Ck) Fish Passage- obstructions to passage and access	199604200	$ 621,420	Restore and Enhance Anadromous Fish Populations and Habitat in Salmon Creek This project is directed at reconnecting a productive tributary of the Okanogan River, Salmon Creek. This project involves a water lease with the Okanogan Irrigation District and construction of a low flow channel within the lower reach.	Realign, Connect, and/or Create Channel	* # of stream miles treated, including off-channels, after realignment
						Install Well	
						Acquire Water Instream	
						Develop and Negotiate Water Right Transaction	
			200000100	$ 206,999	Anadromous Fish Habitat & Passage The Tribe proposes continuing habitat rehabilitation efforts to decrease sediment loads and improve passage for anadromous steelhead and salmon. In addition, monitoring and evaluation efforts will assess effectiveness of ongoing activities.	Develop Alternative Water Source	
						Install Fence	* # of miles of fence
			200714500	$ 40,763	Okanogan Livestock and Water Provide a cost share program to assist producers in developing offsite water for livestock and provide assistanc fencing riparian areas. Allowing producers to respond to and prevent complaints.	Develop Alternative Water Source	
						Install Fence	* # of miles of fence
						Plant Vegetation	
			200722400	$ 480,453	Implementation of the Okanogan Subbasin Plan. Initiate a Programmatic and Sequenced set of Key Habitat Restoration and Protection Actions The integration of science into management, decision-making and recommended actions is an essential task for resource managers. This phased and programmatic plan is the centerpiece for mitigation, recovery and conservation in the Okanogan R & the Province.	Enhance Floodplain	* # of acres treated
						Plant Vegetation	* # of acres of planted
						Realign, Connect, and/or Create Channel	* # of riparian miles treated
							* # of stream miles treated, including off-channels, after realignment
						Upland Erosion and Sedimentation Control	* # of acres treated
						Acquire Water Instream	* # of acres treated
							* # of miles of total stream reach improvement, including primary and secondary reaches
							* Amount of water secured
			200201301	$ 3,500,000	Water Entity (RPA 151) NWPPC Fund water right transactions that restore streamflows and focused riparian easements on criticial fish-bearing Columbia Basin tributaries. Implemented as the Columbia Basin Water Transactions Program (CBWTP) in a partnership between BPA and NFWF.	Acquire Water Instream	
						Develop and Negotiate Water Right Transaction	

Table 2. Mid-Columbia Steelhead 2007-2009 BPA Tributary Habitat Actions

Mid Columbia Steelhead							
MPG	**Populations**	**Tributary Habitat Limiting Factors** (FCRPS BiOp Remand Habitat Workgroup products)	**BPA Project Nbr**	**Average annual planning budget**	**Project Title**	**Action Description**	**Reporting Metric**
Eastern Cascades	Klickitat River (above BON)	Floodplain Connectivity and Function- disconnected floodplain Stream Flow- altered high and low flows, low summer stream flow, flow effects of groundwater use Fish Passage- improperly screened diversions, road culvert passage obstructions, passage at mouth of tributaries (passage barrier at Bowman Creek) Channel Structure and Complexity- limited key in-channel habitat quantity, stability and diversity, loss of key habitat, unstable channel, loss of habitat diversity Riparian Areas and LWD Recruitment- reduced LWD Stream Substrate- Excess fine sediment load from roads, tilled land, bank erosion, cropping & livestock Water Quality- high water temp (lack of shade), availability of food/nutrients, low dissolved oxygen, pathogens Other - Harassment/poaching, competition with hatchery fish, predation - lack of cover	199705600 2007 Interim Ops Agreement	$ 261,000 (FY07)	Klickitat Watershed Enhancement This project (KWEP) restores, enhances, and protects watershed health to aid recovery of native salmonid stocks in the Klickitat subbasin. Implemented by the Yakama Nation Fisheries Program and funded by BPA, KWEP addresses FWP goals and objectives.	Create, Restore, and/or Enhance Wetland	
						Decommission Road	
						Develop Alternative Water Source	
						Enhance Floodplain	
						Enhance Nutrients Instream	
						Improve/Relocate Road	
						Increase Instream Habitat Complexity	
						Install Fence	
						Plant Vegetation	
						Realign, Connect, and/or Create Channel	
						Remove vegetation	
						Upland Erosion and Sedimentation Control	
						Maintain Vegetation	
						Operate and Maintain Habitat/Passage	
						Remove Debris	
						Install Fish Passage Structure	
						Install Flow Measuring Device	
			198812035	$ 461,666	YKFP Klickitat Management, Data, and Habitat Proposal provides for all YN management functions associated with the Yakima/Klickitat Fisheries Project including project planning, O&M, research, data management, and habitat improvement and acquisition actions in the Klickitat Subbasin.	Habitat improvement	
						Lease Land	
			200102100	$ 86,168	15 Mile Creek Riparian Buffers This proposal develops riparian buffer systems on streams in the Fifteenmile Subbasin and other direct tributaries to the Columbia River in northern Wasco County. Implementation of buffer plans developed under this proposal are fully funded by USDA.	Riparian Enhancement	# acres affected
							# riparian miles enhanced

Table 2. Mid-Columbia Steelhead 2007-2009 BPA Tributary Habitat Actions

Mid Columbia Steelhead							
MPG	**Populations**	**Tributary Habitat Limiting Factors** (FCRPS BiOp Remand Habitat Workgroup products)	**BPA Project Nbr**	**Average annual planning budget**	**Project Title**	**Action Description**	**Reporting Metric**
Eastern Cascades (con't)	Fifteen Mile Creek (above TDA)	Stream Flow- low flows Channel Structure and Complextiy- habitat quality, diversity	199304000	$ 323,685	Fifteenmile Creek Habitat Restoration and Monitoring Project Provide continued operation and maintenance on previously installed fencing and instream habitat, monitor the success of all restoration efforts, and begin implementation to improve instream habitat complexity within the Fifteenmile Creek Subbasin.	Develop Alternative Water Source	
						Increase Instream Habitat Complexity	
						Install Fence	* # of miles of fence
						Maintain Vegetation	
						Operate and Maintain Habitat/Passage	
			200201301	$ 3,500,000	Water Entity (RPA 151) NWPPC Fund water right transactions that restore streamflows and focused riparian easements on criticial fish-bearing Columbia Basin tributaries. Implemented as the Columbia Basin Water Transactions Program (CBWTP) in a partnership between BPA and NFWF.	Acquire Water Instream	
						Develop and Negotiate Water Right Transaction	
	Westside Deschutes (above TDA)	Fish Passage- physical barriers Stream Flow- hydrologic barriers Floodplain Connectivity and Function- floodplain condition Channel Structure and Complexity- habitat diversity Water Quality- water chemistry, toxics/pollutants	No actions proposed for this population				
	Eastside Deschutes (above TDA)	Stream Flow- low flows Channel Structure and Complexity- habitat quality, quantity and diversity Water Quality- water chemistry	199404200	$ 383,662	Trout Creek Fish Habitat Restoration Project Construction, O&M, and M&E of numerous new and existing instream and riparian habitat restoration projects; Monitoring and Evaluation of summer steelhead smolt production and adult return. M&E of instream and riparian habitat restoration	Develop Alternative Water Source	
						Enhance Floodplain	* # of acres treated
						Realign, Connect, and/or Create Channel	* # of stream miles treated, including off-channels, after realignment
						Maintain Vegetation	
			199802800	$ 165,000	Trout Creek Watershed Restoration Project Implementation of numerous riparian and upland habitat improvement projects on private lands in the Trout Creek watershed, Deshutes basin. Monitoring and evaluation of current and past projects.	Enhance Floodplain	* # of acres treated
						Plant Vegetation	* # of acres of planted * # of riparian miles treated
						Realign, Connect, and/or Create Channel	* # of stream miles treated, including off-channels, after realignment
						Remove/Install Diversion	* # of miles of habitat accessed

Table 2. Mid-Columbia Steelhead 2007-2009 BPA Tributary Habitat Actions

Mid Columbia Steelhead							
MPG	**Populations**	**Tributary Habitat Limiting Factors** (FCRPS BiOp Remand Habitat Workgroup products)	**BPA Project Nbr**	**Average annual planning budget**	**Project Title**	**Action Description**	**Reporting Metric**
Eastern Cascades (con't)	Eastside Deschutes (above TDA) (con't)		199802800 (con't)			Install Pipeline	* Amount of unprotected water flow returned to the stream by conservation in acre-feet
			200201900	$ 70,160	Wasco Riparian Buffers This proposal develops riparian buffer systems in southern Wasco County in the lower Deschutes and lower John Day subbasins of the Columbia Plateau Province. Implementation of buffer plans developed under this proposal is fully funded by USDA.	Riparian Enhancement	# acres affected
							# riparian miles enhanced
	Crooked River (Historic population)		No projects for this population				
	Rock Creek (above JDA)	Riparian Areas and Condition- riparian condition, lack of LWD Stream Flow- excessive high flows, low flows Floodplain Connectivity and Function- floodplain connectivity, loss of side channel habitat Channel Structure and Complexity- degraded habitat quality/diversity Stream Substrate- excessive sediment load Water Quality- high water temperature	No projects for this population				
John Day River (All of the projects listed for the John Day River MPG are located in the NPCC John Day subbasin and benefit at least 1 of the populations in this MPG	Lower Main Stem Tributaries John Day (above JDA)	Riparian Areas and LWD Recruitment-riparian conditions Water Quality- high water temperatures Stream Flow- low flows Fish Passage- migration barriers	198402100	$ 518,000	Mainstem, Middle Fork, John Day Rivers Fish Habitat Enhancement Project This project was initiated on July 1, 1984, (BPA) contract number DE A179-84 BP17460 and allows for initial landowner contacts, agreement development, project design, budgeting, and implementation for anadromous fish habitat on private lands.	Develop Alternative Water Source	
	North Fork John Day (above JDA)	Riparian Areas and LWD Recruitment- riparian conditions Water Quality- high water temperatures, water chemistry Channel Structure and Complexity- habitat diversity Stream Flow- low flows				Increase Instream Habitat Complexity	* # of stream miles treated
	Mid Fork John Day (above JDA)	Water Quality- high water temperature, water chemistry				Install Fence	* # of miles of fence
	South Fork John Day (above JDA)	Floodplain Connectivity and Function- floodplain connectivity				Plant Vegetation	* # of acres of planted
	Upper Main Stem John Day (above JDA)	Riparian Areas and LWD Recruitment- riparian conditions Stream Substrate- sedimentation Water Quality- high water temperatures Stream Flow- low flow				Remove vegetation	* # of acres treated
						Operate and Maintain Habitat/Passage	
			199306600	$ 1,042,700	Oregon Fish Screens Project The project provides immediate and long-term protection for anadromous and resident fish species in the John Day, Umatilla, and Walla Walla basins by the installation or replacement of out dated fish protection and passage devices on irrigation diversions.	Operate and Maintain Habitat/Passage	
						Install Fish Passage Structure	* # of miles of habitat accessed

Table 2. Mid-Columbia Steelhead 2007-2009 BPA Tributary Habitat Actions

Mid Columbia Steelhead							
MPG	**Populations**	**Tributary Habitat Limiting Factors** (FCRPS BiOp Remand Habitat Workgroup products)	**BPA Project Nbr**	**Average annual planning budget**	**Project Title**	**Action Description**	**Reporting Metric**
John Day River (con't) All of the projects listed for the John Day River MPG are located in the NPCC John Day subbasin and benefit at least 1 of the populations in this MPG			199306600 (con't)			Install Fish Screen	* Flow rate at the screen diversion allowed by the water right
						Install Fish Screen	* Quantity of water protected by screening, as determined by what is stated in the water right or calculated based on flow rate
						Remove/Install Diversion	* # of miles of habitat accessed
			199801800	$ 1,728,011	John Day Watershed Restoration Continue implementation of protection and restoration actions, planned under the John Day Subbasin Plan, to improve water quality, water quantity, and riparian habitat, and to eliminate passage barriers for anadromous and resident fish.	Develop Alternative Water Source	
						Increase Instream Habitat Complexity	* # of stream miles treated
						Plant Vegetation	* # of riparian miles treated
						Remove vegetation	* # of acres treated
						Maintain Vegetation	
						Install Fish Passage Structure	* # of miles of habitat accessed
						Remove/Install Diversion	* # of miles of habitat accessed
						Install Pipeline	* Amount of unprotected water flow returned to the stream by conservation in cfs
			199901000	$ 18,887	Pine Hollow/Jackknife Habitat Implement practices to reduce erosion, flooding, and protect critical areas in the stream corridor which will allow natural recovery of riparian vegetation and channel stability in the Pine Hollow and Jackknife watersheds.	Develop Alternative Water Source	
						Install Fence	
						Plant Vegetation	* # of acres of planted
						Remove vegetation	* # of acres treated
						Upland Erosion and Sedimentation Control	

Table 2. Mid-Columbia Steelhead 2007-2009 BPA Tributary Habitat Actions

Mid Columbia Steelhead							
MPG	**Populations**	**Tributary Habitat Limiting Factors** (FCRPS BiOp Remand Habitat Workgroup products)	**BPA Project Nbr**	**Average annual planning budget**	**Project Title**	**Action Description**	**Reporting Metric**
John Day River (con't) All of the projects listed for the John Day River MPG are located in the NPCC John Day subbasin and benefit at least 1 of the populations in this MPG			200001500	$ 200,070	Oxbow Conservation Area Management The 1,022-acre Oxbow Conservation Area project is a mitigation property acquired by the CTWSRO through BPA funding. This proposal aims to continue the O&M, M&E, and habitat improvement projects on this valuable anadromous fish property.	Conduct Controlled Burn	
						Increase Instream Habitat Complexity	* # of stream miles treated
							* # of structures installed
						Install Fence	* # of miles of fence
						Plant Vegetation	* # of riparian miles treated
						Realign, Connect, and/or Create Channel	* # of stream miles treated, including off-channels, after realignment
						Remove vegetation	* # of acres treated
						Maintain Vegetation	
						Operate and Maintain Habitat/Passage	
						Install Fish Passage Structure	* # of miles of habitat accessed
						Install Fish Screen	* Flow rate at the screen diversion allowed by the water right
							* Quantity of water protected by screening, as determined by what is stated in the water right or calculated based on flow rate
						Develop and Negotiate Water Right Transaction	
			200003100	$ 216,333	North Fork John Day Basin Anadromous Fish Habitat Enhancement Project Increase habitat for Chinook salmon and steelhead on private and public-owned lands via implementing fencing, off-stream water development, revegetation, culvert replacement, pool development, mine tailing removal and large wood placement projects.	Enhance Floodplain	* # of acres treated
						Increase Instream Habitat Complexity	* # of stream miles treated
						Install Fence	* # of miles of fence
						Plant Vegetation	* # of acres of planted
							* # of riparian miles treated
						Remove Mine Tailings	* # of acres treated
						Maintain Vegetation	
						Install Fish Passage Structure	* # of miles of habitat accessed
						Lease Land	* # of riparian miles protected

Table 2. Mid-Columbia Steelhead 2007-2009 BPA Tributary Habitat Actions

Mid Columbia Steelhead							
MPG	**Populations**	**Tributary Habitat Limiting Factors** (FCRPS BiOp Remand Habitat Workgroup products)	**BPA Project Nbr**	**Average annual planning budget**	**Project Title**	**Action Description**	**Reporting Metric**
John Day River (con't) All of the projects listed for the John Day River MPG are located in the NPCC John Day subbasin and benefit at least 1 of the populations in this MPG			200104101	$ 206,635	Forrest Conservation Area Management The Forrest Conservation Area consists of 4,232 acres and contains 8.5 miles of critical fish habitat in the Upper Mainstem and Middle Fork John Day River systems. Management prioritizes protection of fish, wildlife and their associated habitats.	Conduct Controlled Burn	
						Increase Instream Habitat Complexity	* # of stream miles treated * # of structures installed
						Plant Vegetation	* # of riparian miles treated
						Remove vegetation	* # of acres treated
						Investigate Trespass	
						Maintain Vegetation	
						Operate and Maintain Habitat/Passage	
						Install Fish Passage Structure	* # of miles of habitat accessed
						Install Fish Screen	* Flow rate at the screen diversion allowed by the water right
						Develop and Negotiate Water Right Transaction	
			200201301	$ 3,500,000	Water Entity (RPA 151) NWPPC Fund water right transactions that restore streamflows and focused riparian easements on criticial fish-bearing Columbia Basin tributaries. Implemented as the Columbia Basin Water Transactions Program (CBWTP) in a partnership between BPA and NFWF.	Acquire Water Instream	
						Develop and Negotiate Water Right Transaction	
			200201900	$ 70,160	Wasco Riparian Buffers This proposal develops riparian buffer systems in southern Wasco County in the lower Deschutes and lower John Day subbasins of the Columbia Plateau Province. Implementation of buffer plans developed under this proposal is fully funded by USDA.	Riparian Enhancement	# acres affected # riparian miles enhanced

Table 2. Mid-Columbia Steelhead 2007-2009 BPA Tributary Habitat Actions

Mid Columbia Steelhead							
MPG	**Populations**	**Tributary Habitat Limiting Factors** (FCRPS BiOp Remand Habitat Workgroup products)	**BPA Project Nbr**	**Average annual planning budget**	**Project Title**	**Action Description**	**Reporting Metric**
John Day River (con't) All of the projects listed for the John Day River MPG are located in the NPCC John Day subbasin and benefit at least 1 of the populations in this MPG			200201500	$ 68,337	Provide Coordination and Technical Assistance to Watershed Councils and Individuals in Sherman County, Oregon.	Riparian Enhancement	# acres affected # riparian miles enhanced
			200203400	$ 74,305	Wheeler Co Riparian Buffers This proposal will provide technical support and planning needed to implement riparian buffer contracts (CREP) on streams within Wheeler County. Ripairan buffers address many of the limiting factors identified in the John Day Sub-basin Plan.	Riparian Enhancement	# acres affected # riparian miles enhanced
			200203500	$ 68,498	Gilliam Co Riparian Buffers We seek BPA funding to continue our riparian buffer position. This job entails making 10-15 year contracts with private landowners to establish riparian areas. Non-BPA monies are then leveraged to develop, maintain and enhance fish and wildlife resources.	Riparian Enhancement	# acres affected # riparian miles enhanced
Walla Walla and Umatilla Rivers	Umatilla River (above JDA)	Riparian Areas and LWD Recruitment- reduced LWD Stream Substrate- excessive sediment load, reduced channel bed load stability Stream Flow- low flows; Water Quality- high water temperature Fish Passage- physical barriers, irrigation diversions, loss to unscreened diversions Channel Structure and Complexity- reduced habitat quality-diversity, pools, riffles	198343600	$ 467,785	Umatilla Passage O&M Westland Irrigation District, as contractor to Bonneville Power Administration, and West Extension Irrigation District, as subcontractor to Westland, provide labor, equipment, and material necessary for the operation, care, and maintenance of fish facilities.	Operate and Maintain Habitat/Passage	

Table 2. Mid-Columbia Steelhead 2007-2009 BPA Tributary Habitat Actions

Mid Columbia Steelhead							
MPG	**Populations**	**Tributary Habitat Limiting Factors** (FCRPS BiOp Remand Habitat Workgroup products)	**BPA Project Nbr**	**Average annual planning budget**	**Project Title**	**Action Description**	**Reporting Metric**
Walla Walla and Umatilla Rivers (con't)	Umatilla River (above JDA) con't		198710001	$ 326,000	Umatilla Anadromous Fish Habitat - CTUIR Instream and riparian habitat restoration for fisheries and wildlife in the Umatilla River Basin.	Develop Alternative Water Source	
						Increase Instream Habitat Complexity	* # of structures installed
						Install Fence	* # of miles of fence
						Plant Vegetation	* # of acres of planted
						Remove vegetation	* # of acres treated
						Maintain Vegetation	
						Operate and Maintain Habitat/Passage	
						Remove/Modify Dam	* # of miles of habitat accessed
						Lease Land	* # of acres of new lease
							* # of riparian miles protected
			198710002	$ 280,264	Umatilla Subbasin Fish Habitat Improvement Project The ongoing Umatilla Subbasin Fish Habitat Improvement Project (19871-100-02) is aimed at protecting (where possible) and enhancing/rehabilitating (where required), degraded fish habitat on private lands using passive and active restoration techniques.	Develop Alternative Water Source	
						Improve/Relocate Road	* # of road miles improved, upgraded, or restored
						Increase Instream Habitat Complexity	* # of stream miles treated
						Install Fence	* # of miles of fence
						Plant Vegetation	* # of riparian miles treated
						Realign, Connect, and/or Create Channel	* # of stream miles treated, including off-channels, after realignment
						Remove vegetation	* # of acres treated
						Maintain Vegetation	
						Operate and Maintain Habitat/Passage	
						Remove/Modify Dam	* # of miles of habitat accessed
						Lease Land	* # of acres of new lease
						Develop and Negotiate Water Right Transaction	

Table 2. Mid-Columbia Steelhead 2007-2009 BPA Tributary Habitat Actions

Mid Columbia Steelhead							
MPG	**Populations**	**Tributary Habitat Limiting Factors** (FCRPS BiOp Remand Habitat Workgroup products)	**BPA Project Nbr**	**Average annual planning budget**	**Project Title**	**Action Description**	**Reporting Metric**
Walla Walla and Umatilla Rivers (con't)	Umatilla River (above JDA) con't		198802200	$ 362,164	Umatilla Fish Passage Operations Increase survival of migrating juvenile and adult salmon and steelhead in the Umatilla Basin by operating passage facilities, flow enhancement measures, trapping facilities, and transport equipment to provide adequate passage conditions.	Operate and Maintain Habitat/Passage	
						Trap and Haul	
			198902700	$ 1,150,000	Power Repay Umatilla Basin Project Provide reimbursement of power costs to Umatilla Electric Cooopeative and Pacific Powr & Light Company for the Umatilla Basin Project pumping plants that provide Columbia River water to irrigators in exchange for Umatilla River water left instream.	Acquire Water Instream	
	Walla Walla River (above MCN)	Riparian Areas and LWD Recruitment- riparian degradation, reduced LWD Stream Substrate- sediment load, channel stability; Stream Flow- low flows Water Quality- high water temperature, turbidity Fish Passage- barriers and screens Floodplain Connectivity and Function- floodplain confinement Channel Structure and Complexity- in-stream habitat quality-quantity-diversity, pools, riffles, channelization	199601100	$ 878,667	Walla Walla Juvenile and Adult Passage Improvements Provide safe passage for migrating juvenile and adult salmonids in the Walla Walla Subbasin by constructing and maintaining passage facilities at irrigation diversion dams and canals and other passage barriers.	Install Fish Screen	* Flow rate at the screen diversion allowed by the water right
							* Quantity of water protected by screening, as determined by what is stated in the water right or calculated based on flow rate
			199604601	$ 337,710	Walla Walla River Basin Fish Habitat Enhancement The proposed project is a continued effort by the CTUIR to protect and restore habitat critical to the recovery of salmonid fish populations in the Walla Walla River Basin.	Increase Instream Habitat Complexity	
						Plant Vegetation	
						Maintain Vegetation	
			200003300	$ 89,000	Walla Walla River Fish Passage Operations Increase survival of migrating salmonids in the Walla Walla Basin by coordinating the overall passage program including monitoring passage conditions and operation of passage facilities and transport equipment to provide adequate passage conditions.	Operate and Maintain Habitat/Passage	
						Trap and Haul	
			200203600	$ 447,000	Restore Walla Walla River Flow Irrigation efficiency and shallow aquifer recharge will improve Walla Walla River flows on flow -impaired priority restoration reaches at times of the year that are critical for steelhead, spring Chinook, and bull trout passage and habitat use.	Install Pipeline	* Amount of unprotected water flow returned to the stream by conservation in cfs

Table 2. Mid-Columbia Steelhead 2007-2009 BPA Tributary Habitat Actions

Mid Columbia Steelhead							
MPG	**Populations**	**Tributary Habitat Limiting Factors** (FCRPS BiOp Remand Habitat Workgroup products)	**BPA Project Nbr**	**Average annual planning budget**	**Project Title**	**Action Description**	**Reporting Metric**
Walla Walla and Umatilla Rivers (con't)	Walla Walla River (above MCN) con't		200203600 con't			Install Sprinkler	* Amount of unprotected water flow returned to the stream by conservation in cfs
						Develop and Negotiate Water Right Transaction	
			200721700	$ 182,725	Operation and Maintenance for Walla Walla Basin Passage Projects Operation and maintenance of BPA-Constructed fish passage facilities in the Walla Walla Sub-basin.	Operate and Maintain Habitat/Passage	
			200201301	$ 3,500,000	Water Entity (RPA 151) NWPPC Fund water right transactions that restore streamflows and focused riparian easements on criticial fish-bearing Columbia Basin tributaries. Implemented as the Columbia Basin Water Transactions Program (CBWTP) in a partnership between BPA and NFWF.	Acquire Water Instream	
						Develop and Negotiate Water Right Transaction	
	Touchet River (above MCN)	Riparian Areas and LWD Recruitment- riparian condition, riparian degradation, reduce LWD Stream Substrate- excessive sediment load, reduced channel bedload stability Stream Flow- low flows Water Quality- high water temperatures, elevated turbidity Fish Passage- barriers and screens Floodplain Connectivity and Function- floodplain confinement, floodplain condition Channel Structure and Complexity- habitat quality, diversity, reduced pool abundance	Projects in the NPCC Walla Walla subbasin may implement actions that benefit the Touchet River population				
Yakima River Group	Satus Creek (above MCN)	Floodplain Connectivity and Function- degraded/disconnected floodplain, loss of side channels and side channel thermal refugia Stream Flow- higher/lower flow from loss of natural storage Stream Substrate- elevated sediment loads from return flows Water Quality- high water temperature Fish Passage- entrainment in diversion structures, passage obstructions due to false	199206200 2007 Interim Ops Agreement	$ 725,000 (FY07)	Yakama Nation - Riparian/Wetlands Restoration Continue implementation on YN Wetlands/Riparian Restoration Project by protecting and restoring native floodplain habitats along anadromous fish-bearing waterways in the agricultural area of the Yakama Reservation (~2,000 acres per year).	Plant Vegetation	* # of acres of planted
	Toppenish Creek (above MCN)					Maintain Vegetation	
	Naches River (above MCN)					Operate and Maintain Habitat/Passage	
	Upper Mainstem Yakima (above MCN)					Remove Debris	
						Lease Land	* # of acres of new lease

Table 2. Mid-Columbia Steelhead 2007-2009 BPA Tributary Habitat Actions

Mid Columbia Steelhead							
MPG	**Populations**	**Tributary Habitat Limiting Factors** (FCRPS BiOp Remand Habitat Workgroup products)	**BPA Project Nbr**	**Average annual planning budget**	**Project Title**	**Action Description**	**Reporting Metric**
Yakima River Group (con't) All of the projects listed for the Yakima River Group MPG are located in the NPCC Yakima subbasin and benefit at least 1 of the populations in this MPG			199603501 2007 Interim Ops Agreement	$ 420,000 (FY07)	Yakama Reservation Watersheds Project The YRWP works to restore natural function to the Satus, Toppenish and Ahtanum Watersheds. Our restoration and monitoring efforts take a comprehensive approach to the restoration of habitat for fisheries resources including steelhead and bull trout.	Enhance Floodplain	* # of acres treated
						Increase Instream Habitat Complexity	* # of stream miles treated * # of structures installed
						Install Fence	* # of miles of fence
						Plant Vegetation	* # of acres of planted * # of riparian miles treated
						Realign, Connect, and/or Create Channel	* # of stream miles treated, including off-channels, after realignment
						Lease Land	* # of acres of renewed lease
			198812025	$ 151,333	YKFP Management, Data, Habitat Proposal provides for all YN management functions associated with the Yakima/Klickitat Fisheries Project including project planning, O&M, research, data management, and habitat improvement and acquisition actions in the Yakima Subbasin.	Increase Instream Habitat Complexity	
						Plant Vegetation	
			199200900	$ 161,500	Yakima Phase II/Huntsville Screen Operation & Maintenance Continue to provide operation and maintenance to BPA's Phase II Fish Screen Facilities to ensure they provide maximum protection to all species and life stages of fish. This O&M function will include the addition of the Manastash basin facilities.	Operate and Maintain Habitat/Passage	
			199503300	$ 91,200	O&M Yakima Basin Fish Screens This proposal provides for continuation of funding for the existing comprehensive operation & maintenance program by the USBR of BPA owned Yakima Phase II fish screening and trapping facilities.	Operate and Maintain Habitat/Passage	

Table 2. Mid-Columbia Steelhead 2007-2009 BPA Tributary Habitat Actions

Mid Columbia Steelhead							
MPG	**Populations**	**Tributary Habitat Limiting Factors** (FCRPS BiOp Remand Habitat Workgroup products)	**BPA Project Nbr**	**Average annual planning budget**	**Project Title**	**Action Description**	**Reporting Metric**
Yakima River Group (con't) All of the projects listed for the Yakima River Group MPG are located in the NPCC Yakima subbasin and benefit at least 1 of the populations in this MPG			200202501	$ 879,987	Yakima Tributary Access & Habitat Program The Yakima Tributary Access and Habitat Program intends to: a) screen diversion structures; b) provide for fish passage at man-made barriers; c) assist landowners improve stream habitat; and d) coordinate the acquisition of riparian buffer easements.	Create, Restore, and/or Enhance Wetland	* # of acres treated
						Develop Alternative Water Source	
						Enhance Floodplain	* # of acres treated
						Increase Instream Habitat Complexity	* # of stream miles treated
						Install Fence	* # of miles of fence
						Plant Vegetation	* # of riparian miles treated
						Realign, Connect, and/or Create Channel	* # of stream miles treated, including off-channels, after realignment
						Maintain Vegetation	
						Install Fish Passage Structure	* # of miles of habitat accessed
						Install Fish Screen	* Flow rate at the screen diversion allowed by the water right
							* Quantity of water protected by screening, as determined by what is stated in the water right or calculated based on flow rate
						Remove/Install Diversion	* # of miles of habitat accessed
						Install Pipeline	* Amount of unprotected water flow returned to the stream by conservation in cfs
						Install Well	* Amount of unprotected water flow returned to the stream by conservation in cfs

Table 2. Mid-Columbia Steelhead 2007-2009 BPA Tributary Habitat Actions

Mid Columbia Steelhead							
MPG	**Populations**	**Tributary Habitat Limiting Factors** (FCRPS BiOp Remand Habitat Workgroup products)	**BPA Project Nbr**	**Average annual planning budget**	**Project Title**	**Action Description**	**Reporting Metric**
Yakima River Group (con't) All of the projects listed for the Yakima River Group MPG are located in the NPCC Yakima subbasin and benefit at least 1 of the populations in this MPG			200300100	$ 823,477	Manastash Crk Passage & Screening The Manastash Creek Project will provide fish passage, diversion screening and seek instream flow to support fish recovery in the Yakima Basin. This proposal is for Phase 1: screening/passage. Phase 2: instream flow will be a second proposal.	Plant Vegetation	* # of acres of planted
							* # of riparian miles treated
						Maintain Vegetation	
						Operate and Maintain Habitat/Passage	
						Install Fish Passage Structure	* # of miles of habitat accessed
						Install Fish Screen	* Flow rate at the screen diversion allowed by the water right
							* Quantity of water protected by screening, as determined by what is stated in the water right or calculated based on flow rate
						Remove/Modify Dam	* # of miles of habitat accessed
						Install Pipeline	
			200702000	$ 297,666	Manastash Instream Flow Enhancement This proposal seeks to enhance instream flow by working with water users to implement irrigation conveyance and onfarm water use efficiency projects, to trust water to the creek and investigate diversion timing to assist steelhead migration.	Install Pipeline	* Amount of unprotected water flow returned to the stream by conservation in acre-feet
							* Amount of unprotected water flow returned to the stream by conservation in cfs
							* Estimated # of miles of primary stream reach improvement
							* Estimated # of miles of total stream reach improvement
						Install Sprinkler	* Amount of unprotected water flow returned to the stream by conservation in acre-feet
							* Amount of unprotected water flow returned to the stream by conservation in cfs

Table 2. Mid-Columbia Steelhead 2007-2009 BPA Tributary Habitat Actions

Mid Columbia Steelhead							
MPG	**Populations**	**Tributary Habitat Limiting Factors** (FCRPS BiOp Remand Habitat Workgroup products)	**BPA Project Nbr**	**Average annual planning budget**	**Project Title**	**Action Description**	**Reporting Metric**
Yakima River Group (con't) All of the projects listed for the Yakima River Group MPG are located in the NPCC Yakima subbasin and benefit at least 1 of the populations in this MPG			200702000 con't			Install Sprinkler	* Estimated # of miles of primary stream reach improvement
							* Estimated # of miles of total stream reach improvement
						Install Well	
						Acquire Water Instream	* # of miles of primary stream reach improvement
							* Amount of water secured
							* Flow of water returned to the stream as prescribed in the water acquisition
						Develop and Negotiate Water Right Transaction	
			200711200	$ 340,000	Teanaway Watershed - Protect Critical Habitat from Development, Reduce Water Temperatures and Increase Instream Flows, Restore Habitat Forming Processes in the Floodplain Teanaway watershed supports viable salmonid populations with complex spatial structure and diversity. Maximizing abundance and productivity of focal species requires protecting critical habitat, augmenting instream flows, & restoring floodplain functions.	Increase Instream Habitat Complexity	* # of stream miles treated
							* # of structures installed
						Install Fence	* # of miles of fence
						Plant Vegetation	* # of acres of planted
							* # of riparian miles treated
						Maintain Vegetation	
						Operate and Maintain Habitat/Passage	
						Acquire Water Instream	* # of miles of primary stream reach improvement
							* # of miles of total stream reach improvement, including primary and secondary reaches
							* Amount of water secured
							* Flow of water returned to the stream as prescribed in the water acquisition
						Develop and Negotiate Water Right Transaction	

Table 2. Mid-Columbia Steelhead 2007-2009 BPA Tributary Habitat Actions

Mid Columbia Steelhead							
MPG	**Populations**	**Tributary Habitat Limiting Factors** (FCRPS BiOp Remand Habitat Workgroup products)	**BPA Project Nbr**	**Average annual planning budget**	**Project Title**	**Action Description**	**Reporting Metric**
Yakima River Group (con't) All of the projects listed for the Yakima River Group MPG are located in the NPCC Yakima subbasin and benefit at least 1 of the populations in this MPG			200711300	$ 100,000	Cowiche Restoration and Protection Project (Easement/Fee Simple Acquisition) The goal of this project is to protect stream and riparian habitat, and floodplain functions along the Cowiche Creek. The project will acquire conservation easements protecting more than five miles of critical, high quality, steelhead and coho habitat.	Lease Land	* # of riparian miles protected
			200719400	$ 183,333	Oak Flats Acquisition and Habitat Enhancement Acquire a 357 acre multi-parcel site on the Naches River to protect from rural development and enhance 3.0 miles of streamside riparian habitat. Site supports Chinook salmon and Federally threatened mid-Columbia summer steelhead and bull trout.	Enhance Floodplain	* # of acres treated
						Plant Vegetation	* # of riparian miles treated
						Remove Debris	
						Remove/Modify Dam	* # of miles of habitat accessed
						Acquire Water Instream	* # of miles of primary stream reach improvement
			200201301	$ 3,500,000	Water Entity (RPA 151) NWPPC Fund water right transactions that restore streamflows and focused riparian easements on criticial fish-bearing Columbia Basin tributaries. Implemented as the Columbia Basin Water Transactions Program (CBWTP) in a partnership between BPA and NFWF.	Acquire Water Instream	
						Develop and Negotiate Water Right Transaction	
			199705100	$ 500,000	Yakima Basin Side Channels We will replace problematic irrigation diversions and culverts in the Lower North Fork and Mid-mainstem John Day Watersheds with fish-friendly structures that ensure fish passage and improve riparian habitat while efficiently meeting landmanagers' needs.	Land Purchase	* # of acres of new purchase/easement

Table 3-a. Snake River Steelhead 2007-2009 BPA Tributary Habitat Actions

Snake River Steelhead							
MPG	**Populations**	**Tributary Habitat Limiting Factors** (FCRPS BiOp Remand Habitat Workgroup products)	**Project Nbr**	**Average annual planning budget**	**Project Title & Short Description**	**Action Description**	**Reporting Metric**
Lower Snake	Tucannon River	Tucannon, Pataha & Deadman AUs: Floodplain Connectivity and Function- floodplain confinement Channel Structure and Complexity- reduced habitat diversity (LWD) Riparian Areas and LWD Recruitment- riparian degradation Stream Flow- low stream flow Water Quality-high water temperature & turbidity Fish Passage-barriers & screens	199401806	$ 331,333	Tucannon Stream and Riparian Protection, Enhancement, and Restoration Implement habitat protection, enhancement, and recovery strategies to support Subbasin Plan identified ESA focal, cultural significant and species of interest recovery within the Tucannon Subbasin.	Increase Instream Habitat Complexity	* # of stream miles treated
							* # of structures installed
						Lease Land	* # of acres of new lease
							* # of riparian miles protected
			199401807	$ 64,333	Improve Habitat For Fall Chinook, Steelhead in the Lower Snake and Tucannon Sub basins To obtain funding to continue with the districts effort to reduce soil erosion on the uplands and along the streams of Garfield County to improve water quality and fish habitat.	Develop Alternative Water Source	
						Install Fence	
						Plant Vegetation	* # of acres of planted
						Practice No-till and Conservation Tillage Systems	
						Remove vegetation	* # of acres treated
						Upland Erosion and Sedimentation Control	* # of acres treated
	Asotin Creek (extirpated)	Asotin, Alpowa & George Creek AUs: Floodplain Connectivity and Function- floodplain confinement Channel Structure and Complexity- reduced habitat diversity (LWD) Riparian Areas and LWD Recruitment- riparian degradation Stream Flow- low stream flow Water Quality - high water temperature & turbidity	199401805	$ 267,000	Continued Implementation of Prioritized Asotin Creek Watershed Habitat Projects On-going project for prioritizing & implementing on-the-ground habitat projects for wild steelhead & Chinook salmon in Asotin watershed. Bull trout also benefit from this ridge-top-to-ridge-top approach with match from private landowners & other grants.	Develop Alternative Water Source	
						Install Fence	* # of miles of fence
						Plant Vegetation	* # of riparian miles treated
						Practice No-till and Conservation Tillage Systems	* # of acres treated
						Operate and Maintain Habitat/Passage	
			200205000	$ 233,333	Continued Riparian Buffer Projects on Couse/Tenmile and other Salmonid Bearing Streams in Asotin County On-going project to continue implementation of prioritized habitat protection on private property for ESA listed steelhead, Chinook salmon and bull trout as identified in the Asotin Subbasin Plan. Cost share provided by private landowners & other sources.	Develop Alternative Water Source	
						Install Fence	* # of miles of fence
						Plant Vegetation	* # of riparian miles treated
						Practice No-till and Conservation Tillage Systems	* # of acres treated
						Upland Erosion and Sedimentation Control	* # of acres treated

Table 3-a. Snake River Steelhead 2007-2009 BPA Tributary Habitat Actions

Snake River Steelhead							
MPG	**Populations**	**Tributary Habitat Limiting Factors** (FCRPS BiOp Remand Habitat Workgroup products)	**Project Nbr**	**Average annual planning budget**	**Project Title & Short Description**	**Action Description**	**Reporting Metric**
Grande Ronde The projects listed for the Grande Ronde MPG are located in the NPCC Grande Ronde subbasin and will benefit at least 1 of the populations in this MPG.	Upper MS Grande Ronde	Channel Structure and Complexity- reduced habitat quality, diversity, LWD Riparian Areas and LWD Recruitment- impaired riparian condition Water Quality- high water temperature, impaired water chemistry Floodplain Connectivity and Function- impaired floodplain condition Stream Flow- low flows Fish Passage- physical passage barriers	198402500	$ 365,000	ODFW Blue Mountain Oregon Fish Habitat Improvement This project works with landowners, and other government and quasi-governmental agencies to protect and enhance habitat for federal ESA listed fish in the Blue Mountain Province of Oregon.	Create, Restore, and/or Enhance Wetland	* # of acres treated
	Wallowa River	Channel Structure and Complexity- reduced habitat quality, diversity, LWD Riparian Areas and LWD Recruitment- impaired riparian condition Water Quality- high water temperature, water chemistry Floodplain Connectivity and Function- impaired floodplain condition Stream Flow- low flows Fish Passage- physical barriers				Develop Alternative Water Source	
	Lower Grande Ronde	Channel Structure and Complexity- reduced habitat quality – diversity, LWD Riparian Areas and LWD Recruitment- impaired riparian condition Floodplain Connectivity and Function- impaired floodplain condition Fish Passage- physical barriers				Increase Instream Habitat Complexity	* # of stream miles treated
	Joseph Creek	Channel Structure and Complexity- reduced habitat diversity, quality, LWD Riparian Areas and LWD Recruitment- riparian degradation Water Quality- high water temperature, water chemistry, turbidity (WA only) Floodplain Connectivity and Function- floodplain condition and confinement Stream Flow - low flow (WA only) Fish Passage - barriers and screens				Install Fence	* # of miles of fence
						Plant Vegetation	* # of acres of planted
						Realign, Connect, and/or Create Channel	* # of stream miles treated, including off-channels, after realignment
						Maintain Vegetation	
						Operate and Maintain Habitat/Passage	

Table 3-a. Snake River Steelhead 2007-2009 BPA Tributary Habitat Actions

Snake River Steelhead							
MPG	**Populations**	**Tributary Habitat Limiting Factors** (FCRPS BiOp Remand Habitat Workgroup products)	**Project Nbr**	**Average annual planning budget**	**Project Title & Short Description**	**Action Description**	**Reporting Metric**
Grande Ronde (con't) The projects listed for the Grande Ronde MPG are located in the NPCC Grande Ronde subbasin and will benefit at least 1 of the populations in this MPG.			199202601	$ 2,183,849	Grand Ronde Model Watershed Program Habitat Restoration - Planning, Coordination and Implementation The project coordinates BPA funded restoration activities in the Grande Ronde and Imnaha Subbasins working with tribes, agencies and landowners. The project annually implements 10-20 habitat restoration projects. Project also to consider including habitat actions proposed in Wallowa, Lostine, & Joseph Cr. watersheds (200710500, 200711600, 200724500).	Develop Alternative Water Source	
						Increase Instream Habitat Complexity	* # of stream miles treated
						Install Fence	* # of miles of fence
						Plant Vegetation	* # of acres of planted
						Realign, Connect, and/or Create Channel	* # of stream miles treated, including off-channels, after realignment
						Install Fish Passage Structure	* # of miles of habitat accessed
			199608300	$ 190,000	CTUIR Grande Ronde Subbasin Restoration Project The CTUIR Grande Ronde Subbasin Restoration Project plans, designs, implements, maintains, and monitors habitat enhancement and restoration projects in the Grande Ronde Subbasin. Planned FY 2007-09 projects include Meadow Cr, End Cr, Ladd Cr, and main GR.	Create, Restore, and/or Enhance Wetland	* # of acres treated
						Develop Alternative Water Source	
						Install Fence	* # of miles of fence
						Plant Vegetation	* # of riparian miles treated
						Realign, Connect, and/or Create Channel	* # of stream miles treated, including off-channels, after realignment
						Maintain Vegetation	
			200201301	$ 3,500,000	Water Entity (RPA 151) NWPPC Fund water right transactions that restore streamflows and focused riparian easements on criticial fish-bearing Columbia Basin tributaries. Implemented as the Columbia Basin Water Transactions Program (CBWTP) in a partnership between BPA and NFWF.	Acquire Water Instream	# of miles of primary stream reach improvement
							# of miles of total stream reach improvement
							Amount of water secured in acre-feet/year
			200739300	$ 176,500	NPT Protect and Restore NE OR Funding for Coordination, Planning, Design, Implementation. Initially the funds were placed under 200724500. Established a new project for the Wallowa and Imnaha watersheds.	Install Fish Passage Structure	* # of miles of habitat accessed

Table 3-a. Snake River Steelhead 2007-2009 BPA Tributary Habitat Actions

Snake River Steelhead							
MPG	**Populations**	**Tributary Habitat Limiting Factors** (FCRPS BiOp Remand Habitat Workgroup products)	**Project Nbr**	**Average annual planning budget**	**Project Title & Short Description**	**Action Description**	**Reporting Metric**
Clearwater River The projects listed for the Clearwater River MPG are located in the NPCC Clearwater subbasin and will benefit at least 1 of the populations in this MPG.	Lower M S Clearwater	Riparian Areas and LWD Recruitment- impaired riparian condition and function Stream Substrate- elevated stream bed instability, elevated sediment Floodplain Connectivity and Function- reduced floodplain connectivity, altered floodplain Channel Structure a	199607702	$ 260,722	Protect and Restore Lolo Creek Watershed Protect and restore the Lolo Creek Watershed to provide quality habitat for anadromous and resident fish. This will be accomplished by watershed resotration projects such as culvert replacement, road obliteration, and streambank stabilization.	Decommission Road	* # of road miles decommissioned
	North Fork Clearwater (blocked)					Increase Instream Habitat Complexity	* # of acres treated
	Lolo Creek	Riparian Areas and LWD Recruitment- loss of riparian function Stream Substrate- sediment from roads and historic mining, sediment from upstream sources Floodplain Connectivity and Function- reduced floodplain connectivity and function from grazing and flo				Plant Vegetation	* # of riparian miles treated
	Lochsa River	Riparian Areas and LWD Recruitment				Remove vegetation	* # of acres treated
	Selway River					Upland Erosion and Sedimentation Control	* # of acres treated
	South Fork Clearwater	Floodplain Connectivity and Function Channel Structure and Complexity, Riparian Areas and LWD Recruitment Stream Substrate					* # of miles of habitat accessed
						Maintain Vegetation	
						Install Fish Passage Structure	* # of miles of habitat accessed
			199607703	$ 122,614	Protect and Restore Waw'aalamnime to 'Imnamatnoon Creek Analysis Area This project will protect, restore, and return critical spawning and rearing habitat to the Analysis Area using a holistic approach to restoration. Projects will be coordinated with the USFS.	Decommission Road	* # of road miles decommissioned
						Improve/Relocate Road	* # of road miles improved, upgraded, or restored
						Plant Vegetation	
						Remove vegetation	* # of acres treated
						Upland Erosion and Sedimentation Control	
						Remove/Modify Dam	

Table 3-a. Snake River Steelhead 2007-2009 BPA Tributary Habitat Actions

Snake River Steelhead							
MPG	**Populations**	**Tributary Habitat Limiting Factors** (FCRPS BiOp Remand Habitat Workgroup products)	**Project Nbr**	**Average annual planning budget**	**Project Title & Short Description**	**Action Description**	**Reporting Metric**
Clearwater River (con't) The projects listed for the Clearwater River MPG are located in the NPCC Clearwater subbasin and will benefit at least 1 of the populations in this MPG.			199607705	$ 331,259	Restore McComas Meadows/Meadow Creek Watershed Protect, restore, and enhance the Meadow Creek Watershed to provide quality habitat for anadromous and resident fish. This will be accomplished by watershed resotration projects such as culvert replacement, road obliteration, and streambank stabilization.	Decommission Road	* # of road miles decommissioned
						Increase Instream Habitat Complexity	* # of stream miles treated
						Plant Vegetation	* # of acres of planted * # of riparian miles treated
						Remove vegetation	* # of acres treated
						Maintain Vegetation	
						Install Fish Passage Structure	* # of miles of habitat accessed
			199901600	$ 165,000	Protect & Restore the Big Canyon Creek Watershed This project is to protect, restore, and return critical spawning and reareing habitat using a ridgetop to ridge top approach, based on a complete watershed assessment and following the Clearwater Subbasin Management Plan.	Create, Restore, and/or Enhance Wetland	* # of acres treated
						Decommission Road	* # of road miles decommissioned
						Develop Alternative Water Source	
						Improve/Relocate Road	* # of road miles improved, upgraded, or restored
						Install Fence	* # of miles of fence
						Plant Vegetation	* # of acres of planted
						Remove vegetation	* # of acres treated
						Upland Erosion and Sedimentation Control	* # of acres treated
						Maintain Vegetation	
						Operate and Maintain Habitat/Passage	
						Lease Land	* # of acres of new lease
			199901700	$ 389,765	Protect and Restore Lapwai Creek Watershed This project will protect, restore and return critical spawning and rearing fish habitat using a ridge top to ridge top approach, based on a complete watershed assessment.	Create, Restore, and/or Enhance Wetland	* # of acres treated
						Decommission Road	* # of road miles decommissioned
						Develop Alternative Water Source	
						Improve/Relocate Road	* # of road miles improved, upgraded, or restored
						Install Fence	* # of miles of fence
						Plant Vegetation	* # of acres of planted
						Remove vegetation	* # of acres treated
						Upland Erosion and Sedimentation Control	* # of acres treated
						Maintain Vegetation	
						Operate and Maintain Habitat/Passage	
						Install Fish Passage Structure	* # of miles of habitat accessed
						Lease Land	* # of acres of new lease

Table 3-a. Snake River Steelhead 2007-2009 BPA Tributary Habitat Actions

MPG	Populations	Tributary Habitat Limiting Factors (FCRPS BiOp Remand Habitat Workgroup products)	Project Nbr	Average annual planning budget	Project Title & Short Description	Action Description	Reporting Metric
Clearwater River (con't) The projects listed for the Clearwater River MPG are located in the NPCC Clearwater subbasin and will benefit at least 1 of the populations in this MPG.			200003500	$ 317,474	Rehabilitate Newsome Creek - S Protect and restore Newsome Creek Watershed for the benefit of both anadromous and resident fish using an overall watershed approach. This project is a cooperative effort between the Nez Perce Tribe and the Nez Perce National Forest.	Decommission Road	* # of road miles decommissioned
						Enhance Floodplain	* # of acres treated
						Improve/Relocate Road	* # of road miles improved, upgraded, or restored
						Increase Instream Habitat Complexity	* # of stream miles treated
						Plant Vegetation	* # of acres of planted * # of riparian miles treated
						Realign, Connect, and/or Create Channel	* # of stream miles treated, including off-channels, after realignment
						Remove Mine Tailings	* # of miles of habitat accessed
						Remove vegetation	* # of acres treated
						Upland Erosion and Sedimentation Control	* # of acres treated
						Remove/Modify Dam	* # of miles of habitat accessed
			200003600	$ 150,000	Protect and Restore Mill Creek Protect, restore, and enhance the Mill Creek Watershed to provide quality habitat for anadromous and resident fish. This will be accomplished by watershed resotration projects such as culvert replacement and riparian restoration.	Plant Vegetation	* # of riparian miles treated
						Remove vegetation	* # of acres treated
						Maintain Vegetation	
						Install Fish Passage Structure	* # of miles of habitat accessed
			200206100	$ 397,486	Restore Potlatch River Watershed Implementation stage for the Potlatch River Watershed Management Plan with focus on restoration of A-run steelhead spawning and rearing habitat through the implementation of best management practices on private agricultural, forest and range lands.	Develop Alternative Water Source	
						Increase Instream Habitat Complexity	* # of stream miles treated
						Install Fence	* # of miles of fence
						Practice No-till and Conservation Tillage Systems	* # of acres treated
						Upland Erosion and Sedimentation Control	* # of acres treated
			200207000	$ 43,333	Lapwai Creek Anadromous Habitat This project restores, protects and enhances steelhead spawing and rearing habitat in the Lapwai Creek Watershed. Information is collected to fill data gaps and BMPs are installed on agricultural and forestlands to achieve biological objectives.	Create, Restore, and/or Enhance Wetland	* # of acres treated
						Develop Alternative Water Source	
						Improve/Relocate Road	* # of road miles improved, upgraded, or restored
						Increase Instream Habitat Complexity	* # of stream miles treated
						Install Fence	* # of miles of fence
						Plant Vegetation	* # of acres of planted * # of riparian miles treated
						Remove vegetation	* # of acres treated

Table 3-a. Snake River Steelhead 2007-2009 BPA Tributary Habitat Actions

Snake River Steelhead							
MPG	**Populations**	**Tributary Habitat Limiting Factors** (FCRPS BiOp Remand Habitat Workgroup products)	**Project Nbr**	**Average annual planning budget**	**Project Title & Short Description**	**Action Description**	**Reporting Metric**
Clearwater River (con't) The projects listed for the Clearwater River MPG are located in the NPCC Clearwater subbasin and will benefit at least 1 of the populations in this MPG.			200207000 (con't)			Upland Erosion and Sedimentation Control	* # of acres treated
						Maintain Vegetation	
						Operate and Maintain Habitat/Passage	
						Remove/Install Diversion	
						Remove/Modify Dam	* # of miles of habitat accessed
			200207200	$ 393,118	Protect & Restore Red River Watershed Protect and restore the Red River Watershed for the benefit of both anadromous and resident fish using an overall watershed approach. This project is a cooperative effort between the Nez Perce Tribe and the Nez Perce National Forest.	Decommission Road	* # of road miles decommissioned
						Improve/Relocate Road	* # of road miles improved, upgraded, or restored
						Increase Instream Habitat Complexity	* # of stream miles treated
						Plant Vegetation	* # of acres of planted
						Realign, Connect, and/or Create Channel	* # of stream miles treated, including off-channels, after realignment
						Remove vegetation	* # of acres treated
						Upland Erosion and Sedimentation Control	* # of acres treated
						Remove/Modify Dam	* # of miles of habitat accessed
			200207400	$ 76,041	Protect and Restore Crooked Fork to Colt Killed Analysis Area This project will protect, restore, and return critical spawning and rearing habitat to the Analysis Area using a holistic approach to restoration. Projects will be coordinated with the Clearwater National Forest.	Decommission Road	* # of road miles decommissioned
						Improve/Relocate Road	* # of road miles improved, upgraded, or restored
						Plant Vegetation	* # of acres of planted * # of riparian miles treated
						Remove vegetation	* # of acres treated
						Upland Erosion and Sedimentation Control	
						Remove/Modify Dam	* # of miles of habitat accessed

Table 3-a. Snake River Steelhead 2007-2009 BPA Tributary Habitat Actions

Snake River Steelhead							
MPG	**Populations**	**Tributary Habitat Limiting Factors** (FCRPS BiOp Remand Habitat Workgroup products)	**Project Nbr**	**Average annual planning budget**	**Project Title & Short Description**	**Action Description**	**Reporting Metric**
Salmon River The projects listed for the Salmon River MPG are located in the NPCC Salmon subbasin and will benefit at least 1 of the populations in this MPG.	Little Salmon	Channel Structure and Complexity- altered Mainstem structure Riparian Areas and LWD Recruitment- impaired riparian condition Stream Substrate- increased sediment Stream Flow- low flows Water Quality- elevated temperature, elevated nutrient concentrations	199401500	$ 1,443,333	Idaho Fish Screening and Passage Improvements This project will protect, restore, and return critical spawning and rearing habitat to the Analysis Area using a holistic approach to restoration. Projects will be coordinated with the Clearwater National Forest.	Operate and Maintain Habitat/Passage	
	Chamberlain Creek					Install Fish Screen	* Flow rate at the screen diversion allowed by the water right
	South Fork Salmon River	Sediment, water quality in EFSF (Stibnite mine site)					
	Secesh River	Sediment				Remove/Install Diversion	* # of miles of habitat accessed
	Panther Creek	Riparian Areas and LWD Recruitment- loss of floodplain connectivity and function as result of road encroachment Stream Substrate- elevated sediment levels Floodplain Connectivity and Function- loss of floodplain connectivity and function as result of road					
	Upper Mid Fork Salmon River					Install Pipeline	* Amount of unprotected water flow returned to the stream by conservation in cfs * Estimated # of miles of primary stream reach improvement
	North Fork Salmon River	Channel Structure and Complexity- channelized and relocated channels Floodplain Connectivity and Function- floodplain connectivity and function impaired from development and encroachment Riparian Areas and LWD Recruitment- riparian condition impaired from					
	Lower Mid Fork Salmon River	Floodplain Connectivity and Function- impaired connectivity to floodplain Riparian Areas and LWD Recruitment- reduced riparian function as a result of development and encroachment Stream Substrate- elevated sediment loading Stream Flow- low flow Fish Pass				Install Sprinkler	* Amount of unprotected water flow returned to the stream by conservation in cfs
	Lemhi River	Stream Substrate- high sediment loading Stream Flow- Reduced streamflow Water Quality- elevated temperature Fish Passage- passage barriers, entrainment in irrigation diversions	199901900	$ 384,236	Restore Salmon River (Challis, Idaho) Passive restoration by securing easements will assist restoration efforts via the Corps 206 Program. The development of side channels will help create a more naturally functioning floodplain, provide a wide array of environmental and ecological benefit.	Investigate Trespass	

Table 3-a. Snake River Steelhead 2007-2009 BPA Tributary Habitat Actions

Snake River Steelhead							
MPG	**Populations**	**Tributary Habitat Limiting Factors** (FCRPS BiOp Remand Habitat Workgroup products)	**Project Nbr**	**Average annual planning budget**	**Project Title & Short Description**	**Action Description**	**Reporting Metric**
Salmon River (con't)	Pahsimeroi River	Riparian Areas and LWD Recruitment- poor riparian conditions Stream Substrate- elevated sediment loading Stream Flow- low flows Water Quality- excess nutrients, elevated temperature Fish Passage- passage barriers	200205900	$ 116,667	Yankee Fork Salmon River Dredge Tailings Restoration Project Reconnect the Yankee Fork River to its floodplain and restore natural channel characteristics and processes in a segment impacted by dredge-mining. Integrate biological and physical data with project experiences to develop future restoration alternatives.	Plant Vegetation	
	Upper East Fork Salmon River	Irrigation Withdrawals Floodplain Connectivity and Function- reduced connectivity and function from development and road encroachment Riparian Areas and LWD Recruitment- impaired status and function as a result of development and road encroachment Stream				Remove Mine Tailings	
	Upper Main Stem Salmon	Migration barriers, water temperature, sediment, streamflow. (For tributaries with significant water withdrawals: previous factors plus entrainment in irrigation diversions)	200706400	$ 106,791	Protect and Restore Slate Creek Restore and protect the Slate Creek Watershed for the benefit of both resident and anadromous fish using an overall watershed approach. Restoration and protection efforts will be done cooperatively with the Nez Perce National Forest.	Decommission Road	* # of road miles decommissioned
						Plant Vegetation	* # of acres of planted
						Remove vegetation	* # of acres treated
						Upland Erosion and Sedimentation Control	* # of acres treated
			200706500	$ 21,667	Coordinate and Implement Tributary Habitat Restoration in the Little Salmon River and Lower Salmon River, Idaho Implement fish habitat restoration on private lands dominated by agricultural practices using cost sharing by Bonneville, Idaho Pacific Coast Salmon Recovery Funds, Idaho Water Quality Program for Agriculture, and landowner participation.	Develop Alternative Water Source	
						Install Fence	* # of miles of fence
						Plant Vegetation	* # of acres of planted
						Remove vegetation	* # of acres treated
						Maintain Vegetation	
						Remove/Install Diversion	* # of miles of habitat accessed
						Install Flow Measuring Device	
			200712700	$ 305,867	Reestablish Connectivity and Restore Fish Habitat in the East Fork of the South Fork Salmon River Watershed This project will reestablish fish passage through a 30-foot tall cascade using natural channel design and rehabilitate one mile of fish habitat through an anthropogenically degraded reach of the upper mainstem East Fork of the South Fork Salmon River.	Enhance Floodplain	* # of acres treated
						Increase Instream Habitat Complexity	* # of stream miles treated
						Plant Vegetation	* # of riparian miles treated
						Trap and Haul	* # of fish
						Install Fish Passage Structure	* # of miles of habitat accessed
			200726800	$ 250,000	Idaho Watershed Habitat Restoration Project via Custer Soil and Water Conservation District The project scope is to implement high priority action items to maintain, enhance and restore fish habitat and fish passage in the priority stream segments of the Upper Salmon Basin area within the administrative boundaries of the Custer SWCD.	Install Fence	* # of miles of fence
						Operate and Maintain Habitat/Passage	
						Remove/Install Diversion	* # of miles of habitat accessed
						Remove/Modify Dam	* # of miles of habitat accessed
						Install Pipeline	* Estimated # of miles of primary stream reach improvement

Table 3-a. Snake River Steelhead 2007-2009 BPA Tributary Habitat Actions

Snake River Steelhead							
MPG	**Populations**	**Tributary Habitat Limiting Factors** (FCRPS BiOp Remand Habitat Workgroup products)	**Project Nbr**	**Average annual planning budget**	**Project Title & Short Description**	**Action Description**	**Reporting Metric**
Salmon River (con't) The projects listed for the Salmon River MPG are located in the NPCC Salmon subbasin and will benefit at least 1 of the populations in this MPG.			200201301	$ 3,500,000	Water Entity (RPA 151) NWPPC Fund water right transactions that restore streamflows and focused riparian easements on criticial fish-bearing Columbia Basin tributaries. Implemented as the Columbia Basin Water Transactions Program (CBWTP) in a partnership between BPA and NFWF.	Acquire Water Instream	# of miles of primary stream reach improvement # of miles of total stream reach improvement Amount of water secured in acre-feet/year
			200739400	$ 250,000	Idaho Watershed Habitat Restoration Lemhi County Move funds for coordination, planning, design and implementation from 1992-026-03, Upper Salmon Basin Watershed Project.	Install Fence	* # of miles of fence
						Install Fish Passage Structure	* # of miles of habitat accessed
						Install Fish Screen	* Flow rate at the screen diversion allowed by the water right
						Acquire Water Instream	# of miles of primary stream reach improvement
Imnaha River	Imnaha River	Channel Structure and Complexity- reduced habitat quality, diversity, LWD Floodplain Connectivity and Function- impaired floodplain condition iparian Areas and LWD Recruitment- impaired riparian condition Fish Passage- physical barriers	199202601	$ 2,183,849	Grand Ronde Model Watershed Program Habitat Restoration - Planning, Coordination and Implementation The project coordinates BPA funded restoration activities in the Grande Ronde and Imnaha Subbasins working with tribes, agencies and landowners. The project annually implements 10-20 habitat restoration projects. Project also to consider including habitat actions proposed in Wallowa, Lostine, & Joseph Cr. watersheds (200710500, 200711600, 200724500).	Develop Alternative Water Source	
						Increase Instream Habitat Complexity	* # of stream miles treated
						Install Fence	* # of miles of fence
						Plant Vegetation	* # of acres of planted
						Realign, Connect, and/or Create Channel	* # of stream miles treated, including off-channels, after realignment
						Install Fish Passage Structure	* # of miles of habitat accessed
			200739300	$ 176,500	NPT Protect and Restore NE OR Funding for Coordination, Planning, Design, Implementation. Initially the funds were placed under 200724500. Established a new project for the Wallowa and Imnaha watersheds.	Install Fish Passage Structure	* # of miles of habitat accessed

Table 3-b. Snake River Spring Summer Chinook 2007-2009 BPA Tributary Habitat Actions

Snake River Spring Summer Chinook							
MPG	**Populations**	**Tributary Habitat Limiting Factors** (FCRPS BiOp Remand Habitat Workgroup products)	**Project Nbr**	**Average annual planning budget**	**Project Title & Short Description**	**Action Description**	**Reporting Metric**
Lower Snake: Main Stem Tributaries	Tucannon River	Floodplain Connectivity and Function - Floodplain confinement Channel Structure and Complexity - Habitat diversity, reduced LWD Riparian Areas and LWD Recruitment - riparian degradation Stream Flow- low stream flow Water Quality - high water temperature, high water turbidity Fish Passage - barriers and screens	199401806	$ 331,333	Tucannon Stream and Riparian Protection, Enhancement, and Restoration Implement habitat protection, enhancement, and recovery strategies to support Subbasin Plan identified ESA focal, cultural significant and species of interest recovery within the Tucannon Subbasin.	Increase Instream Habitat Complexity	* # of stream miles treated
							* # of structures installed
						Lease Land	* # of acres of new lease
							* # of riparian miles protected
			199401807	$ 64,333	Improve Habitat For Fall Chinook, Steelhead in the Lower Snake and Tucannon Sub basins To obtain funding to continue with the districts effort to reduce soil erosion on the uplands and along the streams of Garfield County to improve water quality and fish habitat.	Plant Vegetation	* # of acres of planted
						Remove vegetation	* # of acres treated
						Upland Erosion and Sedimentation Control	* # of acres treated
			200201301	$ 3,500,000	Water Entity (RPA 151) NWPPC Fund water right transactions that restore streamflows and focused riparian easements on criticial fish-bearing Columbia Basin tributaries. Implemented as the Columbia Basin Water Transactions Program (CBWTP) in a partnership between BPA and NFWF.	Acquire Water Instream	* flow of water returned to the stream as prescribed in the water acquisition in cfs
	Asotin Creek (extirpated)	Floodplain Connectivity and Function - Floodplain confinement Channel Structure and Complexity - Habitat diversity, reduced LWD Riparian Areas and LWD Recruitment - riparian degradation Stream Flow- low stream flow Water Quality - high water temperature, high water turbidity Fish Passage - barriers and screens	199401805	$ 267,000	Continued Implementation of Prioritized Asotin Creek Watershed Habitat Projects On-going project for prioritizing & implementing on-the-ground habitat projects for wild steelhead & Chinook salmon in Asotin watershed. Bull trout also benefit from this ridge-top-to-ridge-top approach with match from private landowners & other grants.	Install Fence	* # of miles of fence
						Plant Vegetation	* # of riparian miles treated
						Practice No-till and Conservation Tillage Systems	* # of acres treated
			200205000	$ 233,333	Continued Riparian Buffer Projects on Couse/Tenmile and other Salmonid Bearing Streams in Asotin County On-going project to continue implementation of prioritized habitat protection on private property for ESA listed steelhead, Chinook salmon and bull trout as identified in the Asotin Subbasin Plan. Cost share provided by private landowners & other sources.	Install Fence	* # of miles of fence
						Plant Vegetation	* # of riparian miles treated
						Practice No-till and Conservation Tillage Systems	* # of acres treated
						Upland Erosion and Sedimentation Control	* # of acres treated

Table 3-b. Snake River Spring Summer Chinook 2007-2009 BPA Tributary Habitat Actions

Snake River Spring Summer Chinook							
MPG	**Populations**	**Tributary Habitat Limiting Factors** (FCRPS BiOp Remand Habitat Workgroup products)	**Project Nbr**	**Average annual planning budget**	**Project Title & Short Description**	**Action Description**	**Reporting Metric**
Grande Ronde / Imnaha The projects listed for the Grande Ronde MPG are located in the NPCC Grande Ronde or Imnaha subbasins and will benefit at least 1 of the populations in this MPG.	Wenaha River	Floodplain Connectivity and Function- Floodplain confinement and condition Channel Structure and Complexity- Habitat diversity, reduced LWD Riparian Areas and LWD Recruitment- Riparian degradation and condition Stream Flow- low stream flow Water Quality- high water temperature, high water turbidity Fish Passage- barriers and screens	198402500	$ 365,000	ODFW Blue Mountain Oregon Fish Habitat Improvement This project works with landowners, and other government and quasi-governmental agencies to protect and enhance habitat for federal ESA listed fish in the Blue Mountain Province of Oregon.	Create, Restore, and/or Enhance Wetland	* # of acres treated
						Increase Instream Habitat Complexity	* # of stream miles treated
	Lostine River / Wollowa					Install Fence	* # of miles of fence
						Plant Vegetation	* # of acres of planted
	Catherine Creek					Realign, Connect, and/or Create Channel	* # of stream miles treated, including off-channels, after realignment
			199202601	$ 2,183,849	Grand Ronde Model Watershed Program Habitat Restoration - Planning, Coordination and Implementation The project coordinates BPA funded restoration activities in the Grande Ronde and Imnaha Subbasins working with tribes, agencies and landowners. The project annually implements 10-20 habitat restoration projects. Project also to consider including habitat actions proposed in Wallowa, Lostine, & Joseph Cr. watersheds (200710500, 200711600, 200724500).	Increase Instream Habitat Complexity	* # of stream miles treated
	Upper Mainstem Grande Ronde					Install Fence	* # of miles of fence
	Imnaha Mainstem					Plant Vegetation	* # of acres of planted
	Minam River	No limiting factors identified for this population				Realign, Connect, and/or Create Channel	* # of stream miles treated, including off-channels, after realignment
						Install Fish Passage Structure	* # of miles of habitat accessed
			199608300	$ 190,000	CTUIR Grande Ronde Subbasin Restoration Project The CTUIR Grande Ronde Subbasin Restoration Project plans, designs, implements, maintains, and monitors habitat enhancement and restoration projects in the Grande Ronde Subbasin. Planned FY 2007-09 projects include Meadow Cr, End Cr, Ladd Cr, and main GR.	Create, Restore, and/or Enhance Wetland	* # of acres treated
						Install Fence	* # of miles of fence
						Plant Vegetation	* # of riparian miles treated
						Realign, Connect, and/or Create Channel	* # of stream miles treated, including off-channels, after realignment

Table 3-b. Snake River Spring Summer Chinook 2007-2009 BPA Tributary Habitat Actions

Snake River Spring Summer Chinook							
MPG	**Populations**	**Tributary Habitat Limiting Factors** (FCRPS BiOp Remand Habitat Workgroup products)	**Project Nbr**	**Average annual planning budget**	**Project Title & Short Description**	**Action Description**	**Reporting Metric**
Grande Ronde / Imnaha (con't) The projects listed for the Grande Ronde MPG are located in the NPCC Grande Ronde or Imnaha subbasins and will benefit at least 1 of the populations in this MPG.			200739300	$ 176,500	NPT Protect and Restore NE OR Funding for Coordination, Planning, Design, Implementation. Initially the funds were placed under 200724500. Established a new project for the Wallowa and Imnaha watersheds.	Decommission Road	* # of road miles decommissioned
						Enhance Floodplain	* # of acres treated
						Increase Instream Habitat Complexity	* # of structures installed
						Install Fence	* # of miles of fence
						Install Fish Passage Structure	* # of miles of habitat accessed
						Maintain Vegetation	
						Plant Vegetation	* # of acres of planted
						Realign, Connect, and/or Create Channel	* # of stream miles treated, including off-channels, after realignment
						Remove vegetation	
			200201301	$ 3,500,000	Water Entity (RPA 151) NWPPC Fund water right transactions that restore streamflows and focused riparian easements on criticial fish-bearing Columbia Basin tributaries. Implemented as the Columbia Basin Water Transactions Program (CBWTP) in a partnership between BPA and NFWF.	Acquire Water Instream	* flow of water returned to the stream as prescribed in the water acquisition in cfs
South Fork Salmon River The projects listed for the South Fork, Middle Fork, or Upper Salmon MPGs are located in the NPCC Salmon subbasin and will benefit at least 1 of the populations in those MPGs	Little Salmon River	Channel Structure and Complexity- altered channels Stream Substrate- sediment Riparian Areas and LWD Recruitment- riparian condition Stream Flow- low flows Water Quality- temperature, nutrients	199401500	$ 1,443,333	Idaho Fish Screening and Passage Improvements The project protects anadromous fish and improves fish passage in Idaho's anadromous fish corridors by consolidation and elimination of irrigation diversions, conservation of water, and screening fish from gravity and pump water withdrawal systems.	Install Fish Screen	* Flow rate at the screen diversion allowed by the water right
	East Fork South Fork Salmon River / Johnson Creek	Channel Morphology (App E)				Remove/Install Diversion	* # of miles of habitat accessed
	Secesh River	Channel Morphology - floodplain loss (App E)	200706400	$ 106,791	Protect and Restore Slate Creek Restore and protect the Slate Creek Watershed for the benefit of both resident and anadromous fish using an overall watershed approach. Restoration and protection efforts will be done cooperatively with the Nez Perce National Forest.	Decommission Road	* # of road miles decommissioned
	Main Stem South Fork Salmon River	Channel Morphology (App E)				Plant Vegetation	* # of acres of planted

Table 3-b. Snake River Spring Summer Chinook 2007-2009 BPA Tributary Habitat Actions

Snake River Spring Summer Chinook							
MPG	**Populations**	**Tributary Habitat Limiting Factors** (FCRPS BiOp Remand Habitat Workgroup products)	**Project Nbr**	**Average annual planning budget**	**Project Title & Short Description**	**Action Description**	**Reporting Metric**
Middle Fork Salmon River The projects listed for the South Fork, Middle Fork, or Upper Salmon MPGs are located in the NPCC Salmon subbasin and will benefit at least 1 of the populations in those MPGs	Chamberlain Creek	No limiting factors identified for this population	200706400 (con't)			Remove vegetation	* # of acres treated
	Lower Mid Fork Salmon	No limiting factors identified for this population				Upland Erosion and Sedimentation Control	* # of acres treated
	Big Creek	Channel Morphology (App E)	200706500	$ 21,667	Coordinate and Implement Tributary Habitat Restoration in the Little Salmon River and Lower Salmon River, Idaho Implement fish habitat restoration on private lands dominated by agricultural practices using cost sharing by Bonneville, Idaho Pacific Coast Salmon Recovery Funds, Idaho Water Quality Program for Agriculture, and landowner participation.	Install Fence	* # of miles of fence
	Camas Creek	Flow (App E)				Plant Vegetation	* # of acres of planted
	Loon Creek	No limiting factors identified for this population				Remove vegetation	* # of acres treated
	Upper Mid Fork Salmon	No limiting factors identified for this population				Remove/Install Diversion	* # of miles of habitat accessed
	Sulpher Creek	Flow (App E)	200712700	$ 305,867	Reestablish Connectivity and Restore Fish Habitat in the East Fork of the South Fork Salmon River Watershed This project will reestablish fish passage through a 30-foot tall cascade using natural channel design and rehabilitate one mile of fish habitat through an anthropogenically degraded reach of the upper mainstem East Fork of the South Fork Salmon River.	Enhance Floodplain	* # of acres treated
	Bear Valley Creek	No limiting factors identified for this population				Increase Instream Habitat Complexity	* # of stream miles treated
	Marsh Creek	Channel Morphology (App E)				Plant Vegetation	* # of riparian miles treated

Table 3-b. Snake River Spring Summer Chinook 2007-2009 BPA Tributary Habitat Actions

Snake River Spring Summer Chinook							
MPG	**Populations**	**Tributary Habitat Limiting Factors** (FCRPS BiOp Remand Habitat Workgroup products)	**Project Nbr**	**Average annual planning budget**	**Project Title & Short Description**	**Action Description**	**Reporting Metric**
Upper Salmon River The projects listed for the South Fork, Middle Fork, or Upper Salmon MPGs are located in the NPCC Salmon subbasin and will benefit at least 1 of the populations in those MPGs	Lemhi	Stream Flow- low flow Water Quality- water temperature Fish Passage- migration barriers, entrainment in irrigation diversions	200712700 (con't)			Install Fish Passage Structure	* # of miles of habitat accessed
			200726800	$ 250,000	Idaho Watershed Habitat Restoration Project via Custer Soil and Water Conservation District The project scope is to implement high priority action items to maintain, enhance and restore fish habitat and fish passage in the priority stream segments of the Upper Salmon Basin area within the administrative boundaries of the Custer SWCD.	Install Fence	* # of miles of fence
	Lower Mainstem Upper Salmon River	Channel Structure and Complexity- degraded bank stability Riparian Areas and LWD Recruitment- degraded and altered riparian function Stream Flow- altered hydrology, dewatering, degraded hydrologic connection to Mainstem Stream Substrate- elevated sediment Water Quality- water temperature (elevated in summer and severely reduced in winter) Fish Passage- passage barriers, entrainment in irrigation diversions				Remove/Install Diversion	* # of miles of habitat accessed
	Pahsimeroi	Stream Flow- low flow Water Quality- water temperature Fish Passage- migration barriers, entrainment in irrigation diversions				Remove/Modify Dam	* # of miles of habitat accessed
	East Fork Upper Salmon River	Riparian Areas and LWD Recruitment- Altered Riparian Community, riparian condition Stream Flow- Altered Hydrology, low flow Water Quality- water temperature, nutrients Stream Substrate- sediment Fish Passage- migration barriers	200201301	$ 3,500,000	Water Entity (RPA 151) NWPPC Fund water right transactions that restore streamflows and focused riparian easements on criticial fish-bearing Columbia Basin tributaries. Implemented as the Columbia Basin Water Transactions Program (CBWTP) in a partnership between BPA and NFWF.	Acquire Water Instream	* flow of water returned to the stream as prescribed in the water acquisition in cfs

Table 3-b. Snake River Spring Summer Chinook 2007-2009 BPA Tributary Habitat Actions

Snake River Spring Summer Chinook							
MPG	**Populations**	**Tributary Habitat Limiting Factors** (FCRPS BiOp Remand Habitat Workgroup products)	**Project Nbr**	**Average annual planning budget**	**Project Title & Short Description**	**Action Description**	**Reporting Metric**
Upper Salmon River (con't)	Main Stem Upper Salmon River	Stream Flow- low flow Water Quality- water temperature Stream Substrate- sediment Fish Passage- migration barriers, entrainment in irrigation diversions	200739400	$ 250,000	<u>Idaho Watershed Habitat Restoration Lemhi County</u> Move funds for coordination, planning, design and implementation from 1992-026-03, Upper Salmon Basin Watershed Project.	Install Fence	* # of miles of fence
	Valley Creek	Channel Structure and Complexity- channel alteration Riparian Areas and LWD Recruitment- impaired riparian condition Stream Flow- low flow Water Quality- water temperature Stream Substrate- elevated sediment Fish Passage- migration barriers Other- Exotic Species (Brook Trout)				Install Fish Passage Structure	* # of miles of habitat accessed
	Yankee Fork	Water Quality - siltation, mining (legacy and recent), road and development encroachment, logging, grazing, wetlands fill and draining Fish Passage Floodplain Connectivity and Function Channel Structure and Complexity - streambank degradation, stream channel alteration Riparian Areas and LWD Recruitment Stream Substrate Stream Flow				Install Fish Screen	* Flow rate at the screen diversion allowed by the water right
	Panther (extirpated)	No limiting factors identified for this population				Acquire Water Instream	# of miles of primary stream reach improvement
	North Fork Upper Salmon River	Floodplain Connectivity and Function- connectivity to floodplain, wetlands fill and draining; Channel Structure and Complexity- stream bank degradation Riparian Areas and LWD Recruitment- degraded riparian function, road and development encroachment Stream Flow- altered hydrology, low flows Water Quality- pollutants, legacy mining Stream Substrate- sediment Fish Passage- passage barriers	199901900	$ 384,236	<u>Restore Salmon River (Challis, Idaho)</u> Passive restoration by securing easements will assist restoration efforts via the Corps 206 Program. The development of side channels will help create a more naturally functioning floodplain, provide a wide array of environmental and ecological benefit.	Investigate Trespass	
			200205900	$ 116,667	<u>Yankee Fork Salmon River Dredge Tailings Restoration Project</u> Reconnect the Yankee Fork River to its floodplain and restore natural channel characteristics and processes in a segment impacted by dredge-mining. Integrate biological and physical data with project experiences to develop future restoration alternatives.	Plant Vegetation	
						Remove Mine Tailings	

Table 4-a. Snake River Spring Summer Chinook 2008-2009 Additional Tributary Habitat Actions

Snake River Spring and Summer Chinook						
MPG	**Populations**	**Assessment Unit (AU)**	**Primary Limiting Factor(s) (PLF) by AU**	**Action Description**	**Cost Above BPA 2007-09 Planning Budget**	**Reporting Metric** *(tbd)*
Grande Ronde	Catherine Creek	Catherine Creek	In-channel characteristics	In-steam enhancement, LWD, modify/enhance channel	$150,000	
				Opportunistic channel enhancement	$2,100	7 mi
			Riparian / Floodplain	livestock exclusion/reveg/weed control/expand streamside buffers/levee or road mod/restore meadows	$295,000	
				wetland project development	$50,000	
				riparian fencing (FS)	$60,000	4 mi
				road obliteration/sediment reduction (FS)	$55,000	2 mi
			Fish Passage	culverts/irrigation diversion improvements	$300,000	
				Catherine Creek State Diversion Fish Passage	$83,000	4 mi
			Fish Passage	Catherine Creek Diversion Townley-Dobin	$140,000	25
				Catherine Creek Davis Dams Fish Passage (design)	$100,000	
				Scout Creek Culvert Replacement (design)	$6,000	
	Upper Grande Ronde	Mid Grande Ronde River and Tribs	In-channel characteristics	End Creek Restoration - Phase IV	$33,000	
				Willow Ck channel improvement /wetland restoration (new)	$600,000	4
				Indian Ck channel enhancement and wetland restoration	$500,000	4 mi
			Riparian / Floodplain	Indian/Little Indian riparian fencing/water development- start in 09, continue through 15 (FS)	$1,000	.5 mi
			Passage	culverts/irrigation diversion improvements	$100,000	5

Table 4-a. Snake River Spring Summer Chinook 2008-2009 Additional Tributary Habitat Actions

Snake River Spring and Summer Chinook						
MPG	**Populations**	**Assessment Unit (AU)**	**Primary Limiting Factor(s) (PLF) by AU**	**Action Description**	**Cost Above BPA 2007-09 Planning Budget**	**Reporting Metric** *(tbd)*
Grande Ronde (con't)	Upper Grande Ronde (con't)	Upper Grande Ronde and Tribs	In-channel characteristics	Upper GR River mine tailings (FS)	$300,000	2 mi
				Fly Ck (FS)	$275,000	6 mi
				UGR/Fly/Sheep Ck riparian fencing + water development- 2009 (FS)	$129,000	9 mi
				Camp Carson erosion control 2008 (FS)	$45,000	1 mi
	Lostine	Lostine River	Lack of passage - Lack of access to diversity of habitats,	Fish Passage Improvements	$542,400	
Middle Fork Salmon	Big Creek	Entire Big Creek Watershed	Sediment effects on rearing and spawning success - lack of intersticial space, reduced pool volume, reduced spawning success	Road Decommissioning, Road Improvement, Culvert Removal / Replacement, Riparian Restoration near Mining Sites, Weed Management, Silvacultural BMPs	$590,000	
			Migration Barriers associated with roads and mining activities	Assess stream crossings and anthropogenic migration barriers to determine actions necessary for salmonid passage. Provide for salmonid passage at identified passage barriers (e.g., culvert replacement)		
South Fork Salmon River	South Fork Salmon River mainstem	EFSF Salmon and tribs	Sediment effects on rearing and spawning success - lack of intersticial space, reduced pool volume, reduced spawning success	Road Decommissioning, Road Improvement, Culvert Removal / Replacement, Riparian Restoration, Mine rehabilitation	$162,800	
			Migration Barriers	Assess stream crossings and anthropogenic migration barriers to determine actions necessary for salmonid passage. Provide for salmonid passage at identified passage barriers. The Stibnite-Glory Hole passage project is a priority.		
	Secesh River	Entire Secesh Basin	Sediment effects on rearing and spawning success - lack of intersticial space, reduced pool volume, reduced spawning success	Road Decommissioning, Road Improvement, Culvert Removal / Replacement, Weed Management, Silvacultural BMPs	Included in EFSF Salmon above	
				2008-09 Total	***$4,519,300***	

Table 4-b. Snake River Steelhead 2008-2009 Additional Tributary Habitat Actions

Snake River Steelhead						
MPG	**Populations**	**Assessment Unit (AU)**	**Primary Limiting Factor(s) (PLF) by AU**	**Action Description**	**Cost Above BPA 2007-09 Planning Budget**	**Reporting Metric** *(tbd)*
Grande Ronde	Upper Grande Ronde	Mid Grande Ronde River and Tribs	In-channel characteristics	End Creek Restoration - Phase IV	$33,000	
				Willow Ck channel improvement /wetland restoration (new)	$600,000	4
				Indian Ck channel enhancement and wetland restoration	$500,000	4 mi
			Riparian / Floodplain	Indian/Little Indian Riparian fencing/water development 2009 start (FS)	$1,000	5
		Upper Grande Ronde and Tribs	In-channel characteristics	Upper GR River mine tailings (FS)	$300,000	2 mi
				Fly Ck (FS)	$275,000	6 mi
			Sediment	Camp Carson erosion control (FS)	$45,000	1 mi
		Catherine Creek	In-channel characteristics	In-steam enhancement, LWD, modify/enhance channel	$150,000	
			Riparian / Floodplain	livestock exclusion/reveg/weed control/expand streamside buffers/levee or road mod/restore meadows	$295,000	
				wetland project development	$50,000	
				Catherine Ck road obliteration/sediment reduction 2009 start (FS)	$55,000	2 mi
			Fish Passage	culverts/irrigation diversion improvements	$300,000	
				Catherine Creek State Diversion Fish Passage	$83,000	4 mi
				Catherine Creek Diversion Townley-Dobin	$140,000	25
				Catherine Creek Davis Dams Fish Passage (design)	$100,000	
				Scout Creek Culvert Replacement (design)	$6,000	

Table 4-b. Snake River Steelhead 2008-2009 Additional Tributary Habitat Actions

Snake River Steelhead						
MPG	**Populations**	**Assessment Unit (AU)**	**Primary Limiting Factor(s) (PLF) by AU**	**Action Description**	**Cost Above BPA 2007-09 Planning Budget**	**Reporting Metric** *(tbd)*
Clearwater River	Lochsa	Crooked Fork	Connectivity - Lack of access to diversity of habitats	Culvert Replacement or Removal	$500,000	
			Sediment effects on rearing and spawning success - lack of intersticial space, reduced pool volume, reduced spawning success	Road Removal and Improvement/ Land Acquisition		
			Temperature and Instream Habitat-poor quality pools and structure	Revegetation to allow for woody debris recruitment and riparian area cover. Land Acquisition		
		Middle Lochsa North Face Tribs (from Post Office to Bald Mountain)	Loss of riparian vegetation and complexity, lack of shade, loss of nutrients	Riparian Rehabilitation	$212,544	
			Lack of passage - Lack of access to diversity of habitats,	Culvert Replacement or Removal		
			Sediment effects on rearing and spawning success - lack of intersticial space, reduced pool volume, reduced spawning success	Road Decommissioning,Culvert Removal / Replacement, Noxious Weed Control		
			Temperature	Road Removal, Riparian Rehabilitation		
		Lower Lochsa (Fish Creek to Pete King Creek)	Loss of riparian vegetation and complexity, lack of shade, loss of nutrients	Riparian Rehabilitation	$800,000	
			Lack of passage - Lack of access to diversity of habitats	Culvert Replacement or Removal, Remove engineered instream structures		
			Temperature	Road Removal, Riparian Rehabilitation		
			Sediment effects on rearing and spawning success - lack of intersticial space, reduced pool volume, reduced spawning success	Road Decommissioning,Culvert Removal / Replacement, Noxious Weed Control		
	Lolo Creek	Musselshell Creek	Sediment from roads, timber harvest, cattle grazing, and historic mining - effects on rearing and spawning success, intersticial space and pool volume.	Road Decommissioning and road drainage improvements, Weed Control	$140,000	
		Musselshell Creek (con't)	Loss of riparian vegetation and complexity - lack of stream shading resulting in elevated temperatures	Riparian Rehabilitation & Large Woody Debris		
			Lack of passage - Lack of access to diversity of habitats,	Musselshell Tunnel/ Stream Relocation, Culvert Replacement		

Table 4-b. Snake River Steelhead 2008-2009 Additional Tributary Habitat Actions

Snake River Steelhead						
MPG	**Populations**	**Assessment Unit (AU)**	**Primary Limiting Factor(s) (PLF) by AU**	**Action Description**	**Cost Above BPA 2007-09 Planning Budget**	**Reporting Metric** *(tbd)*
Clearwater River (con't)	Lolo Creek (con't)	Yoosa Creek	Sediment from roads, timber harvest, cattle grazing, and historic mining - effects on rearing and spawning success, intersticial space and pool volume.	Road Decommissioning and road drainage improvements, Weed Control	$200,000	
		Lolo Creek	Sediment from roads, timber harvest, cattle grazing,- effects on rearing and spawning success, intersticial space and pool volume	Road obliteration and road drainage improvements	$200,000	
			Reduced channel complexity from streamside roads, reduced LWD & historic dredge mining	Riparian Rehabilitation & Large Woody Debris		
			Loss of riparian vegetation and complexity - lack of stream shading resulting in elevated temperatures	Riparian planting		
			Lack of passage - Lack of access to diversity of habitats.	Culvert Replacement, Eldorado Falls Adjustment		
	Selway River	O'Hara Creek	Sediment from roads, timber harvest, cattle grazing - effects on rearing and spawning success, intersticial space and pool volume.	Road Decommissioning and road drainage improvements, Weed Control	$50,000	
			Loss of riparian vegetation and complexity - lack of stream shading resulting in elevated temperatures	Riparian Rehabilitation & Large Woody Debris		
		Lower Selway River	Sediment from roads - effects on rearing and spawning success, intersticial space and pool volume.	Riparian Rehabilitation & Sediment Filters	$350,000	
			Lack of passage - Lack of access to diversity of habitats,	Culvert Replacement		
	South Fork Clearwater River	Newsome Creek	Channel Morphology - Channel straightened, lack of pools, lack of pool depth, lack of complexity, lack of cover	Channel / Riparian Rehabilitation	$643,200	
			Loss of riparian vegetation and complexity - dredge mine effects, lack of shade, loss of nutrients	Channel / Riparian Rehabilitation		
			Lack of passage - Lack of access to diversity of habitats,	Culvert Replacement		
			Sediment effects on rearing and spawning success - lack of intersticial space, reduced pool volume, reduced spawning success	Road Decommissioning, Road Improvement, Culvert Removal / Repalcement		

Table 4-b. Snake River Steelhead 2008-2009 Additional Tributary Habitat Actions

Snake River Steelhead						
MPG	**Populations**	**Assessment Unit (AU)**	**Primary Limiting Factor(s) (PLF) by AU**	**Action Description**	**Cost Above BPA 2007-09 Planning Budget**	**Reporting Metric** *(tbd)*
Clearwater River (con't)	South Fork Clearwater River (con't)	Meadow Creek	Sediment effects on rearing and spawning success - lack of intersticial space, reduced pool volume, reduced spawning success	Road Decommissioning, Soil Restoration, Culvert Removal / Replacement, Weed Control	$400,000	
			Lack of passage - Lack of access to diversity of habitats,	Culvert Replacement		
			Loss of riparian vegetation and complexity - lack of large woody debris recruitment resulting in lack of habitat complexity	Riparian Rehabilitation		
			Loss of riparian vegetation and complexity - lack of stream shading resulting in elevated temperatures	Riparian Rehabilitation		
		Mill Creek	Lack of passage - Lack of access to diversity of habitats,	Culvert Replacement	$300,000	
			Loss of riparian vegetation and complexity - lack of large woody debris recruitment resulting in lack of habitat complexity	Riparian Rehabilitation		
			Loss of riparian vegetation and complexity - lack of stream shading resulting in elevated temperatures	Riparian Rehabilitation		
		American River	Channel Morphology - Channel straightened, lack of pools, lack of pool depth, lack of complexity, lack of cover	Channel / Riparian Rehabilitation on Telephone, Whitaker, & Queen Creeks. BLM proposed restoration of American River.	$683,000	
			Loss of riparian vegetation and complexity - dredge mine effects, lack of shade, loss of nutrients	Channel / Riparian Rehabilitation on Telephone, Whitaker, & Queen Creeks		
			Lack of passage - Lack of access to diversity of habitats	Culvert Replacement		
			Sediment effects on rearing and spawning success - lack of intersticial space, reduced pool volume, reduced spawning success	Road Decommissioning, Road Improvement, Culvert Removal / Replacement, Weed Control		
			Riparian and channel alteration from floodplain/riparian development	Maines Estate Land Acquisition / Conservation Easements		

Table 4-b. Snake River Steelhead 2008-2009 Additional Tributary Habitat Actions

Snake River Steelhead						
MPG	**Populations**	**Assessment Unit (AU)**	**Primary Limiting Factor(s) (PLF) by AU**	**Action Description**	**Cost Above BPA 2007-09 Planning Budget**	**Reporting Metric** *(tbd)*
Clearwater River (con't)	South Fork Clearwater River (con't)	Crooked River	Channel Morphology - Channel straightened, lack of pools, lack of pool depth, lack of complexity, lack of cover	Channel / Riparian Rehabilitation, includes both BPA Proposals and FS Stewardship Actions	$770,800	
			Loss of riparian vegetation and complexity - dredge mine effects, lack of shade, loss of nutrients	Channel / Riparian Rehabilitation, includes both BPA Proposals and FS Stewardship Actions		
			Lack of passage - Lack of access to diversity of habitats	Culvert Replacement		
			Sediment effects on rearing and spawning success - lack of intersticial space, reduced pool volume, reduced spawning success	Road Decommissioning, Road Improvement, Culvert Removal / Replacement, Weed Control		
		Red River	Channel Morphology - Channel straightened, lack of pools, lack of pool depth, lack of complexity, lack of cover	Channel / Riparian Rehabilitation	$397,400	
			Loss of riparian vegetation and complexity - dredge mine effects, lack of shade, loss of nutrients	Channel / Riparian Rehabilitation		
			Lack of passage - Lack of access to diversity of habitats,	Culvert Replacement		
			Sediment effects on rearing and spawning success - lack of intersticial space, reduced pool volume, reduced spawning success	Road Decommissioning, Road Improvement, Culvert Removal / Replacement, Weed Control		
			Riparian and channel alteration from floodplain/riparian development.	Red River Meadows Land Acquisition / Conservation Easements		
Salmon River	Big Creek	Entire Big Creek Watershed	Chemical Pollution From Mining Activities	Mine Rehabilitation and Riparian Restoration	$590,000	
			Sediment effects on rearing and spawning success - lack of intersticial space, reduced pool volume, reduced spawning success	Road Decommissioning, Road Improvement, Culvert Removal / Replacement, Riparian Restoration near Mining Sites, Weed Management, Silvacultural BMPs		
			Migration Barriers associated with roads and mining activities	Assess stream crossings and anthropogenic migration barriers to determine actions necessary for salmonid passage. Provide for salmonid passage at identified passage barriers (e.g., culvert replacement).		

Table 4-b. Snake River Steelhead 2008-2009 Additional Tributary Habitat Actions

Snake River Steelhead						
MPG	**Populations**	**Assessment Unit (AU)**	**Primary Limiting Factor(s) (PLF) by AU**	**Action Description**	**Cost Above BPA 2007-09 Planning Budget**	**Reporting Metric** *(tbd)*
Salmon River (con't)	Secesh River	Entire Secesh Basin	Sediment effects on rearing and spawning success - lack of intersticial space, reduced pool volume, reduced spawning success	Road Decommissioning, Road Improvement, Culvert Removal / Replacement, Weed Management, Silvacultural BMPs	$162,800	
	South Fork Salmon	EFSF Salmon and tribs	Sediment effects on rearing and spawning success - lack of intersticial space, reduced pool volume, reduced spawning success	Road Decommissioning, Road Improvement, Culvert Removal / Replacement, Riparian Restoration, Mine Rehabilitation	Included in Secesh	
			Migration Barriers	Assess stream crossings and anthropogenic migration barriers to determine actions necessary for salmonid passage. Provide for salmonid passage at identified passage barriers. The Stibnite-Glory Hole passage project is a priority.		
			Heavy Metal Contamination	Mine oversight and management to protect and restore water quality and fish habitat. Riparian, floodplain, and wetland restoration.		
				2008-09 Total	***$9,332,744***	

Table 4-c. Upper Columbia River Steelhead 2008-2009 Additional Tributary Habitat Actions

Upper Columbia River Steelhead						
MPG	**Populations**	**Assessment Unit (AU)**	**Primary Limiting Factor(s) (PLF) by AU**	**Action Description**	**Cost Above BPA 2007-09 Planning Budget**	**Reporting Metric** *(tbd)*
Upper Columbia River - Below Chief Joseph	Okanogan River	Omak Creek MSA	Passage-culverts	Provide Passage at Barriers	$ 545,000	20 mi
		Small Trib Creeks Combined mSA	Riparian and floodplain function	Land Acquisition	$ 350,000	7.9 ac .5 mi
		Salmon Creek	Low stream flow	Water Acquisition		700 +AF
			In-channel habitat quantity*	Salmon Creek Project funded under 2007-09 F&W Pgm Funding Decision. Potential to fund water acquisition through the WaterEntity/CBWTP.	$ 251,000	4.3 mi
			Passage-flow barrier in lower reach	Improve Water Management/Channel Reconstruction		11 mi
		Loup Loup Creek	Low stream flow	Improve Water Management	$ 24,000	1.5 cfs
			Riparian and floodplain function	Water Conservation	$ 3,000	0.2 mi
			Passage- flow barrier in lower reach	Provide Passage at Barriers	$ 255,000	2.2 mi
				2008-09 Total	***$ 1,428,000***	

Table 5-a. Reclamation Technical Assistance Complementary to BPA-Funded Tributary Habitat Actions Listed in Tables 1, 2, and 3

Reclamation technical assistance for projects listed in Table 5a complements BPA-funded projects listed in Tables 1, 2, and 3.

Upper Columbia Steelhead

Limiting Factor	Project Title	Subbasin	Short Description
Habitat - Streamflow	Knapp-Wham/Hannon Detweiler Ditch Consolidation Phases 2	Entiat	Replace part of stream diversion with wells
Habitat - Access	Methow Valley Irrigation District East Canal Diversion	Methow	Will replace the structure with a new one located at the original point of diversion. The upstream location will allow a much less obtrusive structure that will not require a constructed fishway for passage.
Habitat - Access	Methow Valley Irrigation District West Canal Diversion	Methow	Design and construct a new diversion structure and headgate that would prevent entry and minimize the effects of MVD's operations on listed salmonids.
Habitat - Channel Complexity	Elbow Coulee Side Channel Restoration	Methow	The objective of this geomorphology project is to restore off-channel rearing habitat in a side channel off the mainstem Twisp River.
Habitat - Channel Complexity	Jennings Habitat Complexity Project	Methow	The purpose of the project is to reconnect the floodplain to the river and establish off-channel habitat.
Habitat - Channel Complexity	Upper Beaver Creek Side Channel Reconnection	Methow	This geomorphology project involves re-connecting a former beaver pond area and channel to the existing Beaver Creek channel in the Methow subbasin, with the objective of providing off-channel rearing habitat and floodplain connectivity.
Habitat - Channel Complexity	Buckley Floodplain Restoration	Methow	This project will provide off-channel rearing habitat and improve floodplain connectivity by providing flow and fish access to a series of existing ponds.
Habitat - Channel Complexity	Lower Eight Mile	Methow	Floodplain restoration in Middle Chewuch
Habitat - Channel Complexity	Windhaven Reach	Methow	Side Channel Reconnection in Lower Chewuch
Habitat - Channel Complexity	Lehman Reach Projects	Methow	Side channel Reconnection and ground water /irrigation water utilization in Middle Methow
Habitat - Channel Complexity	McNae Island Channel Restoration	Methow	Channel Restoration below MVID East Diversion

Reclamation provides technical assistance for habitat projects to improve survival of Upper Columbia steelhead populations in the Entiat, Methow, and Wenatchee subbasins. Reclamation technical assistance complements BPA-funded projects listed in Table 1.

Table 5-a. Reclamation Technical Assistance Complementary to BPA-Funded Tributary Habitat Actions Listed in Tables 1, 2, and 3

Upper Columbia Spring Chinook

Limiting Factor	Project Title	Subbasin	Short Description
Habitat - Streamflow	Knapp-Wham/Hannon Detweiler Ditch Consolidation Phases 2	Entiat	Replace part of stream diversion with wells
Habitat - Access	Methow Valley Irrigation District East Canal Diversion	Methow	Will replace the structure with a new one located at the original point of diversion. The upstream location will allow a much less obtrusive structure that will not require a constructed fishway for passage.
Habitat - Access	Methow Valley Irrigation District West Canal Diversion	Methow	Design and construct a new diversion structure and headgate that would prevent entry and minimize the effects of MVD's operations on listed salmonids.
Habitat - Channel Complexity	Elbow Coulee Side Channel Restoration	Methow	The objective of this geomorphology project is to restore off-channel rearing habitat in a side channel off the mainstem Twisp River.
Habitat - Channel Complexity	Jennings Habitat Complexity Project	Methow	The purpose of the project is to reconnect the floodplain to the river and establish off-channel habitat.
Habitat - Channel Complexity	Buckley Floodplain Restoration	Methow	This project will provide off-channel rearing habitat and improve floodplain connectivity by providing flow and fish access to a series of existing ponds.
Habitat - Channel Complexity	Lower Eight Mile	Methow	Floodplain restoration in Middle Chewuch
Habitat - Channel Complexity	Windhaven Reach	Methow	Side Channel Reconnection in Lower Chewuch
Habitat - Channel Complexity	Lehman Reach Projects	Methow	Side channel Reconnection and ground water /irrigation water utilization in Middle Methow
Habitat - Channel Complexity	McNae Island Channel Restoration	Methow	Channel Restoration below MVID East Diversion

Reclamation provides technical assistance for habitat projects to improve survival of Upper Columbia spring chinook populations in the Entiat, Methow, and Wenatchee subbasins. Reclamation technical assistance complements BPA-funded projects listed in Table 1.

Table 5-a. Reclamation Technical Assistance Complementary to BPA-Funded Tributary Habitat Actions Listed in Tables 1, 2, and 3

Snake River Spring/Summer Chinook

Limiting Factor	Project Title	Subbasin	Short Description
Habitat - Access	L-1 Diversion Replacement	Lemhi	The existing L-1 diversion push-up dam will be replaced with a permanent engineered structure that incorporates fish passage facilities to improve upstream and downstream migration.
Habitat - Access	L-3A0 Diversion Replacement	Lemhi	The existing gravel push-up dam spanning the Lemhi River, has no provisions for fish passage and can be an impediment during low streamflow conditions.
Habitat - Access	Lemhi River-L-44 Diversion Replacement	Lemhi	The L-44 irrigation diversion on the upper Lemhi River is a typical rock, push up diversion structure. Replacement with a permanent structure that accomodates fish passage will reduce instream maintenance and improve migration access.
Habitat - Access	L-7 Wasteway Ditch Fish Screen	Lemhi	The L-7 ditch is located on the Lemhi River, Lemhi County, ID. Presently adult salmon and steelhead that are migrating up the Lemhi River are being attracted into the return flow from the L-7 irrigation ditch system. A barrier or screen located near the ditch outlet is needed to prevent fish from entering the ditch system.
Habitat - Access	Pole Creek Diversion	Salmon River upstream from Redfish Lake	Replace wooden check structure with a structure passable to migrating fish
Habitat - Access	East Fork Salmon River-EF 13 Diversion	East Fork Salmon River	This project would construct a permanent diversion structure. Fish passage around the site will be provided.
Habitat - Access	East Fork Salmon River-EF 14 Diversion	East Fork Salmon River	EF 14 is an irrigation diversion with a gravel push-up dame. The diversion is unstable and must be re-built several times each year. This project would construct a more permanent rock diversion structure, along with a fish screen that meets NOAA criteria.
Habitat - Access	East Fork Salmon River EF 16 Diversion	East Fork Salmon River	EF 16 is an irrigation diversion with a gravel push-up dam. The diversion is unstable and must be rebuilt several times each year. This project would consolidate three diversions by building a more permanent rock diversion structure, building a new fish screen and new headgate structure.
Habitat - Access	Big Springs #1	Pahsimeroi	Replace gravel push-up streucture with a structure passable to migrating fish
Habitat - Access	Big Springs #2	Pahsimeroi	Replace gravel push-up streucture with a structure passable to migrating fish

Reclamation provides technical assistance for habitat projects to improve survival of Snake River spring/summer chinook populations in the Grande Ronde, Lemhi, Pahsimeroi, Upper Salmon (including Salmon River upstream and downstream from Redfish Lake, Valley Creek, East Fork Salmon River spring/summer chinook populations, and upper mainstem Salmon River and East Fork Salmon River steelhead populations), and Little Salmon subbasins. Reclamation technical assistance complements BPA-funded projects listed in Table 3.

Table 5-a. Reclamation Technical Assistance Complementary to BPA-Funded Tributary Habitat Actions Listed in Tables 1, 2, and 3

Snake River Steelhead

Limiting Factor	Project Title	Subbasin	Short Description
Habitat - Access	L-1 Diversion Replacement	Lemhi	The existing L-1 diversion push-up dam will be replaced with a permanent engineered structure that incorporates fish passage facilities to improve upstream and downstream migration.
Habitat - Access	L-3A0 Diversion Replacement	Lemhi	The existing gravel push-up dam spanning the Lemhi River, has no provisions for fish passage and can be an impediment during low streamflow conditions.
Habitat - Access	Lemhi River-L-44 Diversion Replacement	Lemhi	The L-44 irrigation diversion on the upper Lemhi River is a typical rock, push up diversion structure. Replacement with a permanent structure that accomodates fish passage will reduce instream maintenance and improve migration access.
Habitat - Access	L-7 Wasteway Ditch Fish Screen	Lemhi	The L-7 ditch is located on the Lemhi River, Lemhi County, ID. Presently adult salmon and steelhead that are migrating up the Lemhi River are being attracted into the return flow from the L-7 irrigation ditch system. A barrier or screen located near the ditch outlet is needed to prevent fish from entering the ditch system.
Habitat - Access	Pole Creek Diversion	Salmon River upstream from Redfish Lake	Replace wooden check structure with a structure passable to migrating fish
Habitat - Access	East Fork Salmon River-EF 13 Diversion	East Fork Salmon River	This project would construct a permanent diversion structure. Fish passage around the site will be provided.
Habitat - Access	East Fork Salmon River-EF 14 Diversion	East Fork Salmon River	EF 14 is an irrigation diversion with a gravel push-up dame. The diversion is unstable and must be re-built several times each year. This project would construct a more permanent rock diversion structure, along with a fish screen that meets NOAA criteria.
Habitat - Access	East Fork Salmon River EF 16 Diversion	East Fork Salmon River	EF 16 is an irrigation diversion with a gravel push-up dam. The diversion is unstable and must be rebuilt several times each year. This project would consolidate three diversions by building a more permanent rock diversion structure, building a new fish screen and new headgate structure.
Habitat - Access	Big Springs #1	Pahsimeroi	Replace gravel push-up structure with a structure passable to migrating fish
Habitat - Access	Big Springs #2	Pahsimeroi	Replace gravel push-up structure with a structure passable to migrating fish

Reclamation provides technical assistance for habitat projects to improve survival of Snake River steelhead populations in the Grande Ronde, Lemhi, Pahsimeroi, Upper Salmon (including Salmon River upstream and downstream from Redfish Lake, Valley Creek, East Fork Salmon River spring/summer chinook populations, and upper mainstem Salmon River and East Fork Salmon River steelhead populations), and Little Salmon subbasins. Reclamation technical assistance complements BPA-funded projects listed in Table 3.

Table 5-a. Reclamation Technical Assistance Complementary to BPA-Funded Tributary Habitat Actions Listed in Tables 1, 2, and 3

Mid-Columbia Steelhead

Limiting Factor	Project Title	Subbasin	Short Description
Habitat - Access	Middle Fork Smith Diversion (08 const)	Middle Fork John Day	Replace the current dam with a lay-flat stanchion type dam. The new structure would incorporate fish passage meeting current criteria.
Habitat - Access	North Ditch Diversion	Middle Fork John Day	Replace the current dam with a lay-flat stanchion type dam. The new structure would incorporate fish passage meeting current criteria.
Habitat - Access	South Ditch Diversion	Middle Fork John Day	Replace the current dam with a lay-flat stanchion type dam. The new structure would incorporate fish passage meeting current criteria.
Habitat - Access	Upper Clear Creek Diversion	Middle Fork John Day	Replace the current dam with a lay-flat stanchion type dam. The new structure would incorporate fish passage meeting current criteria.
Habitat - Access	Vinegar Creek Diversion	Middle Fork John Day	Replace the current dam with a lay-flat stanchion type dam. The new structure would incorporate fish passage meeting current criteria.
Habitat - Access	Big Boulder Creek Diversion	Middle Fork John Day	Replace the current dam with a lay-flat stanchion type dam. The new structure would incorporate fish passage meeting current criteria.
Habitat - Channel Complexity	TNC Phase I	Middle Fork John Day	The Nature Conservancy has asked Reclamation for technical assistance in design and planning for a variety of habitat improvements on their Dunstan Homestead Preserve property on the Middle Fork John Day. Phase I of the project will be to determine the feasibility and then the ultimate design and planning for three side channel projects.
Habitat - Channel Complexity	TNC Phase II	Middle Fork John Day	Improve complexity to the mainstem of the Middle Fork John Day River
Habitat - Channel Complexity	Big Boulder Creek	Middle Fork John Day	The Nature Conservancy and the Oregon Department of Fish and Wildlife acting as advisor to landowner has asked Reclamation for technical assistance in design and planning for channel reconfiguration and large wood placements on Big Boulder Creek.
Habitat - Channel Complexity	Dead Cow Gulch	Middle Fork John Day	Dead Cow Gulch is currently blocked to fish passage near its mouth by two culverts. The channel has also been moved to a different path which further limits access and available habitat. This project would reroute the stream into a more natural alignment and eliminate the culverts as a barrier.
Habitat - Access	Blue Mt Diversion	Upper John Day	Replace the current dam with a lay-flat stanchion type dam. The new structure would incorporate fish passage meeting current criteria.
Habitat - Access	Reynolds, Morgan Div.	Upper John Day	Replace the current dam with a lay-flat stanchion type dam. The new structure would incorporate fish passage meeting current criteria.
Habitat - Access	Reynolds, Axe Div.	Upper John Day	Replace the current dam with a lay-flat stanchion type dam. The new structure would incorporate fish passage meeting current criteria.
Habitat - Access	Panama Diversion (08 const)	Upper John Day	Replace the current dam with a lay-flat stanchion type dam. The new structure would incorporate fish passage meeting current criteria.
Habitat - Access	Bowers Ditch (08 const)	Upper John Day	Replace the current dam with a lay-flat stanchion type dam. The new structure would incorporate fish passage meeting current criteria.
Habitat - Access	Long Box (08 const)	Upper John Day	Replace the current dam with a lay-flat stanchion type dam. The new structure would incorporate fish passage meeting current criteria.
Habitat - Access	Beech Creek Crossing (08 const)	Upper John Day	Replace the current dam with a lay-flat stanchion type dam. The new structure would incorporate fish passage meeting current criteria.
Habitat - Access	Hufstader Pump (08 const)	Upper John Day	Replace instream diversion with a pump system

Table 5-a. Reclamation Technical Assistance Complementary to BPA-Funded Tributary Habitat Actions Listed in Tables 1, 2, and 3

Limiting Factor	Project Title	Subbasin	Short Description
Habitat - Access	Diversion, UPJD RM 210.2	Upper John Day	Replace the current dam with a lay-flat stanchion type dam. The new structure would incorporate fish passage meeting current criteria.
Habitat - Access	Diversion, UPJD RM 209	Upper John Day	Replace the current dam with a lay-flat stanchion type dam. The new structure would incorporate fish passage meeting current criteria.
Habitat - Access	Diversion, UPJD RM 222.5	Upper John Day	Replace the current dam with a lay-flat stanchion type dam. The new structure would incorporate fish passage meeting current criteria.
Habitat - Access	Diversion, Bridge Creek Diversion	Upper John Day	Replace the current dam with a lay-flat stanchion type dam. The new structure would incorporate fish passage meeting current criteria.
Habitat - Access	Diversion, UPJD RM 214.3	Upper John Day	Replace the current dam with a lay-flat stanchion type dam. The new structure would incorporate fish passage meeting current criteria.
Habitat - Access	Diversion, UPJD RM 253.3	Upper John Day	Replace the current dam with a lay-flat stanchion type dam. The new structure would incorporate fish passage meeting current criteria.
Habitat - Access	Diversion, UPJD RM 253.2	Upper John Day	Replace the current dam with a lay-flat stanchion type dam. The new structure would incorporate fish passage meeting current criteria.
Habitat - Access	Diversion, UPJD RM 252.3	Upper John Day	Replace the current dam with a lay-flat stanchion type dam. The new structure would incorporate fish passage meeting current criteria.
Habitat - Access	Page Pump Station RM 231.7	Upper John Day	Replace instream diversion with a pump system
Habitat - Channel Complexity	Reach 8 Design	Upper John Day	The work will involve design of features to improve habitat. The river is partially constrained by levees resulting in a fairly straight, wide, and shallow cross section. The proposed project is to remove the levees and strategically place large wood to increase channel complexity, narrow the channel, and stimulate natural increases in sinuosity.

Reclamation provides technical assistance for habitat projects to improve survival of Mid-Columbia River steelhead populations in the North Fork, Middle Fork, Upper Main, and South Fork John Day River subbasins. Reclamation technical assistance complements BPA-funded projects listed in Table 2.

Table 5-b. Reclamation Technical Assistance Supplementary to BPA-Funded Tributary Habitat Actions Listed in tables 1, 2, and 3

Reclamation technical assistance in Table 5b supplements BPA funding and Reclamation technical assistance associated with projects listed in Tables 1, 2, 3, and 5a. The habitat actions listed in this table are currently planned to be implemented without BPA funding and were not identified in time to be included in the evaluation of the changes in habitat quality listed in Attachment B.2.2-1. Implementation of the habitat actions in this table from 2007 through 2009 is expected to contribute an additional habitat quality improvement beyond the amounts shown in Attachment B.2.2-1; this will be evaluated in the future. Replacements are not necessary as no benefit was claimed yet.

Upper Columbia Steelhead

Limiting Factor	Project Title	Subbasin	Short Description
Habitat - Channel Access	Stormy Creek Culverts	Entiat	This project restores passage at 2 culverts on Stormy Creek
Habitat - Channel Access Channel Complexity	Knapp-Wham/Hannon Detweiler Ditch Consolidation Phases 1 and 3	Entiat	Consolidation of two ditches with diversions that constitute barriers with one diversion reconfigured to better pass ESA listed anadromous species.
Habitat - Channel Complexity	Bridge to Bridge Resoration, Phases 4 and 5	Entiat	Phases II and III will reconnect off-channel habitat, reconnect floodplain connectivity and off-channel habitat, restore mainstem large pool habitat for adult resting and restore cover and restore streambank stability and riparian vegetation.
Habitat - Channel Complexity	Stillwater Complexity Project	Entiat	The intended impacts of this measure are to increase LWD density and habitat diversity, as well as the amount of backwater pool and tool tail-out habitat.
Habitat - Channel Complexity	Keystone Canyon	Entiat	Remove push-up diversion dam and add habitat improvement/floodplain conectivity features
Habitat - Channel Complexity	Harrison Side Channel	Entiat	Side channel reconnection
Habitat - Channel Complexity, Entrainment	Milne Diversion Removal	Entiat	Remove diversion and replace with multiple instream habitat structures
Habitat - Channel Access	Three Mission Creek Projects: Miller, Turnbull and Jurgins	Wenatchee	Miller and Turnbull- Repair and installation of low stage log weirs to re-establish plunge pool habitat and thalweg, and increase complexity. Jurgins- Install a low stage rock weir with large woody debris to provide plunge pool habitat, control bank erosion, increase complexity, and re-establish thalweg.
Habitat - Channel Access	Gagnon Diversion Project	Wenatchee	This project will address a partial barrier to listed salmonids in the Wenatchee River near Cashmere WA by eliminating the need for annual maintenance and periodic re-excavation of a side channel used as a source for irrigation withdrawal.
Habitat - Channel Access	Alder Creek #2 Culvert Passage Project	Wenatchee	This culvert is a barrier to fish passage because of the outfall velocities associated with it. This project will consist of a detailed analysis of the culvert using WDFW protocol and replacing it as necessary.
Habitat - Channel Access	WPP Alder Creek 2 & 3	Wenatchee	This project proposes to replace a culvert on Alder Creek that doesn't meet cjrrent WDFW and NOAA passage criteria. It carries a paved county road over Alder Creek, and will be analyzed as both a retrofit and replacement.
Habitat - Channel Access	WPP Beaver Creek 3 Culvert Replacements	Wenatchee	This project will address 3 barrier culverts on Beaver Creek by replacing the existing culverts with modular bridges with a span less than 30 feet.
Habitat - Channel Complexity	Wenatchee Watershed Fluvial Habitat Resoration Plan	Wenatchee	The deliverable of this RFP will be a Wenatchee Watershed Fluvial Habitat Restoration Plan Scope of Work . A draft of the plan will be required by May 31, 2007
Habitat - Channel Complexity	Gagnon CMZ Project	Wenatchee	This project proposes to create (excavate) a backchannel feature (along the floodplain of the Gagnon CMZ Site) to link the existing pond to the main stream, thus providing high flow salmonid refuge habitat.
Habitat - Channel Complexity, Entrainment	Jones Shotwell Ditch	Wenatchee	This project would bring the Jones Shotwell Ditch Company's fish screen into compliance with NOAA Fisheries criteria.
Habitat - Channel Access	Red Shirt Diversion Renovation	Methow	This project will remove the last irrigation-related passage barrier in Beaver Creek - a major tributary of the Methow River

Table 5-b. Reclamation Technical Assistance Supplementary to BPA-Funded Tributary Habitat Actions Listed in tables 1, 2, and 3

Limiting Factor	Project Title	Subbasin	Short Description
Habitat - Channel Access	Poorman Creek Road Culvert Replacement	Methow	This project will replace a barrier culvert on a County Road
Habitat - Channel Complexity	Big Valley Reach Assessment	Methow	Reach Assessment study of Big Valley Reach to identify complexity projects in reach
Habitat - Channel Complexity	Heath Floodplain Restoration	Methow	This project will create passage into 2 spring- fed ponds that are currently blocked by dams and road embankments. It will also bridge two streams that are currently crossed by vehicles using unimproved fords which has degraded the streams in the vicinity
Habitat - Channel Complexity	Lower Eightmile Floodplain Restoration	Methow	This project will create passage into 2 spring- fed ponds that are currently blocked by dams and road embankments. It will also bridge two streams that are currently crossed by vehicles using unimproved fords which has degraded the streams in the vicinity
Habitat - Channel Complexity	Patterson Pond Reconnect	Methow	Floodplain restoration in Middle Chewuch
Habitat - Channel Complexity	Fender Mill Floodplain Restoration	Methow	This project will remove the remnants of an old lumber mill pond and irrigation causing stranding after high flows from the floodplain. It will also reconnect a side channel blocked by the remains of the dams headworks.

Reclamation technical assistance supplements projects listed in Table 1.

Upper Columbia Spring Chinook

Habitat - Channel Access	Stormy Creek Culverts	Entiat	This project restores passage at 2 culverts on Stormy Creek
Habitat - Channel Access Channel Complexity	Knapp-Wham/Hannon Detweiler Ditch Consolidation Phases 1 and 3	Entiat	Consolidation of two ditches with diversions that constitute barriers with one diversion reconfigured to better pass ESA listed anadromous species.
Habitat - Channel Complexity	Bridge to Bridge Resoration, Phases 4 and 5	Entiat	Phases II and III will reconnect off-channel habitat, reconnect floodplain connectivity and off-channel habitat, restore mainstem large pool habitat for adult resting and restore cover and restore streambank stability and riparian vegetation.
Habitat - Channel Complexity	Stillwater Complexity Project	Entiat	The intended impacts of this measure are to increase LWD density and habitat diversity, as well as the amount of backwater pool and tool tail-out habitat.
Habitat - Channel Complexity	Keystone Canyon	Entiat	Remove push-up diversion dam and add habitat improvement/floodplain conectivity features
Habitat - Channel Complexity	Harrison Side Channel	Entiat	Side channel reconnection
Habitat - Channel Complexity, Entrainment	Milne Diversion Removal	Entiat	Remove diversion and replace with multiple instream habitat structures
Habitat - Channel Access	Three Mission Creek Projects: Miller, Turnbull and Jurgins	Wenatchee	Miller and Turnbull- Repair and installation of low stage log weirs to re-establish plunge pool habitat and thalweg, and increase complexity. Jurgins- Install a low stage rock weir with large woody debris to provide plunge pool habitat, control bank erosion, increase complexity, and re-establish thalweg.
Habitat - Channel Access	Gagnon Diversion Project	Wenatchee	This project will address a partial barrier to listed salmonids in the Wenatchee River near Cashmere WA by eliminating the need for annual maintenance and periodic re-excavation of a side channel used as a source for irrigation withdrawal.
Habitat - Channel Access	Alder Creek #2 Culvert Passage Project	Wenatchee	This culvert is a barrier to fish passage because of the outfall velocities associated with it. This project will consist of a detailed analysis of the culvert using WDFW protocol and replacing it as necessary.

Table 5-b. Reclamation Technical Assistance Supplementary to BPA-Funded Tributary Habitat Actions Listed in tables 1, 2, and 3

Limiting Factor	Project Title	Subbasin	Short Description
Habitat - Channel Access	WPP Alder Creek 2 & 3	Wenatchee	This project proposes to replace a culvert on Alder Creek that doesn't meet cjrrent WDFW and NOAA passage criteria. It carries a paved county road over Alder Creek, and will be analyzed as both a retrofit and replacement.
Habitat - Channel Access	WPP Beaver Creek 3 Culvert Replacements	Wenatchee	This project will address 3 barrier culverts on Beaver Creek by replacing the existing culverts with modular bridges with a span less than 30 feet.
Habitat - Channel Complexity	Wenatchee Watershed Fluvial Habitat Resoration Plan	Wenatchee	The deliverable of this RFP will be a Wenatchee Watershed Fluvial Habitat Restoration Plan Scope of Work . A draft of the plan will be required by May 31, 2007
Habitat - Channel Complexity	Gagnon CMZ Project	Wenatchee	This project proposes to create (excavate) a backchannel feature (along the floodplain of the Gagnon CMZ Site) to link the existing pond to the main stream, thus providing high flow salmonid refuge habitat.
Habitat - Channel Complexity, Entrainment	Jones Shotwell Ditch	Wenatchee	This project would bring the Jones Shotwell Ditch Company's fish screen into compliance with NOAA Fisheries criteria.
Habitat - Channel Complexity	Big Valley Reach Assessment	Methow	Reach Assessment study of Big Valley Reach to identify complexity projects in reach
Habitat - Channel Complexity	Heath Floodplain Restoration	Methow	This project will create passage into 2 spring- fed ponds that are currently blocked by dams and road embankments. It will also bridge two streams that are currently crossed by vehicles using unimproved fords which has degraded the streams in the vicinity
Habitat - Channel Complexity	Lower Eightmile Floodplain Restoration	Methow	This project will create passage into 2 spring- fed ponds that are currently blocked by dams and road embankments. It will also bridge two streams that are currently crossed by vehicles using unimproved fords which has degraded the streams in the vicinity
Habitat - Channel Complexity	Patterson Pond Reconnect	Methow	Floodplain restoration in Middle Chewuch
Habitat - Channel Complexity	Fender Mill Floodplain Restoration	Methow	This project will remove the remnants of an old lumber mill pond and irrigation causing stranding after high flows from the floodplain. It will also reconnect a side channel blocked by the remains of the dams headworks.

Reclamation technical assistance supplements projects listed in Table 1.

Snake River Spring/Summer Chinook

Reclamation provides technical assistance for habitat projects to improve survival of Snake River spring/summer chinook populations in the Grande Ronde, Lemhi, Pahsimeroi, Upper Salmon (including Salmon River upstream and downstream from Redfish Lake, Valley Creek, East Fork Salmon River spring/summer chinook populations, and upper mainstem Salmon River and East Fork Salmon River steelhead populations), and Little Salmon subbasins. Reclamation technical assistance supplements projects listed in Table 3.

Snake River Steelhead

Reclamation provides technical assistance for habitat projects to improve survival of Snake River steelhead populations in the Grande Ronde, Lemhi, Pahsimeroi, Upper Salmon (including Salmon River upstream and downstream from Redfish Lake, Valley Creek, East Fork Salmon River spring/summer chinook populations, and upper mainstem Salmon River and East Fork Salmon River steelhead populations), and Little Salmon subbasins. Reclamation technical assistance supplements projects listed in Table 3.

Mid-Columbia Steelhead

Habitat - Channel Complexity	CTWSRO (MCA)	Middle Fork John Day	Multidisciplenary Channel Assessment study of Middle Fork John Day geomorphology to help identify feasibility and scope of potential channel complexity projects
Habitat - Channel Complexity	CTWSRO (MCA Study)	Upper John Day	Multidisciplenary Channel Assessment study of Upper John Day geomorphology to help identify feasibility and scope of potential channel complexity projects

Reclamation provides technical assistance for habitat projects to improve survival of Mid-Columbia River steelhead populations in the North Fork, Middle Fork, Upper Main, and South Fork John Day River subbasins. Reclamation technical assistance supplements projects listed in Table 2.

Table 6. Habitat Actions for Lower Columbia River ESUs

Lower Columbia ESUs						
ESU /Population	**Tributary Habitat Limiting Factors**	**BPA Project Nbr**	**Average annual planning budget**	**Project Title & Short Description**	**Action Description**	**Reporting Metric**
Lower Columbia River coho/Lower Gorge tributaries Lower Columbia River Spring Chinook/Hood Lower Columbia River steelhead (summer & winter)/Hood	Altered channel morphology and floodplain, excessive sediment, degraded water quality, reduced streamflow, impaired passage	199802100	$657,333	Hood River Fish Habitat Implement habitat improvement actions in the Hood River subbasin that will support wild fish and supplementation efforts of the Hood River Production Program (HRPP).	Increase Instream Habitat Complexity	* # of stream miles treated
					Install Fence	* # of miles of fence
					Plant Vegetation	* # of acres of planted
						* # of riparian miles treated
					Install Fish Passage Structure	* # of miles of habitat accessed
					Install Fish Screen	* Does the screen meet NOAA/FSOC specs?
						* Flow rate at the screen diversion allowed by the water right
						* Quantity of water protected by screening, as determined by what is stated in the water right or calculated based on flow rate
					Remove/Modify Dam	* # of miles of habitat accessed
					Install Pipeline	* Amount of unprotected water flow returned to the stream by conservation in cfs
						* Estimated # of miles of primary stream reach improvement
					Plant Vegetation	(blank)
					Realign, Connect, and/or Create Channel	* # of stream miles treated, including off-channels, after realignment
					Remove/Modify Dam	* # of miles of habitat accessed
Lower Columbia River steelhead (summer & winter)/Wind	Altered channel morphology and floodplain, excessive sediment, degraded water quality, reduced streamflow, impaired passage	200707700	$917,333	Hemlock Dam Removal This project will remove a 26-ft high dam on Trout Creek, a tributary to the Wind River. Trout Creek provides spawning and rearing habitat for LCR steelhead. The project will restore unimpeded fish passage and improve water quality and habitat.	Plant Vegetation	(blank)
					Realign, Connect, and/or Create Channel	* # of stream miles treated, including off-channels, after realignment
					Remove/Modify Dam	* # of miles of habitat accessed

Attachment B.2.2-3
Lower Columbia River Estuary Partnership Criteria for Identifying and Prioritizing Habitat Protection and Restoration Projects

Criteria for Identifying and Prioritizing Habitat Protection and Restoration Projects on the Lower Columbia River and Estuary*

Ecosystem Criteria

1) Habitat Connectivity
This criterion recognizes that habitat connectivity is a landscape level concept. It emphasizes linkages between habitat areas that provide a variety of functions for species at various stages of their life cycle and that gradual alteration of landscapes through natural succession and retrogression allow species that require a variety of habitat components to disperse and survive. In the Lower Columbia, historic changes have limited or cut off species' access to resources needed for their development. Specific emphasis on species with narrow ecological requirements should be considered. Upland habitat areas adjacent to drainage ways, existing protected/restored sites, and areas offering diverse habitat types, function, and successional stages should also be considered.

2) Areas of Historic Habitat Type Loss
Land use activities such as diking, filling, and shoreline hardening have removed many of the shallow, peripheral wetlands along the Lower Columbia, isolating the river from its floodplain. This criterion recognizes that historic wetland types such as emergent and forested wetlands that are particularly important for salmonids and a variety of bird species, have been greatly diminished. These habitats promote networks of physical complexity such as shallow, dendritic channels and backwater sloughs.

3) Improvement in Ecosystem Function
This criterion acknowledges that some restoration actions can result in greater enhancement of ecosystem functions than others. This criterion emphasizes that location of a project may in some cases be more important than size of the project.

4) Adequate Size and Shape
Size refers to reach length and the size of the potential habitat within a reach. In general, larger size enhances habitat stability, increases the number of species that can potentially use the site, makes it easier to find by migratory species, and increases within-habitat complexity.

5) Level of Complexity
This criterion refers to the number and interspersion of different types of habitats within a given restoration reach or area. As the number of habitats increase, so do the number of species that can occupy an area, and the number of functions supported by an area. Higher complexity potentially results in higher biodiversity. It is recognized that some restoration efforts, such as a chum channel, may not strive for habitat complexity.

6) Accessibility For Target Species
Accessibility refers to unencumbered access by Columbia River estuary habitat-dependent aquatic and terrestrial species. Projects that allow or enhance access of these species to important habitats would potentially enhance the feeding, rearing, and refuge functions of the site are preferred. This criterion acknowledges the need to restore habitat for those threatened and endangered species, both aquatic and terrestrial, whose populations are at precariously low numbers and who might benefit from improved near-shore habitat conditions.

Implementation Criteria

1) Use Natural Processes to Restore and Maintain Structure over Habitat Creation
This criterion recognizes that restoration measures should attempt to re-establish the dynamics of estuarine hydrology, sedimentology, geomorphology and other habitat-forming processes that naturally create and maintain habitat, rather than implanting habitat structures at inappropriate or unsustainable locations. Restoration tasks should initiate or accelerate natural processes. Nearly all manifestations of restoration are accomplished by these processes and not by the direct artifice of the restoration. Complex engineering manipulations to create new habitats or to enhance existing habitats can introduce levels of uncertainty about the ecological impacts of such actions and/or the application of the results to other locations.

Restoration methods such as dike, levee, and tide gate removal should receive first priority for restoration since historic habitat features of the surrounding area may still be intact. Areas that require minor alterations and maximize ecosystem function and processes offer a higher certainty of outcomes and may be more cost-effective and self-sustaining. Weight should be given to tidegate improvements with access to quality stream channels where dike breaching is not an option. For purposes of setting natural processes rapidly in motion some artificial manipulation is required, the best ecological engineering practices should be applied in implementing restoration projects, using all available ecological knowledge and maximizing the use of natural processes to achieve goals.

2) Community Support and Participation
Developing partnerships among communities, organizations, individuals and agencies is a critical element to long term estuary restoration success. The following are considerations regarding this criterion:

A. Choose projects with local support that are popular and visible, and have political and environmental education components.
B. Visible, local partners (i.e., those that are technically capable/and can facilitate discussions between local project sponsors and Federal/State agency representatives) are needed to build community support for habitat restoration and protection projects
C. Select habitat restoration and protection projects that are linked to community/watershed councils' goals and objectives
D. Look for synergy with existing projects, spatially and biologically, and those with community support and ecological output. That involvement requires creativity and flexibility on the part of all involved to look for ecological, social, and economics incentives when identifying potential projects
E. Depending on the stakeholder and/or landowner, social and economic considerations may be as important as environmental considerations when choosing potential habitat restoration and protection projects

3) Potential for Self Maintenance and Certainty of Success
Self-maintenance addresses the ability of a site to persist and evolve toward a natural (historical) habitat condition without significant on-going human intervention. Conditions for controlling factors in the reach and in the management unit must be appropriately developed and maintained. Self-maintenance means that the habitat can persist and develop under natural climatic variation, and that the system has a natural degree of resilience to natural perturbations. This criterion relies on needing to know the historical conditions and factors attributed to the current conditions.

4) Potential for Improvement in Ecosystem Function While Avoiding Impacts to Healthy and Functioning Ecosystems
This criterion observes that at times there are competing restoration goals, and while attempting to improve some ecosystem functions, others may be impaired or lost. This criteria stresses that restoration actions should achieve proposed benefits while avoiding the long term or permanent degradation of other ecological functions of natural habitats or broader ecosystems. Restoration actions should avoid replacing one naturally functioning habitat with another, even if the replacement is perceived to benefit salmon. In particular, activities that further reduce the estuarine tidal prism or impair other large-scale estuarine processes (e.g., circulation, salinity intrusion) or attributes should be avoided.

5) Avoid Sites Where Irreversible Change Has Occurred
Many aquatic ecosystems within the Estuary have been so heavily modified that the fundamental processes responsible for historic conditions have been significantly altered, in some cases irrevocably. In the Lower Columbia River, freshwater volume has been reduced or the natural flow cycle altered, inputs of sediments and detritus have changed, and tidal flow has been compromised. In some cases, restoration of historic conditions in their original location or state is simply no longer attainable without restoration of historic processes.

Reconstructing the historical river, tidal floodplain and estuarine structure does not necessarily guarantee restoration success; it only decreases uncertainty. Historic templates often provide the framework for restoration goals, as well as a perspective on how ecosystems have been incrementally degraded. At the minimum, the modified capacities of natural processes to support restoring habitats under present conditions must be well understood to develop realistic restoration goals. In some instances, ecological engineering may be necessary to compensate for diminished processes, but such approaches should be used to initiate self-sustaining restoration rather than as an artificial “fix” requiring long-term maintenance.

6) Capacity of Sponsor/Partnership
Restoration projects are often complex and costly. To effectively implement and monitor a restoration project over the long term it is necessary that the sponsor and project partners have the capacity to successfully manage the project and achieve success. This criterion will consider an organization’s record of project management, its technical expertise, and financial stability.

7) Project Context Within Broader Management and Planning Objectives
This criterion recognizes that within the Lower Columbia system there are a number of management plans and objectives that articulate specific restoration and conservation recommendations. Some of these include; Northwest Power and Conservation Council’s Subbasin Plans, Lower Columbia Fish Recovery Board priorities, Oregon’s Coastal and Estuarine Land Conservation Plan, North American Waterfowl Management Plan, and the Columbia Land Trust’s Land Conservation Priorities. In evaluating proposed restoration projects, considerations should be made to coordinate with these initiatives to minimize duplication of services or contradictory endeavors.

Monitoring Criteria

1) Monitoring and Evaluation with Relationship to Stated Goals and Objectives
Monitoring and adaptive management are essential components of restoration and habitat management. Restoration activities should be placed in the context of an experimental design strategy. Metrics should be developed that enhance an understanding of the connection between habitat variables and species' needs. Restoration designs should be monitored and, based on the concept of adaptive management, altered if necessary to achieve desired endpoints and to insure that local projects are self-sustaining. Information already available on limiting factors and properly functioning conditions should be included in the site selection and project design. The monitoring information must span both water quality and physical habitat parameters. Determining an appropriate scale is a critical component of developing a monitoring and effectiveness criteria.

Goals and biological objectives for restoration should be clearly stated, site specific, measurable and long-term, in many cases greater than 20 years. Performance criteria should derive directly from these goals, and should include both functional and structural elements and be linked to suitable, local reference ("target") habitats. Scientific monitoring based on the established performance criteria is essential to improve restoration techniques and to achieve estuarine restoration goals. Performance criteria should indicate whether restoration is progressing as intended and how the project may be altered or redesigned to better achieve project goals.

2) Linkages to Reference Site(s)
Determining the effectiveness of restoration activities requires comparison to relatively unaltered reference habitats in close proximity to serve as a "control" for evaluating habitat change. This allows for monitoring the growth, species composition, successional stage and time period of the restoration site in comparison to the reference site and assist in developing performance standards and benchmarks for restoration activities in the estuary. Choosing sites that include an experimental restoration design tied to effectiveness monitoring helps promote a better understanding of the relationship between habitat restoration activities and species response and performance resulting from the restoration activity.

3) Transferability of Results
Projects should be designed as explicit tests of restoration actions that will be evaluated, and, if effective, can be scaled up and applied systematically across the landscape. Restoration results should be evaluated uniformly at individual sites and comprehensively at landscape and ecosystem scales to assess whether the cumulative results of local restoration actions achieve overall recovery goals. The results of monitoring can provide the foundation for more effective restoration methods in future projects.

* These criteria are derived in part from:

- **Guiding Ecological Principles For Restoration of Salmon Habitat in the Columbia River Estuary**, Charles ("Si") Simenstad, Dan Bottom
- **An Ecosystem-based Approach to Habitat Restoration Projects with Emphasis on Salmonids in the Columbia River Estuary** - Johnson, G.E., R.M. Thom, A.H. Whiting, G.B. Sutherland, N. Ricci, J.A. Southard, B.D. Ebberts, and J.D. Wilcox. September 30, 2003.
- **Proceedings of the Lower Columbia River and Estuary Habitat Conservation and Restoration Workshop**, Astoria, Oregon - 2001

Section B.2.3—Hatchery Action

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ACRONYMS AND ABBREVIATIONS

BiOp	biological opinion
BMP	best management practice
CCT	Colville Confederated Tribes
Council	Northwest Power and Conservation Council
CTUIR	Confederation Tribes of the Umatilla Indian Reservation
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FCRPS	Federal Columbia River Power System
FY	fiscal year
H/H	Hatchery/Harvest Workgroup
HSRG	Hatchery Scientific Review Group
IDFG	Idaho Department of Fish and Game
LSCRP	Lower Snake River Compensation Plan
NEOH	Northeast Oregon Hatchery
NEPA	National Environmental Policy Act
NFH	National Fish Hatchery
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPT	Nez Perce Tribe
O&M	operations and maintenance
ODFW	Oregon Department of Fish and Wildlife
PWG	Policy Work Group
RA	Reasonable and Prudent Alternative
RM&E	research, monitoring, and evaluation
SBSTOC	Stanley Basin Sockeye Technical Oversight Committee
SNAPP	Safety-Net Artificial Propagation Program
USFWS	U.S. Fish and Wildlife Service

B.2.3 HATCHERY ACTION

B.2.3.1 Introduction

The Action Agencies remain committed in their efforts towards reversing the decline of Endangered Species Act (ESA)-listed salmonid species in the Columbia River Basin. The Action Agencies specific objective is to fund the Federal Columbia River Power System (FCRPS) Mitigation Hatchery Program in a way that contributes to reversing the decline of downward-trending Evolutionarily Significant Units (ESUs) and Distinct Population Segments (DPSs, which is an equivalent term to ESU often used for steelhead).

The global objectives and strategies of the Hatchery Action for all ESUs and DPSs, are:

1. To include, as part of the ESA Section 7 Consultation with National Marine Fisheries Service (NMFS, also called National Oceanic and Atmospheric Administration [NOAA] Fisheries) on the operation of the FCRPS:
    - programmatic consideration of the Federal Action Agencies' funding of all FCRPS hatchery programs required as mitigation for the operation of the FCRPS; and
    - the use and adequacy of the proposed funding decision criteria to reduce impacts of FCRPS hatchery programs on ESA-listed anadromous fish.

2. Describe other specific hatchery actions proposed for Action Agencies' funding intended to prevent extinction, improve viability, and contribute to recovery of listed salmon and steelhead populations in the Interior Columbia River Basin including funding of these categories of actions:
    - actions to reform FCRPS hatchery programs to eliminate or reduce their impact on listed populations; and
    - safety-net programs and other types of conservation hatchery programs to prevent extinction, improve viability, and contribute to recovery of listed salmon and steelhead populations in the interior Columbia River Basin.

The Action Agencies have identified two specific hatchery strategies and their underlying actions that are either ongoing or will be implemented for the Hatchery Action (Figure B.2.3-1).

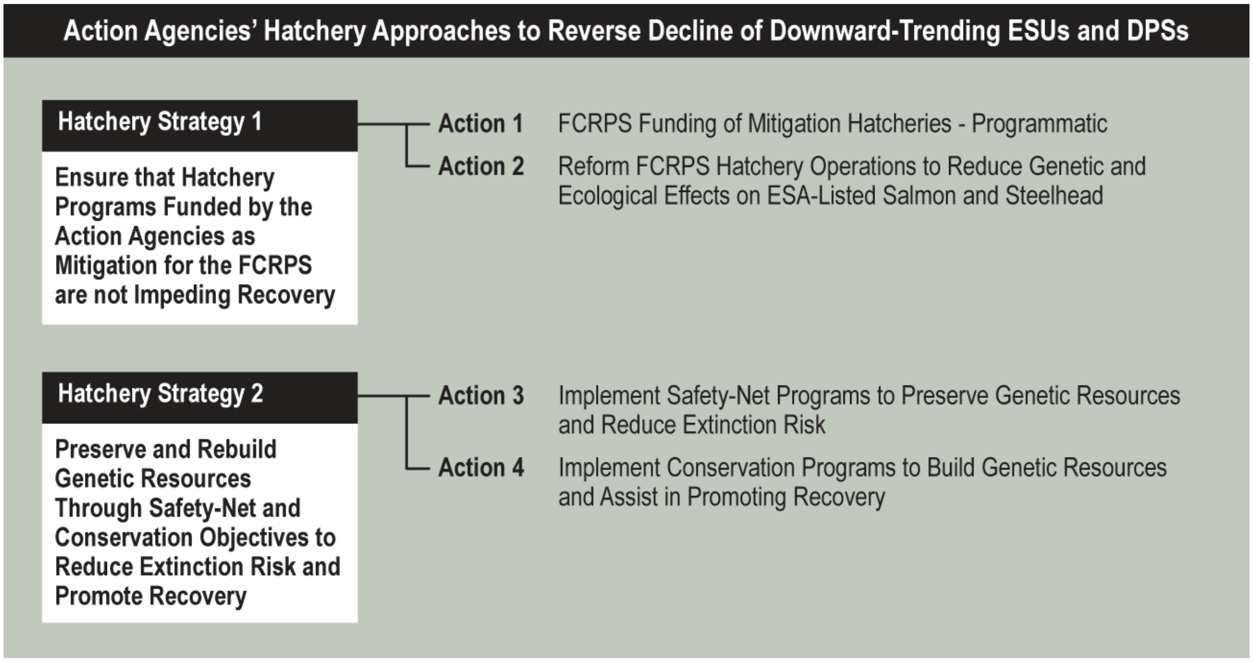

Figure B.2.3-1. Hatchery Approaches to Reverse the Decline of Downward-Trending ESUs

Hatchery Strategy 1 – Ensure that hatchery programs funded by the Action Agencies as mitigation for the FCRPS are not impeding recovery of ESUs. This strategy consists of two actions.

Hatchery Action 1 –FCRPS Funding of Mitigation Hatcheries – Programmatic

The Action Agencies will adopt programmatic criteria for funding decisions on mitigation programs for the FCRPS that incorporate best management practices (BMPs). (Site specific application of BMPs will be defined in ESA Section 7, Section 10, or Section 4(d) consultations with NMFS to be initiated and conducted by hatchery operators with the Action Agencies as cooperating agencies.)

Hatchery Action 2 - Reform FCRPS Hatchery Operations to Reduce Genetic and Ecological Effects on ESA-Listed Salmon and Steelhead

The Action Agencies will undertake/fund reforms to ensure that hatchery programs funded by the Action Agencies as mitigation for the FCRPS are not impeding recovery. The Action Agencies will work with FCRPS mitigation hatchery operators to cost effectively address needed reforms of current hatchery programs while continuing to meet mitigation responsibilities. Specific reforms to be implemented under this action (following any necessary regularly approval) are listed in Table B.2.3-1 (at the end of this section). Other reforms will be identified and implemented following the conclusion of the Columbia River Hatchery Scientific Review Group (HSRG) process.

For the majority of FCRPS mitigation programs, the Action Agencies intend to begin implementation by working with the hatchery operators after these reforms are identified in the current basin-wide review and reform processes. This process includes the Congressionally mandated Columbia River HSRG and the U.S. Fish and Wildlife Service's (USFWS) hatchery review. Both of these hatchery reviews are scheduled for completion in 2008. All implementation is expected to occur within the time period of the FCRPS biological opinion (BiOp).

For FCRPS mitigation hatchery operations identified by NMFS as currently constituting a primary concern (including a factor limiting natural viability of Interior Columbia listed populations), the Action Agencies believe that more rapid action is called for and will expedite work with the hatchery operators to address needed changes to hatchery operations. Some aspects of the Leavenworth National Fish Hatchery complex have been identified in this category.

The Action Agencies have initiated review of the John Day Hatchery Mitigation Program.

Hatchery Strategy 2 – Preserve and rebuild genetic resources through safety-net and conservation objectives to reduce extinction risk and promote recovery. This strategy consists of two actions.

Hatchery Action 3 - Implement Safety-Net Programs to Preserve Genetic Resources and Reduce Extinction Risk

The Action Agencies will continue to fund the operation of on-going "safety-net" programs that are providing benefits to ESA-listed stocks at high risk of extinction by increasing abundance and preserving genetic diversity, and will identify and plan for additional safety-net programs, as needed. Specific safety-net programs to be implemented under this action are listed in Table B.2.3-1.

Hatchery Action 4 - Implement Conservation Programs to Build Genetic Resources and Assist in Promoting Recovery

The Action Agencies will implement conservation programs for ESA-listed stocks where the programs assist in recovery. Specific conservation programs to be implemented under this action are listed in Table B.2.3-1.

The hatchery strategies and underlying actions are described in more detail in the remainder of this section.

B.2.3.2 Background

In addition to operating and maintaining the FCRPS hydropower dams, and marketing the power they produce, the Action Agencies fund a large number of hatchery programs as mitigation and compensation for the adverse environmental impacts caused by the construction and operation of the dams. The funding of these mitigation hatcheries is an interrelated action to the operation and maintenance (O&M) of the FCRPS hydropower projects, and so is being considered in the FCRPS BiOp.

The FCRPS BiOp Remand Collaboration Process included a Hatchery/Harvest Workgroup (H/H Workgroup) established by the Policy Working Group (PWG). Work products from the H/H Workgroup included a hatchery effects paper, a hatchery use and benefits paper, a "Coarse Screen" of potential and continuing hatchery actions to benefit ESA-listed salmon and steelhead, and an accompanying description of the ESA benefits of the actions in the "Coarse Screen."

The "Coarse Screen" was divided into two categories: 1) actions approved by the policy group in the *U.S. v. Oregon* process; and 2) actions that lacked consensus of the *U.S. v. Oregon* parties or were outside of the *U.S. v. Oregon* process. These work products were incorporated into the record of this consultation and are relied upon for biological effects and implementation feasibility by the Action Agencies. It should be noted that these work products of the H/H Workgroup were not consensus documents. It should also be noted that it was understood within the Workgroup that the Action Agencies intended to incorporate the documents into the record of the current consultation and to rely upon them to describe biological effects and assess the feasibility of implementing certain hatchery actions.

B.2.3.2.1 Programmatic Objective and Tiered Approach

The FCRPS Mitigation Hatchery Program is comprised of a number of individual production programs in hatcheries throughout the Columbia River Basin. Overall funding of the program involves strategic decisions regarding the integration of this program with ESA needs and objectives, as required by law. This includes the development of long-range and short-term objectives consistent with ESA requirements, Tribal rights, and other mitigation obligations and objectives and related criteria for the overall hatchery program.

Consultation for the Mitigation Hatchery Program involves a "two-tiered" approach:

- Tier 1 – Current Consultation at the Program Level

  Tier 1 is the current consultation at the program level, which proposes criteria for FCRPS funding of the Mitigation Hatchery Program, including BMPs for minimizing adverse impacts to, and contributing to the survival and recovery of listed species. This first-tier consultation also evaluates the "landscape-level" effects of the continued implementation of the Action Agencies hatchery program funding decisions. This will include guidance and protocols as to how site-specific hatchery reform actions would be designed and implemented to come into compliance with the ESA.

- Tier 2 – Future Consultations

  Tier 2 will consist of the future consultations on individual artificial production programs and site specific hatchery reform actions that will be funded by the Action Agencies and implemented during the term of the overall programmatic BiOp. These second-tier consultations will be led, in most cases by the hatchery operators, and will address reform implementation schedules, ESA Section 7 consultation, and ESA Section 10 (if applicable) permitting. The Action Agencies will be kept informed of the progress of these second-tier processes and will participate in any Section 7 consultations.

Although the tiered approach is a new approach for funding FCRPS hatcheries, the Action Agencies believe that program-level consultation is advisable at this time because of the hatchery programs' links with the FCRPS operations. The FCRPS Mitigation Hatchery Program is extensive in nature, is located across the Columbia Basin, and has potential adverse effects as well as potential benefits for ESA-listed fish.

The ESA, consultation regulations, and the joint NMFS/USFWS *Section 7 Consultation Handbook* allow for and describe programmatic consultation. Programmatic consultations analyze the combined effects of all the actions that make up a program, and then present that analysis and its conclusions in a single document. 'Tiered' consultation allows a programmatic analysis to include actions with similar effects, where the effects cannot be fully analyzed without project-specific information (NMFS 2003).

Benefits of a programmatic approach include:

1. streamlined site-specific consultation processes;
2. minimization of the potential "piece-meal" effects that can occur when evaluating individual projects out of the context of the complete basin-wide FCRPS Mitigation Hatchery Program;
3. more cost-effective integration of ecosystem/recovery planning activities with Action Agencies and hatchery operator activities;
4. added predictability for all parties; and
5. the opportunity to improve and more efficiently integrate the Action Agencies' 7(a)(1) responsibilities at the program level.

B.2.3.2.2 FCRPS Mitigation Hatchery Program

As noted above, the FCRPS Mitigation Hatchery Program is intended to provide a primary means of mitigation for the construction and operation effects of the FCRPS dams. The mitigation programs are those authorized by Federal legislation to compensate or mitigate for lost salmon or steelhead production due to construction or operation of FCRPS hydroelectric facilities. These include the Lower Snake River Compensation Plan (LSRCP) hatchery programs, now funded by BPA through a Direct Funding Agreement with the USFWS (previously funded through appropriations to the USFWS), the Leavenworth National Fish Hatchery (NFH) complex hatcheries funded by Reclamation and BPA (through a Direct Funding Agreement with the Reclamation), and three mitigation hatcheries funded by the Corps and BPA (through a Direct Funding Agreement with the Corps).

BPA funds are used for operation and maintenance of these programs. In addition, BPA funds planning, design, construction, operation, and maintenance for hatchery programs recommended for implementation by the Northwest Power and Conservation Council (Council) under the Fish and Wildlife Program.

The legal history of the various hatcheries that comprise the FCRPS mitigation program is a patchwork of laws and authorizations, including the Mitchell Act, various Water Resources Development Acts, Grand Coulee Dam Project, Columbia Basin Project Act, and the Northwest Power Act. The Action Agencies' funding decisions regarding these hatcheries must also be consistent with the directives of the ESA. The legal background for the FCRPS Mitigation Hatchery Program is described in more detail in Attachment B.2.3-1.

The current annual costs of the FCRPS Mitigation Hatchery Program are:

- BPA's fiscal year (FY) 2006 budgeted costs for the program is shown in Figure B.2.3-2.
- Corps of Engineers' FY 2006 appropriated funding for the program is:
  1. Dworshak - $472,000
  2. John Day - $440,249
- Reclamation's FY 2006 appropriated funding for the program is $340,000.

The overall investment in hatcheries is large. Hatchery investments were made based on the best science at the time and under the guidance of fish and wildlife agencies. It is assumed that many reform actions could occur within this already very large ongoing investment through prioritization.

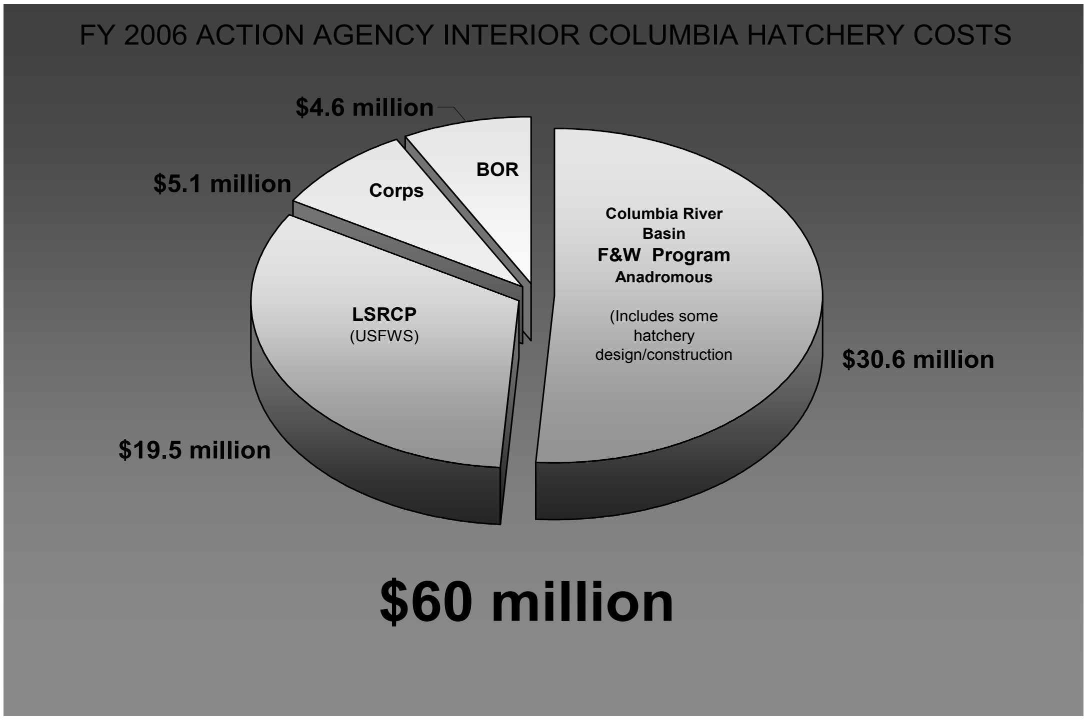

Figure B.2.3-2. FY 2006 Action Agencies'-Funded Fish Hatchery Costs for Interior Columbia Hatcheries

B.2.3.2.3 Relationship to the *U.S. v. Oregon* Process

Salmon and steelhead production above Bonneville Dam is the subject of the *U.S. v. Oregon* process, regardless of the original purpose and funding source.

Currently, an Interim Management Agreement for 2005-2007 is in place. The parties to *U.S. v. Oregon* include the Nez Perce, the Umatilla, the Warm Springs, Yakama, and the Shoshone-Bannock Indian Tribes; the States of Oregon, Washington, and Idaho; and the United States (represented by the USFWS and NMFS). The parties seek to collaboratively formulate a Columbia River Fish Management Plan (CRFM) to protect, rebuild and enhance upper Columbia River fish runs while providing harvest for both Indian and non-Indian fisheries within the Columbia River Basin. Since 1988, in addition to setting harvest goals, the CRFM has included artificial production targets for nearly all of the hatcheries within the Columbia Basin.

Although the Action Agencies are not participants in *U.S. v. Oregon,* they recognize that funding decisions made on the FCRPS Mitigation Hatchery Program have a relationship to this court-directed process. To that end, the Action Agencies intend this consultation to be transparent, and to coordinate with the sovereigns, including the parties to *U.S. v. Oregon* (nearly all of whom are already closely involved in the FCRPS remand). The Action Agencies' intent is to ensure that the FCRPS Mitigation Hatchery Program is consistent with ESA (i.e., that the FCRPS mitigation hatcheries have ESA section 4(d), 7, or 10 authorization for operating under the ESA), and in particular, that the hatcheries are using BMPs to avoid negative impacts to ESA-listed fish and, where possible, to contribute to recovery, and that their future use is consistent with ESA recovery goals. The Action Agencies' intent is not to re-open the existing *U.S. v. Oregon* agreement that expires in 2007 at this time.

B.2.3.2.4 Hatchery Actions under Previous FCRPS Biological Opinions

In both the 2000 and 2004 FCRPS BiOps, the Action Agencies committed to:

- fund safety-net hatchery programs for populations at high risk of extinction;
- develop HGMPs that address ESA objectives;
- implement the identified management practice reforms once the relevant HGMPs were completed and approved by NMFS (although the HGMPS have been submitted to NMFS, they have not yet been approved through completed Section 7 consultations); and
- evaluate hatchery effects on ESA-listed fish.

B.2.3.2.5 Current Columbia Basin-Wide Hatchery Reform Efforts

There are some significant Columbia Basin-wide hatchery review and reform efforts underway that will provide specific guidance for effective hatchery reform, not only of the FCRPS Mitigation Hatchery Program, but all hatchery programs in the Columbia Basin. The Action Agencies intend to use best available science from these review efforts to fund reform actions that assist in recovery and for adaptive management of the FCRPS Hatchery Mitigation Program consistent with the ESA. These reviews are scheduled to be completed by 2008, and as noted above, it is expected that implementation of needed reform actions will take place during the term of the FCRPS BiOp. A description of these current reviews is provided in Attachment B.2.3-2.

B.2.3.3 Hatchery Action Implementation 2000 to 2017

The Action Agencies will continue to meet their FCRPS hatchery mitigation obligations and compensate for FCRPS effects, but will undertake reforms necessary to achieve the objectives described above. The Action Agencies will work with the hatchery operators in their development of plans to implement these reforms over the 10 years of the FCRPS BiOp, sequencing by prioritized biological needs.

The Action Agencies will fund cost-effective reforms in hatchery programs to reduce negative effects of hatcheries on listed species. The specific reforms to be implemented for each program will be identified through the Tier 2 consultation previously described. The Action Agencies will work with the operators to prioritize spending within existing budgets as a first source of funding for reforms specified in the Tier 2 consultation prior to determining whether additional funds are necessary to achieve the needed biological result.

B.2.3.3.1 Near-Term Priority Actions

For near-term priority actions, the Action Agencies intend to begin implementation, starting with the necessary definition, coordination, and planning steps, in the first year of the Remand BiOp. The Action Agencies will continue to fund ongoing safety-net and conservation hatchery programs as long as they are considered by NMFS to improve viability of target populations and benefit recovery. The Action Agencies will also reform the Mitigation Hatchery Program identified by NMFS as currently constituting a primary concern (including a factor limiting natural viability of Interior Columbia listed populations).

The Action Agencies consider these reforms to be the most urgently needed for recovery. Estimated benefits to productivity and recovery of listed populations are expected to be significant when these limiting factors that are reducing survival are addressed and corrected. We also propose to initiate additional conservation hatchery actions that we consider high priority.

Tables B.2.3-2 through B.2.3-10 (presented at the end of this section) list ongoing safety-net and conservation programs as well as new programs proposed for Action Agencies' funding in each ESU or DPS. The qualitative benefits estimates for the actions in Tables B.2.3-2 through B.2.3-10 are based on "best professional judgment" of individual participants in the Remand Collaboration Hatchery/Harvest Workgroup process. The entity, or entities, making the qualitative assessment of benefits is indicated in parentheses in the Benefit Accrued column.

Upper Columbia Steelhead and Chinook Salmon – Leavenworth NFH Complex

The Remand's Hatchery/Harvest Workgroup identified certain hatchery mitigation programs as having significant biological effects to listed stocks that, if corrected, could aid in recovery. Actions to correct these impacts are priorities and are expected to be drawn from the "Coarse Screen" list of hatchery actions developed in the Hatchery/Harvest Workgroup and reviewed by the *U.S. v. Oregon* policy group.

In collaboration with the USFWS, the operator of the Leavenworth NFH Complex (Leavenworth, Entiat, and Winthrop NFHs), the Action Agencies propose to accelerate various reforms in the operations of the Entiat NFH. Action A.1.2 from the "Coarse Screen" would benefit Upper Columbia River Spring Chinook Salmon ESU in the Entiat River. This action discontinues release of the currently reared out-of-basin Carson stock Spring Chinook Salmon from Entiat NFH (which is considered to be a high risk factor) and reprograms the hatchery to rear and release 400,000 yearling Summer Chinook Salmon or Coho Salmon smolts.

Other options may be considered to accomplish the same biological effect during the development of the implementation plan. This action is also consistent with recommendations in the USFWS draft report on a recent comprehensive review of the Leavenworth NFH Complex (USFWS 2007). Discussions with the USFWS are ongoing regarding a transition plan and the time required to phase out the existing program in view of the fact that juvenile Carson stock fish are currently on station and several broodyears of adults have yet to return.

Any reform actions proposed for the Leavenworth NFH Complex must also be consistent with the Complex's ongoing mitigation obligation for Grand Coulee Dam, and will require agreement among the fisheries co-managers. Final decisions will be made on this action following consideration and feedback by the *U.S. v. Oregon* parties on the options presented by the Action Agencies. The Action Agencies currently estimate that implementation will begin in 2008-09, if agreement is reached.

The Action Agencies are currently in discussion with USFWS regarding other hatchery reform actions that can be implemented at the Leavenworth NFH Complex to reduce adverse effects to ESA-listed upper Columbia River salmon and steelhead. The intent of these discussions with USFWS and others will be to work collaboratively with the regional fish managers to identify reforms that:

- meet the mitigation requirement;
- provide cost-effective solutions that consider cost of implementation, long-term operations, and existing maintenance issues; and
- minimize adverse effects on ESA-listed stocks consistent with the programmatic funding criteria described above.

Upper Columbia River Steelhead – Other Actions

For Upper Columbia River steelhead, the Action Agencies will:

- Fund Upper Columbia River steelhead kelt (steelhead that have survived spawning) reconditioning. *Coarse Screen actions A.4.6, A.4.7, and A.4.8*.
- Fund development of a locally adapted Summer Steelhead Program in the Okanogan River. *Coarse Screen action A.3.9.*

Upper Columbia River Spring Chinook Salmon- Other Actions

The Action Agencies support the effort to explore reintroduction of Spring Chinook Salmon in the Okanogan River. A proposal for this action has been made through the Coarse Screen: *Coarse Screen action B.4.6,* "Fund reintroduction of Spring Chinook Salmon in the Okanogan River using Methow Composite stock."

This proposal is part of the Chief Joseph Hatchery Project that is currently undergoing a 3-Step Review to receive BPA funding under the Council's Columbia River Fish and Wildlife Program (Fish and Wildlife Program). The project is expected to complete Step 2 of that review in late summer 2007 and proceed to Step 3 where final design work will be completed. Assuming final Step 3 approval, construction of this new hatchery would start in FY 2009 and be completed in FY 2010. Outplanting of Methow Composite stock Spring Chinook Salmon in the Okanogan River would begin in 2011.

Mid-Columbia River Steelhead

For Mid-Columbia River steelhead, the Action Agencies will fund:

- Mid-Columbia (Yakima River) steelhead kelt reconditioning. *Coarse Screen action A.2.3*.
- For the Touchet River steelhead supplementation program, transition from Lyons Ferry Hatchery broodstock to endemic Touchet River broodstock following BMPs.

Snake River Steelhead

- As an action intended to benefit primarily Snake River B-run steelhead populations, but with potential benefits for all listed salmon and steelhead, the Action Agencies propose to work with NMFS to identify a "trigger" for future safety-net planning or to identify any populations that may currently require safety-net planning.

  As required by the Reasonable and Prudent Alternative (RPA) in the 2000 FCRPS BiOp, BPA funded a Safety-Net Artificial Propagation Program (SNAPP) to identify additional artificial propagation safety-net programs that might be needed to prevent extinction of ESA-listed fish populations. The conclusion of the 2005 project report was that no additional safety nets were needed for the Snake River Spring/Summer Chinook Salmon populations examined, but noted that the risk of extinction for the majority of Snake River Steelhead populations was unknown due to the lack of information on abundance (SNAPP 2005).

  One of the SNAPP Coordinator's recommendations in the SNAPP final report was development of a "trigger," (i.e., a clearly defined threshold) for "excessive risk" of extinction that would initiate future artificial propagation safety-net planning for populations critical to ESU recovery. The specific recommendation was to have the Interior Columbia Basin Technical Recovery Team (TRT) develop the "trigger," possibly through modification of their population viability matrix.

The Action Agencies support the development of the "trigger" and identification of any populations in immediate need of safety-net planning by NMFS and the TRT. In the event a safety-net plan is needed for a population, BPA will seek proposals to meet the need.

- For the Tucannon River steelhead supplementation program, the Action Agencies will fund transition of from Lyons Ferry broodstock to only Tucannon-origin broodstock following BMPs.

Snake River Spring/Summer Chinook Salmon

For the Snake River Spring/Summer Chinook Salmon ESU, the Action Agencies will fund the Northeast Oregon Hatchery (NEOH) Program (including construction and O&M), contingent upon the Nez Perce Tribe (NPT) developing a NMFS-approved management plan for the program. *Coarse Screen action A.3.11*

Snake River Sockeye Salmon

For the Snake River Sockeye Salmon ESU, the Action Agencies will:

- Fund expansion of Snake River sockeye smolt production to 500,000 to 1,000,000 smolts. *Coarse Screen action A.3.19*. BPA will work with the Stanley Basin Sockeye Technical Oversight Committee (SBSTOC) and other interested parties to develop performance standards. If this experimental expanded smolt program for Redfish, Pettit, and Alturas lakes fails to meet the performance standards, the Action Agencies will consider funding implementation of other alternative actions, including, but not limited to, actions proposed in the Remand Collaboration Process, such as reintroduction of Snake River Sockeye Salmon into Wallowa Lake or establishment of a Snake River Sockeye Salmon Hatchery Program below Bonneville Dam that would serve as an "egg bank."
- The Corps and BPA will work with the SBSTOC and NMFS (the Lower Granite Dam adult trap operator) to explore the feasibility and potentially develop a plan for truck transport of a number of returning sockeye adults from Lower Granite Dam to natural or artificial spawning locations in the Stanley Basin. Transported adults would avoid the relatively high mortality incurred by adults migrating upstream in the Snake and Salmon rivers to the Stanley Basin. If needed, we would fund additional infrastructure for trapping, holding, and transportation.

Columbia River Chum Salmon

The Action Agencies will fund assessment of habitat potential, development of re-introduction strategies, and implementation of pilot supplementation programs for chum salmon in selected lower Columbia River tributaries below Bonneville Dam.

Review of the John Day Hatchery Mitigation Program

The current John Day Hatchery Mitigation Program consists of fish reared at the Bonneville and Spring Creek hatcheries and released either on station or at upstream acclimation sites. A review of this program will be undertaken. The intent of the review will be to work collaboratively with the regional fish managers to identify alternative hatchery mitigation strategies, critique alternatives, and implement a strategy that:

- meets the mitigation requirement;

- provides a cost-effective solution that considers both cost of implementation and long-term operations; and
- minimizes any adverse effects on ESA-listed stocks consistent with the programmatic funding criteria described above.

B.2.3.3.2 Longer–Term Priority Actions

For longer-term priorities (begin planning in years 1 to 5; implement in years 3 to 10 of Remand BiOp): The Action Agencies will work with hatchery operators to initiate (or continue) the ongoing HGMP and consultation process, as outlined below, for each hatchery program. In collaboration with co-managers and hatchery operators, Action Agencies will review results of the Columbia River HSRG and USFWS hatchery review processes, when completed in 2008. The hatchery reviews by independent scientists are expected to provide unbiased and scientifically sound recommendations for reforming hatchery programs. The HSRG and USFWS review teams will not make management decisions, only recommendations for co-manager, Action Agencies, and NMFS consideration.

We will incorporate cost-effective reform actions that co-managers, hatchery operators, and NMFS consider beneficial to ESA-listed salmon ESUs and steelhead DPSs into the BiOp Implementation Plan and include funding in the budgets for the Direct Funding Agreements for the FCRPS Mitigation Hatchery Program or the Fish and Wildlife Program, as appropriate. Future changes will be implemented through the hatchery Research, Monitoring and Evaluation (RM&E) program, including termination of ineffective or no longer needed conservation programs or other hatchery programs.

For any new actions proposed by the Action Agencies, the Action Agencies will work with NMFS, hatchery operators, and/or project sponsors to further define/describe the action, accurately estimate capital and expense costs, determine time schedules for implementation, and incorporate this information in the BiOp Implementation Plan. Ongoing discussions and coordination among Action Agencies, co-managers, and NMFS to further define hatchery priorities and details of specific actions will continue.

B.2.3.3.3 Implementation Funding

Funding will be implemented through Reclamation appropriations for Grand Coulee mitigation and through BPA’s Direct Funding Agreement with Reclamation (Entiat NFH, Leavenworth NFH, and Winthrop NFH). Other implementation funding includes Corps appropriations for John Day and Dworshak mitigation, BPA’s Direct Funding Agreement with the Corps, and BPA’s Direct Funding Agreement with USFWS for LSRCP programs.

B.2.3.4 Description of Hatchery Action

B.2.3.4.1 Description

FCRPS hatchery mitigation program actions fall into two broad categories:

> Category 1 - funding of FCRPS hatchery programs to mitigate for the loss or reduction of fish production for fisheries; and
>
> Category 2 - funding of ESA-related conservation hatchery programs to avoid extinction and assist in recovery. This category can be further categorized as three types:

1. *Safety-net programs to prevent extinction of ESA-listed species.* These are programs that use artificial propagation to conserve genetic resources of a population at high risk of extinction. These types of programs have also been called “rescue” programs. An example is the Snake River Sockeye Salmon Captive Broodstock Program prior to the current expansion of smolt production. Without this “emergency” captive broodstock “safety-net” program, the ESU would be extinct.
2. *Short-term supplementation programs to increase (“jumpstart”) abundance of ESA-listed species.* These are artificial propagation programs intended to increase the abundance of ESA-listed populations at low abundance, but not identified as being at high risk of extinction and requiring “emergency” intervention with a hatchery program. Implementation of this type of program can increase and sustain population abundance until such time as habitat improvements or improvements in other major limiting factors allow natural productivity rate greater than one (1.0), the replacement level. The time to achieve recovery for a population can be reduced through this type of hatchery program (Johnson et al. 2006)
3. *Recolonization of unused or restored habitat for ESA-listed species.* These types of programs involve the seeding of unpopulated habitat with ESA-listed hatchery-origin fish with the objective of establishing a self-sustaining natural population, thereby increasing abundance and improving spatial structure of the ESU.

A list of Action Agencies’-funded anadromous artificial production programs in these broad categories in the Interior Columbia region, plus the Bonneville Hatchery and Duncan Creek Chum programs in the Lower Columbia River is provided in Attachment B.2.3-3. This list represents the Action Agencies’-funded hatchery programs that are the subject of this Program-Level Consultation.

B.2.3.4.2 Funding Criteria and Objectives for FCRPS the Mitigation Hatchery Program

The Action Agencies will review and fund the management of FCRPS mitigation hatcheries in a way that continues to meet mitigation obligations and helps to reverse the decline and contribute to the recovery of ESA-listed fish. In particular, the Action Agencies have identified the following ESA-related objectives for the Mitigation Hatchery Program:

- FCRPS mitigation hatcheries designed to mitigate for the loss or reduction of fish production for fisheries are to use BMPs adapted to effectively address site-specific circumstances so that they contribute to the increased viability of ESA-listed natural fish and recovery goals. The BMPs will minimize, to the greatest extent possible, effects on ESA-listed natural fish with a goal of negligible or no negative effect.
- New artificial propagation mitigation programs must not jeopardize ESA-listed ESUs or impede recovery (i.e., must be issued ESA Section 4(d), 7, or 10 authorization) and must incorporate BMPs as described above.
- The Action Agencies will reevaluate the funding of existing programs that may have negative effects on the viability of ESA-listed ESUs through HGMPs for site specific hatchery consultations to determine how mitigation obligations can continue to be met in a manner that does not impede recovery;
- The Action Agencies will fund safety-net programs for populations at high risk of extinction and conservation programs to improve viability and contribute to recovery of ESA-listed populations and ESUs.
- The Action Agencies will conduct RM&E to confirm that these objectives are being met.

- If numbers of natural spawners near recovery goals, the Action Agencies will require that funding for development of plans to reduce/modify/or eliminate hatchery programs operated for a conservation purpose are consistent with NMFS' recovery plans.

The Action Agencies will use these objectives in making future funding decisions related to their hatchery programs.

B.2.3.4.3 Best Management Practices

BMPs are a general set of guidelines that will be tailored, as applicable, to each FCRPS mitigation hatchery, when Tier 2 consultations are conducted. The Action Agencies support and endorse the general guidelines for hatchery operation published by the HSRG in its 2004 Report (HSRG 2004a) and the guidelines in several other peer-reviewed publications (Flagg et al. 2004; Olsen et al. 2004; Mobrand et al. 2005).

In particular, we believe that the HSRG's operational guidelines for integrated and segregated hatchery programs (HSRG 2004b and 2004c) are important guidelines that should be followed as closely as possible to maximize benefits from hatchery supplementation and reduce impacts on listed salmon and steelhead populations. These guidelines are summarized in Attachment B.2.3-4. We agree with the HSRG that a case-by-case analysis of a hatchery programs is required when applying these operational guidelines.

B.2.3.4.4 Procedures for Programmatic Consultation

In this first tier of the programmatic consultation on the funding of hatchery programs connected to the FCRPS, the Action Agencies seek to address the biological effects of the overall FCRPS Mitigation Hatchery Program. The Action Agencies describe the existing and expected near-term future hatchery program and proposed funding criteria and operating guidelines (BMPs) that are believed to generally avoid and minimize adverse effects of the hatchery programs on listed ESUs and, in the case of conservation hatcheries, contribute to recovery. Next, the effect on the ESUs that are the subject of this consultation are examined. The Action Agencies also propose several specific hatchery actions that are believed to aid the recovery of specific listed salmon ESUs and steelhead DPSs and analyze their anticipated effects. For near-term priority actions, the Action Agencies will begin implementation, starting with the necessary definition, coordination, and planning steps, in the first year of the BiOp.

For the majority of the hatchery programs, the particular effects of each individual hatchery program on each listed ESU that may be affected cannot be meaningfully discerned at the Tier 1 level of analysis. Therefore, the Action Agencies are proposing that subsequent second-tier consultations be completed for each individual (or possibly groups of related) hatchery program, which will result in a program-specific biological opinion or concurrence letter. The Action Agencies propose that the Tier 2 consultations be initiated by the submittal of an updated HMGP that clearly describes the existing program and lays out how the program proposes to meet the Tier 1 consultation funding criteria, and implement the operating guidelines (BMPs).

For each hatchery program funded by the Action Agencies, the operator will provide an HGMP (updated if needed) for review by the Action Agencies prior to being submitted to NMFS. The HGMP will include:

- A description of how the operation of the hatchery is meeting BMP practices adapted to address site-specific circumstances; and in the case of supplementation programs aimed at conservation/recovery, a plan for how the operation will be modified when numbers of natural spawners near recovery goals.

- Cost estimates for any actions needed to allow the individual hatchery program to meet the funding criteria and operating guidelines in the programmatic consultation. The Action Agencies will review the proposed actions and estimates and analyze the cost effectiveness of proceeding with the actions prior to submitting the HGMPs to NMFS.

NMFS will be requested to review the HGMPs and National Environmental Policy Act (NEPA) documents[1] submitted by the Action Agencies and hatchery operators and commence the appropriate ESA process.[2] Any needed direct or indirect take will be addressed in this second-tier consultation process.

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[1] National Environmental Policy Act (NEPA) documentation is required for some types of ESA consultations. If major changes in the operations of the hatchery program or new construction are proposed, an appropriate NEPA document prepared by the lead Action Agency will accompany the HGMP. If no changes in operations are required, any existing NEPA documentation will be supplied for NMFS' information and use in the analysis. In cases where ESA Section 10 or 4(d) consultations are required and program-specific consultation has not yet been completed, the lead Action Agency will cooperate with NMFS to complete an appropriate NEPA document.

[2] ESA Section 10 (a)(1)(A) permits for programs that directly take endangered fish, Section 4(d) coverage for programs that directly take threatened fish, and Section 7 for programs that have only indirect take.

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Table B.2.3-1. Specific Projects to Implement Hatchery RPA Actions

Habitat Action 2—Reform FCRPS Hatchery Operations to Reduce Genetic and Ecological Effects on ESU Listed Salmon & Steelhead	
	For **Lower Columbia Chinook Salmon**: The COE will review John Day Hatchery Mitigation Program.
	For **Snake River Steelhead**: Fund the Tucannon River steelhead supplementation program to transition to local broodstock using BMPs.[1]
	For **Middle Columbia River Steelhead**: Fund the Touchet River steelhead supplementation program to transition to local broodstock using BMPs.[2]
Habitat Action 3—Implement Safety-Net Programs to Preserve Genetic Resources and Reduce Extinction Risk	
	For **Snake River Sockeye Salmon**: Fund the safety-net program to achieve annual releases of 150,000 smolts.
	For **Snake River Spring/Summer Chinook Salmon**: Fund the Tucannon River spring/summer Chinook safety-net supplementation program as long as NMFS considers it beneficial and necessary to reduce extinction risk of the target population.
	For **Snake River Spring/Summer Chinook Salmon**: Fund the Upper Grande Ronde and Catherine Creek safety-net supplementation programs using BMPs.
	For **Snake River Spring/Summer Chinook Salmon**: Fund the Johnson Creek / South Fork Salmon River safety-net supplementation program.
	For **Snake River Spring/Summer Chinook Salmon**: Fund the experimental captive rearing program for East Fork and West Fork Yankee Fork Salmon River (until phased out by IDFG).
	For **Snake River Steelhead**, as a project to benefit primarily B-run steelhead, the Action Agencies will work with NMFS to develop a trigger for future artificial propagation safety-net planning or to identify populations for immediate safety-net planning.
Habitat Action 4—Implement Conservation Programs to Build Genetic Resources & Assist in Promoting Recovery	
	For **Upper Columbia River Spring Chinook Salmon**: Fund reintroduction of spring Chinook salmon into the Okanogan Basin consistent with the Upper Columbia River Salmon Recovery Plan and BMPs. Reintroduction will be coordinated with the quality and quantity of available habitat in the Okanogan, and will be contingent on the availability of within ESU broodstock from the Methow Basin.
	For **Upper Columbia River Steelhead**: Fund reconditioning of natural origin kelts for the Entiat, Methow and Okanogan River basins.
	For **Upper Columbia River Steelhead**: Fund development of a local broodstock derived from the Okanogan Basin following BMPs.
	For **Middle Columbia River Steelhead**: Fund reconditioning of natural origin kelts in the Yakima River basin.
	For **Snake River Steelhead**: Fund the small-scale program trapping locally returning steelhead in the East Fork Salmon River for local broodstock supplementation program (no more than 50,000 smolts) following BMPs.
	For **Snake River Spring/Summer Chinook Salmon**: Fund supplementation programs in the Lostine and Imnaha rivers, contingent on a NMFS-approved management plan for the Northeast Oregon Hatchery program.
	For **Snake River Sockeye Salmon**: Fund expansion of the safety-net program to increase smolt releases to between 500,000 and 1 million fish.
	For **Snake River Sockeye Salmon**: The Action Agencies will work with appropriate parties to investigate feasibility and potentially develop a plan for ground transport of adult sockeye from Lower Granite Dam to Redfish Lake.
	For **Columbia River Chum Salmon**: Fund the program to re-introduce chum salmon in Duncan Creek as long as NMFS considers it beneficial to recovery and necessary to reduce extinction risk of the target population.
	For **Columbia River Chum Salmon**: Fund assessment of habitat potential, development of reintroduction strategies, and implementation of pilot supplementation projects in selected Lower Columbia River tributaries below Bonneville Dam.

[1] Current operation of these programs is undergoing site specific ESA Section 7 consultation, a determination has not yet been made.

[2] Current operation of these programs is undergoing site specific ESA Section 7 consultation, a determination has not yet been made.

Table B.2.3-2. Upper Columbia River Steelhead DPS

PAST ACTIONS (2000 - 2006) Benefits Summary							
Population	**Action Agencies' Hatchery Action**	**Viable Salmon Population (VSP) Parameters[1] Positively Affected**				**Benefit accrued to natural population during 2000 - 2006 period**	**Comments**
		A	**P**	**SS**	**D**		
DPS-wide	As required by the RPA in the 2000 FCRPS BiOp, BPA funded the development of Hatchery and Genetic Management Plans (HGMPs) for all Federally funded hatchery programs in the ESU. The objective was to develop the HGMPs for NMFS approval (i.e., ESA section 4(d), 7 or 10 compliance) and identification of and prioritization of hatchery reform measures by NMFS.					**L** benefit from this planning process (BPA).	We expect NMFS to use the HGMPs in their hatchery program ESA Section 7 consultation to identify operational changes that will benefit listed populations.

FUTURE ACTIONS Benefits Summary								
Population	**Action Agencies' Proposed Hatchery Action**	**Continuation of Ongoing Action or New Action**	**VSP Parameters Positively Affected**				**Benefit accrued to natural population during or after BiOp period**	**Comments**
			A	**P**	**SS**	**D**		
Okanogan River	Develop a locally-adapted Summer Steelhead Program to supplement natural production in the Okanogan River. This action is included in FY 2007 to 2009 Fish and Wildlife Program proposal 2007-212-00 submitted by the Confederated Colville Tribes (CCT).	**New**	**X**	**X**		**X**	**H** level of benefit expected to accrue **during** and **after** BiOp period. (USFWS & NMFS)	**Coarse Screen action A.3.9**
Wenatchee Entiat Methow Okanogan	Implement a steelhead kelt reconditioning program in the upper Columbia basin utilizing techniques similar to those already established in the Yakima Basin to build upon that program's results in order to supplement the naturally-spawning steelhead populations in the Wenatchee, Entiat, Methow, and Okanogan River basins.	**New**	**X**		**X**	**?**	**M-H** level of benefit for maintaining population (BPA, using the NMFS & USFWS benefits rating for Middle Columbia River Steelhead kelt reconditioning program in Yakima River)	**Coarse Screen actions A.4.6, A.4.7, and A.4.8.** Need to determine Action Agencies' and Mid-Columbia PUD's funding obligations for this action; potential cost-sharing with Mid-Columbia PUDs.

Benefits Summary for Other Entities' Actions							
Population	**Non-Action Agency Hatchery Action**	**VSP Parameters Positively Affected**				**Benefit accrued to natural population during or after BiOp period**	**Comments**
		A	**P**	**SS**	**D**		
Wenatchee River	Program transitioned to local broodstock. Currently funded by PUD. Full realization of benefits not complete.	**X**	**X**		**X**	**M - H** benefit. Benefits expected to accrue **during** and **after** BiOp period, as expected productivity improvements may take several generations (USFWS & NMFS)	**Coarse Screen action A.2.4**. Past use of Wells stock identified as one of the primary contributors to low productivity. This action eliminated future threat to low productivity from Wells steelhead stock.
Entiat River	Wells stock releases discontinued. Full realization of benefits not complete.	**X**	**X**		**X**	**H** benefit expected to accrue **during** and **after** BiOp period. Previous hatchery program used non-local Wells hatchery stock which has been identified as potentially one of the primary contributors to low productivity. (USFWS & NMFS)	**Coarse Screen A.2.4**. This action addressed one of the primary factors for low steelhead productivity.

[1/] A = Abundance; P = Population Growth Rate; SS = Spatial Structure; D = Diversity

Table B.2.3-3. Upper Columbia River Spring Chinook Salmon ESU

PAST ACTIONS (2000 - 2006) Benefits Summary							
Population	**Action Agencies' Hatchery Action**	**VSP Parameters Positively Affected**				**Benefit accrued to natural population during or after BiOp period**	**Comments**
		A	**P**	**SS**	**D**		
ESU-wide	As required by the RPA in the 2000 FCRPS BiOp, BPA funded the development of Hatchery and Genetic Management Plans (HGMPs) for all Federally funded hatchery programs in the ESU. The objective was to develop the HGMPs for NMFS approval (i.e., ESA section 4(d), 7 or 10 compliance) and identification of and prioritization of hatchery reform measures by NMFS.					**L** benefit from this planning process. (BPA)	We expect NMFS to use the HGMPs in their hatchery program ESA Section 7 consultation to identify operational changes that will benefit listed populations.

FUTURE ACTIONS Benefits Summary								
Population	**Action Agencies' Proposed Hatchery Actions**	**Continuation of Ongoing Action or New Action**	**VSP Parameters Positively Affected**				**Benefit accrued to natural population during or after BiOp period**	**Comments**
			A	**P**	**SS**	**D**		
Entiat	In collaboration with the U.S. Fish and Wildlife Service, the operator of the Leavenworth National Fish Hatchery complex (Leavenworth NFH complex), the Action Agencies propose to accelerate various reforms in the operations of the Entiat National Fish Hatchery (which is part of the Leavenworth NFH complex). Action A.1.2 from the "Coarse Screen" would benefit Upper Columbia River Spring Chinook Salmon in the Entiat River. This action discontinues release of the currently reared out-of-basin Carson stock Spring Chinook Salmon from Entiat NFH (which is	**New**	**X**	**X**		**X**	Discontinuing the Entiat NFH Carson stock Spring Chinook Salmon program, a serious risk factor to the natural Spring Chinook Salmon population, is expected to have **H** benefits during and after the BiOp period (BPA).	**Coarse Screen action A.1.2** This action is also consistent with recommendations in the USFWS draft report on a recent comprehensive review of the Leavenworth NFH complex. Discussions with the USFWS are ongoing regarding a transition plan and the time required to phase out the existing program in view of the fact that juvenile Carson stock fish are currently on station and several broodyears of adults have yet to return. Any reform actions proposed for the Leavenworth NFH complex must also be consistent with the complex's ongoing mitigation obligation for Grand Coulee Dam, and

FUTURE ACTIONS Benefits Summary								
Population	**Action Agencies' Proposed Hatchery Actions**	**Continuation of Ongoing Action or New Action**	**VSP Parameters Positively Affected**				**Benefit accrued to natural population during or after BiOp period**	**Comments**
			A	**P**	**SS**	**D**		
	considered to be a high risk factor) and reprogram the hatchery to rear and release 400,000 yearling Summer Chinook Salmon or Coho Salmon smolts. Other options may be considered to accomplish the same biological effect during the development of the implementation plan.							will require agreement among the fisheries co-managers. Final decisions will be made on this action following consideration and feedback by the *U.S. v. Oregon* parties on the options presented by the Action Agencies. The Agencies currently estimate that implementation will begin in 2008-09 if agreement is reached.
Okanogan	The Action Agencies support the effort to explore reintroduction of listed Spring Chinook Salmon in the Okanogan River. A proposal for this action has been made through *Coarse Screen action B.4.6,* "Fund reintroduction of Spring Chinook Salmon in the Okanogan River using Methow Composite Stock." This proposal is part of the Colville Tribes' Chief Joseph Hatchery project that is currently undergoing 3-Step Review to receive BPA funding under the Fish and Wildlife Program.	**New**	**X**	**X**	**X**		**H** benefit expected to accrue **during** and **after** BiOp period (BPA).	**Coarse Screen action B.4.6.** The Chief Joseph Hatchery project is expected to complete Step 2 of the 3-Step Review process in late summer 2007 and proceed to Step 3 where final design work will be completed. Assuming final Step 3 approval, construction of this new hatchery would start in FY 2009 and be completed in FY 2010. Outplanting of Methow Composite stock Spring Chinook Salmon in the Okanogan River would begin in 2011.

Table B.2.3-4. Snake River Spring/Summer Chinook ESU

PAST ACTIONS (2000 - 2006) Benefits Summary							
		VSP Parameters Positively Affected					
Population	**Action Agencies' Hatchery Action**	**A**	**P**	**SS**	**D**	**Benefit accrued to natural population during 2000 - 2006 period**	**Comments**
ESU-wide	As required by the RPA in the 2000 FCRPS BiOp, BPA funded the development of Hatchery and Genetic Management Plans (HGMPs) for all Federally funded hatchery programs in the ESU. The objective was to develop the HGMPs for NMFS approval (i.e., ESA section 4(d), 7 or 10 compliance) and identification of and prioritization of hatchery reform measures by NMFS.					**L** benefit from this planning process. (BPA)	We expect NMFS to use the HGMPs in their hatchery program ESA Section 7 consultation to identify operational changes that will benefit listed populations.
	As required by the RPA in the 2000 FCRPS BiOp, BPA funded the Safety-Net Artificial Propagation Program (SNAPP) planning process to identify any additional Spring/Summer Chinook Salmon populations at high risk of extinction that would benefit from implementation of a safety-net hatchery program.					**L** benefit from this planning process. (BPA)	Populations identified by the SNAPP planning process as being at severe risk of extinction already had a safety-net program or conservation hatchery program in place to reduce that risk.
Lower Snake							
Tucannon River	BPA funded the Tucannon River Spring Chinook Salmon Captive Broodstock Program (a safety-net program) from 2000 through 2006 to reduce the extinction risk of the target population.	**X**		**X**	**X**	**H** (CTUIR)	**Coarse Screen action A.2.7**. A rescue program to preserve and build genetic resources - NMFS draft *Hatchery Effects Report*.
Salmon River							
East Fork **West Fork** **Yankee Fork** **Lemhi River**	BPA funded the Salmon River Captive Rearing Program (a safety-net program) from 2000 through 2006 to reduce the extinction risk of the target populations.	**X**		**X**	**X**	**H** relative to preserving current genetic resources, but program experimental to test method efficacy. (IDFG). IDFG dropped the Lemhi River population from the study design in 2004.	**Coarse Screen action A.2.6** A research project to evaluate captive rearing techniques and prevent extinction of the target populations.

PAST ACTIONS (2000 - 2006) Benefits Summary							
		VSP Parameters Positively Affected					
Population	**Action Agencies' Hatchery Action**	**A**	**P**	**SS**	**D**	**Benefit accrued to natural population during 2000 - 2006 period**	**Comments**
						Grande Ronde/Imnaha River	
Upper Grande Ronde Catherine Creek Lostine River	BPA funded the Grande Ronde Captive Broodstock Program (a safety-net program) from 2000 through 2006 to reduce extinction risk of the target populations.	X		X	X	**H** benefit during BiOp period (CTUIR)	**Coarse Screen action A.2.8.** A rescue program to preserve and build genetic resources - NMFS draft *Hatchery Effects Report*.
	BPA funded the Grande Ronde Recovery Program (conventional supplementation program) from 2000 through 2006 to reduced extinction risk and contribute to recovery of the target populations.	X		X	X	**H** benefit for reducing extinction risk and contributing to the recovery of the Upper Grande Ronde River, Catherine Creek, and Lostine River Spring/Summer Chinook populations. (BPA)	A recovery program using conventional hatchery supplementation and following practices that promote viability in the wild - NMFS draft *Hatchery Effects Report*.
Lostine River Imnaha River	BPA funded the development of the Master Plan and other planning and design costs for the Northeast Oregon Hatchery					**L** benefit for this planning process (BPA)	
Johnson Creek	BPA funded the Johnson Creek Artificial Propagation and Enhancement program (a safety-net program) to reduce extinction risk of the target population.	X		X	X	**H** - Increases abundance of integrated population and fish spawning naturally, lowers risk of extinction (NPT)	**Coarse Screen action A.2.5**

FUTURE ACTIONS Benefits Summary								
Population	**Action Agencies' Proposed Hatchery Action**	**Continuation of Ongoing Action or New Action**	**VSP Parameters Positively Affected**				**Benefit accrued to natural population during or after BiOp period**	**Comments**
			A	**P**	**SS**	**D**		
Lower Snake								
Tucannon River	Fund Tucannon River Spring Chinook Salmon Captive Broodstock Program (a safety-net program) as long as NMFS considers it beneficial and necessary to reduce the extinction risk of the target population.	**Continued**	**X**		**X**	**X**	**H** (CTUIR)	**Coarse Screen action A.2.7**. A rescue program to preserve and build genetic resources - NMFS draft *Hatchery Effects Report*.
Salmon River								
East Fork West Fork Yankee Fork	Fund the Salmon River Captive Rearing Program (a safety-net program) as long as NMFS considers beneficial and necessary to reduce extinction risk of the target populations.	**Continued**	**X**		**X**	**X**	**H** relative to preserving current genetic resources, but program experimental to test method efficacy. (IDFG). IDFG dropped the Lemhi River population from the study design in 2004.	**Coarse Screen action A.2.6**. A research project to evaluate captive rearing techniques and prevent extinction of the target populations. "Evaluation of adult returns from this research project will be "new" in the sense that the adult fish were not counted as part of the baseline analysis, but because this was primarily a research project to test safety-net methodology, substantial adult return is not anticipated" - IDFG memo to Hatchery/Harvest WG, 10/27/06.
Grande Ronde/Imnaha River								
Upper Grande Ronde Catherine Creek Lostine River	Fund the Grande Ronde Captive Broodstock Program (a safety-net program) to reduce extinction risk of the target populations.	**Continued**	**X**		**X**	**X**	**H** benefit during BiOp period (CTUIR)	**Coarse Screen A.2.8**. A rescue program to preserve and build genetic resources - NMFS draft *Hatchery Effects Report*.

FUTURE ACTIONS Benefits Summary								
Population	Action Agencies' Proposed Hatchery Action	Continuation of Ongoing Action or New Action	VSP Parameters Positively Affected				Benefit accrued to natural population during or after BiOp period	Comments
			A	P	SS	D		
	Fund the Grande Ronde Recovery Program (conventional supplementation program) to reduce extinction risk and contribute to recovery of the target populations.	**Continued**	**X**		**X**	**X**	**H** benefit for reducing extinction risk and contributing to the recovery of the Upper Grande Ronde River, Catherine Creek, and Lostine River Spring/Summer Chinook Salmon populations**.** (BPA)	A recovery program using conventional hatchery supplementation and following practices that promote viability in the wild - NMFS draft *Hatchery Effects Report*.
Lostine River Imnaha River	Fund construction of the Northeast Oregon Hatchery (NEOH) and future O&M of NEOH contingent upon the NPT developing a NMFS-approved management plan for the NEOH program.	**New**	**X**				NMFS, NPT, and BPA are working to determine recovery benefits.	**Coarse Screen action A.3.11**
South Fork Salmon River								
Johnson Creek	Fund the Johnson Creek Artificial Propagation and Enhancement program (a safety-net program) to reduce extinction risk of the target population.	**Continued**	**X**		**X**	**X**	**H** - Increases abundance of integrated population and fish spawning naturally, lowers risk of extinction (NPT)	**Coarse Screen action A.2.5**

Table B.2.3-5. Snake River Steelhead DPS

PAST ACTIONS (2000 - 2006) Benefits Summary							
Population	**Action Agencies' Hatchery Actions**	**VSP Parameters Positively Affected**				**Benefit accrued to natural population during 2000 - 2006 period**	**Comments**
		A	**P**	**SS**	**D**		
DPS-wide	As required by the RPA in the 2000 FCRPS BiOp, BPA funded the development HGMPs for all Federally funded hatchery programs in the ESU. The objective was to develop the HGMPs for NMFS approval (i.e., ESA section 4(d), 7 or 10 compliance) and identification of and prioritization of hatchery reform measures by NMFS.					**L** benefit from this planning process. (BPA)	We expect NMFS to use the HGMPs in their hatchery program ESA Section 7 consultation to identify operational changes that will benefit ESA-listed populations.
	As required by the RPA in the 2000 FCRPS BiOp, BPA funded the Safety-Net Artificial Propagation Program (SNAPP) planning process to identify any additional steelhead populations at high risk of extinction that would benefit from implementation of a safety-net hatchery program.					**L** benefit from this planning process. (BPA)	Populations identified by the SNAPP planning process as being at severe risk of extinction already had a safety-net program or conservation hatchery program in place to reduce that risk.

FUTURE ACTIONS Benefits Summary								
Population	**Action Agencies' Proposed Hatchery Actions**	**Continuation of Ongoing Action or New Action**	**VSP Parameters Positively Affected**				**Benefit accrued to natural population during or after BiOp period**	**Comments**
			A	**P**	**SS**	**D**		
East Fork Salmon River	Continue the ongoing, small-scale program trapping locally returning steelhead in the East Fork Salmon River for a local broodstock supplementation program (no more than 50,000 smolts). This is an Action Agencies'-funded program through LSRCP.	**Continued**	**X**	**X**		**X**	**M** benefits **during** and **after** BiOp period. (Idaho Department of Fish and Game - IDFG)	**Coarse Screen A.2.11**. Adult returns from juvenile releases have only recently begun, so these fish probably would not have been part of baseline analysis - IDFG memo to Hatchery/Harvest Work Group, 10/27/06.

FUTURE ACTIONS Benefits Summary								
Population	**Action Agencies' Proposed Hatchery Actions**	**Continuation of Ongoing Action or New Action**	**VSP Parameters Positively Affected**				**Benefit accrued to natural population during or after BiOp period**	**Comments**
			A	**P**	**SS**	**D**		
DPS-wide	As an action intended to benefit primarily Snake River B-run steelhead, but with potential benefits for all listed salmon and steelhead, BPA will work with NMFS to identify a "trigger" for future safety-net planning or to identify and populations that may require immediate safety-net planning. In the event a safety-net plan is needed for a population, BPA will seek proposals to meet the need.	**New**					A completed safety-net plan for high-risk steelhead populations would ensure that an artificial propagation safety-net project, if determined by NMFS to be necessary to prevent extinction, could be implemented as quickly as possible.	

Table B.2.3-6. Snake River Fall Chinook Salmon ESU

PAST ACTIONS (2000 - 2006) Benefits Summary							
Population	**Action Agencies' Hatchery Action**	**VSP Parameters Positively Affected**				**Benefit accrued to natural population during or after BiOp period**	**Comments**
		A	**P**	**SS**	**D**		
Snake River	As required by the RPA in the 2000 FCRPS BiOp, BPA funded the development of HGMPs for all Federally funded hatchery programs in the ESU. The objective was to develop the HGMPs for NMFS approval (i.e., ESA section 4(d), 7 or 10 compliance) and identification of and prioritization of hatchery reform measures by NMFS.					**L** benefit from this planning process. (BPA)	We expect NMFS to use the HGMPs in their hatchery program ESA Section 7 consultation to identify operational changes that will benefit listed populations.
	BPA funded the ESA-listed Fall Chinook Salmon production program at Nez Perce Tribal Hatchery.	X	X		X	**H** - Increases fish spawning naturally and improves spatial structure and diversity. Important to sustaining population and preventing extirpation. (NPT)	**Coarse Screen action A.2.10**. Adult returns from NPT Hatchery releases began in 2005.
	Action Agencies funded Lower Granite Dam adult salmon and steelhead trap improvements.				X	Benefits will begin accruing in 2007	**Coarse Screen action A.3.16**
	Action Agencies funded operation and maintenance of the Lower Granite Dam adult trap.				X	Benefits will begin accruing in 2007	**Coarse Screen action A.3.16**

FUTURE ACTIONS Benefits Summary								
Population	**Action Agencies' Proposed Hatchery Action**	**Continuation of Ongoing Action or New Action**	**VSP Parameters Positively Affected**				**Benefit accrued to natural population during or after BiOp period**	**Comments**
			A	**P**	**SS**	**D**		
Snake River	Fund the ESA-listed Fall Chinook Salmon production program at NPT Hatchery.	**Continued**	X	X		X	**H** - Increases fish spawning naturally and improves spatial structure and diversity. Important to sustaining population and preventing extirpation. (NPT)	**Coarse Screen action A.2.10**. Adult returns from NPT Hatchery releases began in 2005.

FUTURE ACTIONS Benefits Summary								
Population	**Action Agencies' Proposed Hatchery Action**	**Continuation of Ongoing Action or New Action**	**VSP Parameters Positively Affected**				**Benefit accrued to natural population during or after BiOp period**	**Comments**
			A	**P**	**SS**	**D**		
	Fund the expansion of the Lower Granite Dam adult salmon and steelhead trapping facility.	**Continued**	**X**	**X**		**X**	**M-L** benefits. (NPT) The expanded capacity of the trapping facility will enable: (1) collection of more natural-origin broodstock for Lyons Ferry and NPT hatcheries, with benefits for broodstock management and population diversity; (2) trapping and removal of more out-of-basin stray Fall Chinook Salmon, with benefits to diversity; and (3) improved data collection for run reconstruction and research. (BPA)	**Coarse Screen action A.3.16**. The trap improvements are expected to be completed by February 2007, so the benefits of the expanded trapping facility for Fall Chinook Salmon will begin to accrue in 2007.
	Fund the operation and maintenance of the Lower Granite Dam adult salmon and steelhead trapping facility.	**Continued**	**X**	**X**		**X**		**Coarse Screen action A.3.16.**

Table B.2.3-7. Snake River Sockeye Salmon ESU

PAST ACTIONS (2000 - 2006) Benefits Summary							
		VSP Parameters Positively Affected					
Population	**Action Agencies' Hatchery Action**	**A**	**P**	**SS**	**D**	**Benefit accrued to natural population during or after BiOp period**	**Comments**
Snake River	As required by the RPA in the 2000 FCRPS BiOp, BPA funded the development of HGMPs for all Federally funded hatchery programs in the ESU. The objective was to develop the HGMPs for NMFS approval and identification of and prioritization of hatchery reform measures by NMFS.					**L** benefit from this planning process. (BPA)	We expect NMFS to use the HGMPs in their hatchery program ESA Section 7 consultation to identify operational changes that will benefit listed populations.
	BPA has funded the Snake River Sockeye Salmon Safety-Net Program since its inception in 1991.	**X**		**X**	**X**	**H** contribution to maintaining population**.** (IDFG) **H** benefit for preventing extinction and preserving genetic resources of this population. (BPA) The program is reintroducing Redfish Lake Sockeye Salmon into Alturas and Pettit lakes.	No Coarse Screen action for the ongoing program. The benefits to the expanded smolt program will begin to accrue in 2007, so these benefits are assessed in the Proposed Hatchery Action table for Snake River Sockeye Salmon.

FUTURE ACTIONS Benefits Summary								
Population	**Action Agencies' Proposed Hatchery Action**	**Continuation of Ongoing Action or New Action**	**VSP Parameters Positively Affected**				**Benefit accrued to natural population during or after BiOp period**	**Comments**
			A	**P**	**SS**	**D**		
Snake River	Continue the Snake River Sockeye Salmon Safety-Net Program, including nursery lake habitat enhancement and limnological monitoring, as long as NMFS considers it beneficial to recovery and necessary to reduce the extinction risk of the target population. Complete the expansion of the smolt program to a capacity of 150,000 smolts per year through construction of improvements at Oxbow Hatchery (Oregon Department of Fish and Wildlife -ODFW) and Eagle Hatchery (IDFG).	**Continued**	**X**		**X**	**X**	**H** contribution to maintaining the population (IDFG) **H** benefit for preventing extinction and preserving genetic resources of this population **during** and **after** the period of the BiOp. (BPA) The program is reintroducing Redfish Lake sockeye into Alturas and Pettit lakes. The expansion of the smolt program to a production level of 150,000 smolts, and the subsequent increased adult returns, has the potential to "jump start" natural spawning in the Sawtooth Valley nursery lakes.	No Coarse Screen action for the ongoing program. Program expansion to 150,000 smolts is **Coarse Screen action B.3.15**.
Snake River	Fund implementation of expanded smolt production to a level of 500,000 to 1,000,000 sockeye salmon smolts with the associated broodstock and release infrastructure of the Stanley Basin Sockeye Salmon Program. BPA will work with the Stanley Basin Sockeye Technical Oversight Committee (SBSTOC) and other interested parties to develop performance standards of this RPA.	**New**	**X**		**X**	**X**	Further expansion of the smolt program to a production level of 500,000 - 1,000,000 smolts, and the subsequent increased adult returns, has the potential to provide a substantial "jump start" to natural spawning in the Sawtooth Valley nursery lakes, with **H** level of benefit **during** and **after** the BiOp period (BPA).	**Coarse Screen action A.3.19.** .
Snake River	BPA will work with the SBSTOC, NMFS, and Corps to explore feasibility and to potentially develop a plan for transporting a number of returning sockeye salmon adults from Lower Granite Dam to the Stanley Basin. If needed, fund additional infrastructure for trapping, holding, and/or transportation.	**New**	**X**				**M-H** benefits depending on number of adults successfully transported. Transported adults would avoid the high in-river mortality that has been observed in the migration corridor between Lower Granite Dam and Redfish Lake (BPA).	Not in Coarse Screen

Table B.2.3-8. Mid-Columbia River Steelhead DPS

PAST ACTIONS (2000 - 2006) Benefits Summary							
		VSP Parameters Positively Affected					
Population	**Action Agencies' Hatchery Action**	**A**	**P**	**SS**	**D**	**Benefit accrued to natural population during 2000 - 2006 period**	**Comments**
DPS-wide	As required by the RPA in the 2000 FCRPS BiOp, BPA funded the development of HGMPs for all Federally funded hatchery programs in the ESU. The objective was to develop the HGMPs for NMFS approval and identification of and prioritization of hatchery reform measures by NMFS.					**L** benefit from this planning process. (BPA)	We expect NMFS to use the HGMPs in their hatchery program ESA Section 7 consultation to identify operational changes that will benefit listed populations.
Upper Yakima River Naches River Toppenish River Satus Creek	BPA funded the Yakima River steelhead kelt reconditioning program.	X		X	?	**M-H** level for maintaining population (USFWS & NMFS). M level of benefit expected to accrue during BiOp period. (USFWS & NMFS) Program started in 2000. Short- and long-term reconditioned steelhead kelts represented 2-11% of the annual spawning escapement in the Yakima River from 2001 to 2005.	**Coarse Screen action A.2.3.** Yakama Nation reports that radiotelemetry results have shown that reconditioned kelts successfully located spawning grounds and constructed redds. Yakama Nation is conducting reproductive success study of artificially reconditioned steelhead kelts which should provide important information on use of kelt reconditioning tool.
Umatilla River	BPA funded the Mid-Columbia River steelhead conservation program at the Umatilla Hatchery.	X			X	**H** level of benefit 2000 - 2006 (BPA)	There is no action in the Coarse Screen for this ongoing program. Recovery program for preserving genetic resources and temporarily boosting the number of natural spawners. Natural origin fish abundance averaged more than 2,000 from 1999 to 2004. Tech Recovery Team abundance threshold is 2,250. – NMFS draft *Hatchery Effects Report*.

FUTURE ACTIONS Benefits Summary								
Population	Action Agencies' Proposed Hatchery Action	Continuation of Ongoing Action or New Action	VSP Parameters Positively Affected A	P	SS	D	Benefit accrued to natural population during or after BiOp period	Comments
Upper Yakima River Naches River Toppenish River Satus Creek	Fund the Yakima River steelhead kelt reconditioning program as long as NMFS considers it beneficial to recovery and necessary to reduce extinction risk of the target populations.	**Continued**	**X**		**X**	**?**	**M-H** level for maintaining population (USFWS & NMFS). **M** level of benefit expected to accrue during BiOp period. (USFWS & NMFS) Program started in 2000. Short- and long-term reconditioned steelhead kelts represented 2-11% of the annual spawning escapement in the Yakima River from 2001 to 2005.	**Coarse Screen A.2.3.** Yakama Nation reports that radiotelemetry results have shown that reconditioned kelts successfully located spawning grounds and constructed redds. Yakama Nation is conducting reproductive success study of artificially reconditioned steelhead kelts which should provide important information on use of kelt reconditioning tool.
Umatilla River	Fund the Mid Columbia River steelhead conservation program at the Umatilla Hatchery as long as NMFS considers it beneficial to recovery of the target population.	**Continued**	**X**			**X**	**H** benefit **during** and **after** the BiOp period. (BPA)	There is no action in the Coarse Screen for this ongoing program. Recovery program for preserving genetic resources and temporarily boosting the number of natural spawners. Natural origin fish abundance averaged more than 2,000 from 1999 to 2004. Tech Recovery Team abundance threshold is 2,250. – NMFS draft *Hatchery Effects Report*.

Benefits Summary for Other Entities' Actions							
Population	Non-Action Agency Hatchery Action	VSP Parameters Positively Affected A	P	SS	D	Benefit accrued to natural population during or after BiOp period	Comments
Multiple	Continue and refine alternative broodstock development for Wallowa stock steelhead hatchery program with emphasis on actions to reduce stray rates. Submitted by ODFW.	**?**	**X**		**X**	**L-M** level of benefit expected to accrue during and after the BiOp period. (USFWS & NMFS)	**Coarse Screen action A.2.2.** Straying from out of basin hatchery steelhead identified as a threat. This action will help address this threat.
Deschutes	Deschutes/Warm Springs and Hood River populations: Continue	**?**	**X**		**X**	**L - M l**evel of benefit	**Coarse Screen A.2.1.**

Benefits Summary for Other Entities' Actions							
Population	**Non-Action Agency Hatchery Action**	**VSP Parameters Positively Affected**				**Benefit accrued to natural population during or after BiOp period**	**Comments**
		A	**P**	**SS**	**D**		
Warm Springs Hood River	removal of out-or-basin hatchery steelhead at existing sorting facilities, including Warm Springs weir, Powerdale Dam trap, and Round Butte trap. Out-of-basin hatchery steelhead are identifiable in the Deschutes and Hood River because local broodstocks in these basins already have unique marks.					expected to accrue **during** and **after** BiOp period (USFWS & NMFS)	Straying from out of basin hatchery steelhead identified as a threat. This action will help address this threat.

Table B.2.3-9. Lower-Columbia River Steelhead DPS

PAST ACTIONS Benefits Summary								
Population	**Action Agencies' Hatchery Action**	**VSP Parameters Positively Affected**				**Benefit accrued to natural population during 2000 - 2006 period**	**Comments**
		A	**P**	**SS**	**D**		
DPS-wide	As required by the RPA in the 2000 FCRPS BiOp, BPA funded the development of HGMPs for all Federally funded hatchery programs in the ESU. The objective was to develop the HGMPs for NMFS approval and identification of and prioritization of hatchery reform measures by NMFS.					**L** benefit from this planning process. (BPA)	We expect NMFS to use the HGMPs in their hatchery program ESA Sect. 7 consultation to identify operational changes that will benefit listed populations.
Hood River	BPA funded the Hood River Steelhead safety-net program for winter and summer steelhead.	**X**			**X**	**H** level of benefit 2000 -2006 for reducing extinction risk and increasing abundance. (BPA)	No action in the Coarse Screen for this ongoing program. Program has had a positive effect by increasing the number of natural spawners and preserving genetic resources – NMFS draft *Hatchery Effects Report*

FUTURE ACTIONS Benefits Summary								
Population	**Action Agencies' Proposed Hatchery Action**	**Continuation of Ongoing Action or New Action**	**VSP Parameters Positively Affected**				**Benefit accrued to natural population during 2000 - 2006 period**	**Comments**
			A	**P**	**SS**	**D**		
Hood River	Fund the Hood River Steelhead safety-net program for winter and summer steelhead as long as NMFS considers it beneficial to recovery and necessary to reduce extinction risk of the target populations.	**Continued**	**X**			**X**	**H** level of benefit **during** and **after** the BiOp period for increasing abundance and reducing extinction risk. (BPA)	No action in the Coarse Screen for this ongoing program. Program has had a positive effect by increasing the number of natural spawners and preserving genetic resources – NMFS draft *Hatchery Effects Report*

Table B.2.3-10. Columbia River Chum Salmon ESU

PAST ACTIONS (2000 - 2006) Benefits Summary								
Population	Action Agencies' Hatchery Action		VSP Parameters Positively Affected				Benefit accrued to natural population during or after BiOp period	Comments
			A	P	SS	D		
Lower Columbia Gorge Tributaries	BPA funded the program to re-introduce Columbia River chum salmon in Duncan Creek		X		X	X	**H** benefit for preventing extinction and preserving genetic resources of the population. (BPA)	No action in the Coarse Screen for this ongoing program.

FUTURE ACTIONS Benefits Summary								
Population	Action Agencies' Proposed Hatchery Action	Continuation of Ongoing Action or New Action	VSP Parameters Positively Affected				Benefit accrued to natural population during or after BiOp period	Comments
			A	P	SS	D		
Lower Columbia Gorge Tributaries	Fund the program to re-introduce Columbia River chum salmon in Duncan Creek as long as NMFS considers it beneficial to recovery and necessary to reduce extinction risk of the target population.	**Continued**	X		X	X	**H** benefit for preventing extinction and preserving genetic resources of the population **during** and **after** the period of the BiOp. (BPA)	No action in the Coarse Screen for this ongoing program.
ESU-wide	Fund assessment of habitat potential, development of reintroduction strategies, and implementation of pilot supplementation projects in selected Lower Columbia River Tributaries below Bonneville Dam.	**New**	X		X	X	**H** benefit for preventing extinction and preserving genetic resources of the populations **during** and **after** the period of the BiOp. (BPA)	No action in the Coarse Screen for this new proposal.

Attachment B.2.3-1
Action Agencies Hatchery Mitigation Authorities/Obligations for the Federal Columbia River Power System

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There are numerous legislative sources of authorities that delineate the Action Agencies mitigation obligations and responsibilities. For artificial production or hatchery facilities the primary statutes are the Mitchell Act, the Lower Snake River Compensation Plan (LSRCP), individual hydropower project authorizations, and the Northwest Power Act. The following sections summarize the authorities/obligations for the U.S. Bureau of Reclamation (Reclamation), U.S. Army Corps of Engineers (Corps), LSRCP, and Bonneville Power Administration (BPA).

1. U.S. BUREAU OF RECLAMATION

Leavenworth National Fish Hatchery (NFH) complex is mitigation for the construction of Grand Coulee Dam and is authorized by the Grand Coulee Dam Project, 49 Stat. 1028, August 30, 1935, as part of the Rivers and Harbors Act; reauthorized under the Columbia Basin Project Act, 57 Stat. 14, March 10, 1943; and the Fish and Wildlife Coordination Act, 60 Stat. 1080, August 14, 1946.

2. U.S. ARMY CORPS OF ENGINEERS

The original authorizations for the hatcheries operated by the Corps as mitigation for the Federal Columbia River Power System (FCRPS) occurred primarily through various Flood Control Acts. Generally, Chief of Engineers reports were submitted to Congress at the time of project authorization and included assessments of impacts to fisheries and associated objectives for hatcheries to address those impacts. Typically, the project authorizations included a requirement to construct the project "substantially in conformance" with the Chief of Engineers report.

The Corps has three artificial production facilities to mitigate for the impacts of the 12 Corps projects associated with the FCRPS Biological Opinion (BiOp). The Corps built these hatcheries with appropriated dollars, and funds the U.S. Fish and Wildlife Service (USFWS) and Oregon Department of Fish and Wildlife (ODFW) to operate the facilities.[1] BPA repays the U.S. Treasury for the share of those capital construction costs, and funds the Corps under a direct funding agreement for the annual operation and maintenance expenses in the amounts allocated to the dam's power purpose.

As the Corps completed construction of the last of four dams on the lower Snake River in Washington, it submitted a Chief of Engineers report with findings from a Fish and Wildlife Coordination Act report. In the Water Resource and Development Act of 1976, Congress authorized the LSRCP by stating simply that, "The Secretary of the Army is hereby authorized to undertake the phase I design memorandum stage of advanced engineering of the following water resource development projects, substantially in accordance with, and subject to the conditions recommended by the Chief of Engineers, in the reports hereinafter designated."

After construction of the LSRCP hatchery projects, their ownership was turned over to the USFWS which receives approximately $19.5 million annually for operation and maintenance activities as part of a direct funding agreement with BPA. The responsibility for capital improvements has not yet been agreed upon.

3. LOWER SNAKE RIVER COMPENSATION PLAN

The LSRCP includes specific fish production goals. Unlike most hatchery goals, the LSRCP goals are not stated in terms of fish produced for release, but in terms of the number of returning adults needed to mitigate for the fishery losses. The program has not met its goals, and beginning in the 1990s began changing facility operations, configuration, aquacultural practices, and stock production numbers and

[1] Dworshak National Fish Hatchery, Spring Creek National Fish Hatchery, and Bonneville Hatchery.

composition to address Endangered Species Act (ESA) needs. BPA funded these changes through its direct funding agreement with the USFWS. Neither the USFWS nor BPA sought, nor did Congress grant, any additional legislative authorizations to make these program changes from the original LSRCP.

4. BONNEVILLE POWER ADMINISTRATION

BPA has a number of interrelated authorities it uses to fund hatchery construction, operations, and maintenance. The primary statutes are the Northwest Power Act, including its direct funding provision, the Bonneville Project Act, and the Transmission System Act.

The Northwest Power Act created the Northwest Power and Conservation Council (Council) with, among other responsibilities, to develop a Columbia River Basin Fish and Wildlife Program (Fish and Wildlife Program). Under the Northwest Power Act, BPA has specific duties:

1. to protect, mitigate, and enhance fish and wildlife adversely affected by the construction and operation of the FCRPS;
2. to do so in a manner that provides equitable treatment for such fish and wildlife with the other purposes of the FCRPS, and in a manner consistent with the Council's Fish and Wildlife Program; and
3. to assure the Pacific Northwest of an adequate, efficient, economical, and reliable power supply.

The Council recommends measures to implement the Fish and Wildlife Program (which may include specific recommendations for funding hatchery operations or improvements) and BPA makes funding decisions consistent with the Fish and Wildlife Program and its other statutory requirements. The Administrator must use the Bonneville Fund and the "other authorities of the Administrator" to implement projects that help fulfill his/her mitigation responsibilities under the Northwest Power Act, including hatchery construction, operations, and maintenance. Those "other authorities" include the following:

- The Bonneville Project Act, section 2(f) authority that allows the Administrator to enter into contracts as he/she deems necessary to accomplish BPA's statutory missions.
- The Transmission System Act, section 11(a) that created the Bonneville Fund, and section 11b, that authorized the use of the fund to fulfill the purposes of the Northwest Power Act.

BPA has used these authorities to construct a number of hatcheries since the Northwest Power Act became law in 1980, and pays for the ongoing operation and maintenance for these hatcheries.

In addition, when funding the Corps, Reclamation, or the USFWS for hatchery program operations and maintenance, the Administrator uses his/her express direct funding authority. Section 839d-1 of the Northwest Power Act authorizes the Administrator to make funds available for the generation additions, improvements, and replacements of facilities and equipment at Federal hydroelectric projects in the Pacific Northwest. Section 839d-1 specifically states that the Administrator may provide "any funds that the Administrator determines to make available to the respective Secretary [of the Army or the Interior] for such purposes." These purposes have been interpreted to include associated fish and wildlife mitigation and enhancement measures.

A second source of direct funding authority is found in section 11(b) of the Transmission System Act.[2] Under the Northwest Power Act, BPA ratepayers must not pay for more than the "power share" of FCRPS mitigation.[3] Thus, through its direct sharing agreements with the Corps and the Bureau, BPA pays the "power share" of the hatcheries owned by the Corps and the Bureau.

[2] Section 11(b) authorizes the Administrator to make expenditures from the Bonneville Fund "without further appropriation and without fiscal year limitation . . . for any purpose necessary or appropriate to carry out the duties imposed upon the Administrator. . . ." The TSA sections 11(b)(9) and (10) indicate the Administrator may make expenditures from the Fund for payments to the credit of the reclamation fund or to the U.S. Treasury for repayment of the FCRPS. The TSA section 11(b) (12) allows the Administrator to make payments required to carry out the purposes of the Northwest Power Act, including fish mitigation.

[3] *See* 16 U.S.C. §§ 839b (h) (8) (D); (10) (C).

Attachment B.2.3-2
Current Basin-Wide Hatchery Reform Efforts

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1. HATCHERY AND GENETIC MANAGEMENT PLANS

Measure 169 of the Reasonable and Prudent Action (RPA) of the 2000 FCRPS Biological Opinion (2000 BiOp) called for the Action Agencies to "…fund the development of National Marine Fisheries Service (NMFS, also called National Oceanic and Atmospheric Administration [NOAA] Fisheries-approved Hatchery and Genetic Management Plans (HGMPs) for implementation, including plans for monitoring and revising them as necessary as new information becomes available." The HGMP, developed by NMFS to facilitate the application of hatchery reforms to specific artificial production programs, provides a standardized approach and a consistent body of relevant information about hatchery programs.

According to the 2000 BiOp, the HGMP would comprehensively address facility and operational details relevant to reform measures and the menu of potential hatchery reform actions identified in Section 9.6.4.2 of the 2000 BiOp. The Bonneville Power Administration (BPA) began funding the development of over 200 HGMPs in 2002, continued funding this action under the 2004 Updated Proposed Action (UPA), and recently completed the project in 2006. The HGMPs have been submitted to NMFS for approval.

2. U.S. FISH AND WILDLIFE SERVICE HATCHERY REVIEW

In an effort to improve its hatchery programs, the U.S. Fish and Wildlife Service (USFWS) initiated, in May 2005, a three-year review of the 21 Columbia River Basin salmon and steelhead hatcheries that USFWS owns or operates. The goal is to ensure that the USFWS hatcheries are operated on the best scientific principles and contribute to sustainable fisheries and the recovery of naturally-spawning populations of salmon, steelhead, and other aquatic species of concern.

The internal review, in many ways, resembles the recent and successful Puget Sound and Coastal Washington Hatchery Reform Project. The USFWS believes that much of the background information necessary for reviewing hatcheries in the Columbia Basin has already been compiled in the HGMPs that were developed with BPA funding. The USFWS review project will be completed by September 2008.

3. COLUMBIA RIVER HATCHERY SCIENTIFIC REVIEW GROUP

The purpose of this Congressionally-mandated project is to replicate the recent Puget Sound and Coastal Washington Hatchery Reform Project in the Columbia Basin. The Columbia River Hatchery Scientific Review Group (HSRG) will review all hatcheries within the U. S. portion of the Columbia River Basin. These programs are managed by Federal, State, and Tribal agencies, as well as private entities. Hatchery reform fundamentally requires evaluating hatcheries based on how they affect the fish populations in the watershed in which they are located. This methodical application of science is the foundation upon which the HSRG will conduct its hatchery reviews and make recommendations on reform actions.

The HSRG calls for management based on clear goals, scientifically defensible programs, and informed decision-making. The HSRG's scientific framework and principles are embodied in the HSRG's 2004 report and in Mobrand et al. (2005). The HSRG is currently scheduled to complete its review in spring 2008.

4. ADAPTIVE MANAGEMENT

Although the Columbia River HSRG and USFWS hatchery reviews are not focused entirely on ESA-related hatchery reform, they are expected to recommend many scientifically-sound operational changes and facility modifications to reduce hatchery impacts on listed populations of salmon and steelhead. Unfortunately, these review efforts won't be completed until well after the Remand BiOp has been completed under the current schedule. However, the Action Agencies will consider the recommendations of these reviews and are interested in funding urgently needed reform actions for Action Agency hatchery programs during the period of the BiOp, provided they are cost-effective and are determined by NMFS to improve viability and advance recovery of listed ESUs. In addition, the Action Agencies will review the results from the regional hatchery research, monitoring, and evaluation (RM&E) programs, as well as other relevant research results in the peer-reviewed scientific literature, and use these findings to adaptively manage the artificial production programs that they fund.

REFERENCES

HSRG (Hatchery Scientific Review Group). 2004. Hatchery Reform: Principles and Recommendations of the HSRG. Long Live the Kings, 1305 Fourth Avenue, Suite 810, Seattle, WA 98101. Available online at http://www.lltk.org/HRP.html

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Attachment B.2.3-3. Action Agencies-Funded Anadromous Artificial Production Programs in the Interior Columbia Region and the Lower Columbia River

Attachment B.2.3-3. Action Agencies-Funded Anadromous Artificial Production Programs in the Interior Columbia Region and the Lower Columbia River

Relevant ESU.	Hatchery Program (NMFS designation)	Included in ESU or DPS?**	Primary Hatchery Facility for Program	Purpose (as identified by Action Agencies)	Authorization	Funding	Operator	Integrated or Segregated (Isolated) Program, as identified by hatchery operator in HGMP	Purpose, as identified by hatchery operator in HGMP	Beneficial Effect on Viability (from NMFS draft Hatchery Effects Report)	Risk or Threat to Viability (from NMFS draft Hatchery Effects Report)	Comments
CR Chum	Chum (Duncan Creek Chum)	Yes	Washougal	Safety-Net	Northwest Power Act - Council Fish & Wildlife Program	BPA	PSMFC/ WDFW	Integrated	Conservation/recovery	"+" for reintroducing chum salmon into Duncan Creek and for preserving genetic resources.		2004 UPA Safety-Net Program
LCR Chinook	Fall Chinook (Bonneville Hatchery Fall Chinook- URB)	No	Bonneville	Mitigation	John Day Dam Mitigation	Corps/BPA	ODFW	Segregated	Harvest Research/education		Naturally spawning fish from Bonneville Hatchery (imports from outside the area) pose a risk to population diversity and productivity in Columbia Gorge.	
LCR Chinook	Fall Chinook (Spring Creek NFH Tule Fall Chinook)	Yes	Spring Creek NFH	Mitigation Temporary Substitute	John Day Dam Mitigation	Corps/BPA	USFWS	Segregated	Harvest	"+" because these fish are the most representative of the historical Columbia Gorge tule population. Preserving genetic resources until inundated habitats are restored.		
LCR Chinook	Spring Chinook (Hood R. Spring Chinook)	No	Hood River Production Program	Harvest	Northwest Power Act - Council Fish & Wildlife Program	BPA	ODFW	Integrated	Harvest Conservation/recovery Research/education	"+" for jump-starting re-colonization of spring Chinook in the Hood River.	"-" because broodstock from a different ESU (the nearby Deschutes) were used and because the majority of hatchery fish returns (between 1997 and 2001) derived from this broodstock were precocious males (60% mini jacks and 14% jacks) and stray rates averaged 18% between 1996-2002.	Hood River spring Chinook were extirpated.
MCR Spring Chinook	Spring Chinook (Yakima R. Spring Chinook)	No	Cle Elum	Harvest	Northwest Power Act - Council Fish & Wildlife Program	BPA	YIN	Integrated	Harvest Conservation/recovery Research/education			
LCR Steelhead	Steelhead (Hood R. Summer Steelhead)	Yes	HRPP- Parkdale/ Oak Springs	Safety-Net	Northwest Power Act - Council Fish & Wildlife Program	BPA	ODFW	Integrated	Harvest Conservation/recovery	"+" for increasing the number of natural spawners and preserving genetic resources. Research here is providing important hatchery steelhead productivity information		2004 UPA Safety-Net Program
LCR Steelhead	Steelhead (Hood R. Winter Steelhead)	Yes	HRPP- Parkdale/Oak Springs	Safety-Net	Northwest Power Act - Council Fish & Wildlife Program	BPA	ODFW	Integrated	Harvest Conservation/recovery	"+" for increasing the number of natural spawners and preserving genetic resources. Research here is providing important hatchery steelhead productivity information		2004 UPA Safety-Net Program
MCR Steelhead	Steelhead (Umatilla River Summer Steelhead - ODFW stock # 91)	Yes	Umatilla	Safety-Net	Northwest Power Act - Council Fish & Wildlife Program	BPA	ODFW/ CTUIR	Integrated	Harvest Conservation/recovery Research/education	Recovery program for preserving genetic resources and temporarily boosting the number of natural spawners. Natural origin fish abundance averaged more than 2,000 from 1999 thru 2004. Tech Recovery Team abundance threshold is 2250.	"-" because out of basin hatchery strays (stray rates (avg. of 5.4% between1992-2003) pose a potential risk to pop diversity and productivity. Note that fish from this program stray into other basins and pose a threat to pop diversity and productivity.	2004 UPA Safety-Net Program
MCR Steelhead	Steelhead (Walla Walla Summer Steelhead Program - isolated fishery program)	No	Lyons Ferry	Mitigation	LSRCP	LSRCP/BPA	WDFW	Segregated	Harvest	**No Effect**	**No Effect.** Well-isolated program with <5% of hatchery-origin fish spawning naturally.	
MCR Steelhead	Steelhead (Touchet Summer Steelhead Program - isolated fishery program)	No	Lyons Ferry	Mitigation	LSRCP	LSRCP/BPA	WDFW	Segregated	Harvest		Negative effect on MCR steelhead DPS because non-indigenous naturally spawning hatchery fish potentially pose a risk to population diversity and productivity. Smolt releases reduced by 32% since 2001.	
MCR Steelhead	Steelhead (Touchet R. Endemic Summer Steelhead)	Yes	Lyons Ferry	Mitigation	LSRCP	LSRCP/BPA	WDFW	Integrated	Conservation/recovery		Negative effect on MCR steelhead DPS because naturally spawning hatchery fish pose a risk to population diversity and productivity. Existing facilities are being updated to reduce risks.	

Attachment B.2.3-3. Action Agencies-Funded Anadromous Artificial Production Programs in the Interior Columbia Region and the Lower Columbia River

Relevant ESU.	Hatchery Program (NMFS designation)	Included in ESU or DPS?**	Primary Hatchery Facility for Program	Purpose (as identified by Action Agencies)	Authorization	Funding	Operator	Integrated or Segregated (Isolated) Program, as identified by hatchery operator in HGMP	Purpose, as identified by hatchery operator in HGMP	Beneficial Effect on Viability (from NMFS draft Hatchery Effects Report)	Risk or Threat to Viability (from NMFS draft Hatchery Effects Report)	Comments
MCR Steelhead	Steelhead (Yakima River Kelt Reconditioning Program)	Yes	Prosser Tribal Hatchery	Safety-Net	Northwest Power Act - Council Fish & Wildlife Program	BPA	CRITFC YIN	N/A	Conservation/recovery	"+" Recovery program potentially can increase pop abundance and productivity. Post spawning natural fish are collected in lower Yakima basin, reconditioned, and released to return to their area of origin and spawn a second time.		2004 UPA Safety-Net Program
N/A	Spring Chinook (Umatilla R. Spring Chinook)	N/A	Umatilla	Harvest	Northwest Power Act - Council Fish & Wildlife Program	BPA	ODFW/ CTUIR	Integrated	Harvest Conservation/recovery Research/education		Negative effects due to high stray rates. Umatilla Hatchery strays can approximate 5% of the natural spawners in the Tucannon River.	
N/A	Fall Chinook (Umatilla R. Fall Chinook)	N/A	Umatilla	Harvest	Northwest Power Act - Council Fish & Wildlife Program	BPA	ODFW/ CTUIR	Integrated	Harvest Conservation/recovery Research/education		Strays from this program pose a risk to diversity of the listed Snake River fall Chinook ESU. To reduce this risk, the federal Action Agencies are currently improving the adult salmon/steelhead trapping facilities at Lower Granite Dam on the Snake River to facilitate trapping and removal of these stray hatchery fish	
N/A	Coho (Umatilla River Coho Acclimation)	N/A	Cascade	Harvest	Acclimatiion funded under Northwest Power Act - Council Fish & Wildlife Program	BPA	CTUIR	Integrated	Harvest Conservation/recovery			BPA funds annual acclimation of 1.5 million coho from Cascade and Oxbow hatcheries at multiple CTUIR-operated acclimation facilities on the Umatilla River.
N/A	Coho (Mid-Columbia Coho - Methow)	N/A	Winthrop NFH Entiat NFH Leavenworth NFH	Harvest	Northwest Power Act - Council Fish & Wildlife Program	BPA	YIN	Integrated	Harvest Conservation/recovery			
N/A	Coho (Mid-Columbia Coho - Wenatchee)	N/A	Leavenworth NFH Entiat NFH Willard NFH Cascade	Harvest	Northwest Power Act - Council Fish & Wildlife Program	BPA	YIN	Integrated	Harvest Conservation/recovery Research/education			
N/A	Coho (Yakima R. Coho)	N/A	Prosser Tribal Willard NFH Little White Salmon NFH	Harvest	Northwest Power Act - Council Fish & Wildlife Program	BPA	YIN	Integrated	Harvest Conservation/recovery Research/education			
N/A	Coho (Naches R. Coho)	N/A	Prosser Tribal Willard NFH Little White Salmon NFH	Harvest	Northwest Power Act - Council Fish & Wildlife Program	BPA	YIN	Integrated	Harvest Conservation/recovery Research/education			
N/A	Fall Chinook (Yakima R. - Marion Drain Stock)	N/A	Marion Drain	Harvest	Northwest Power Act - Council Fish & Wildlife Program	BPA	YIN	Integrated	Conservation/recovery Research/education			
N/A	Fall Chinook (Yakima R. Fall Chinook)	N/A	Prosser Tribal Little White Salmon NFH	Harvest	Northwest Power Act - Council Fish & Wildlife Program	BPA	YIN	Integrated	Harvest Conservation/recovery Research/education			

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Relevant ESU.	Hatchery Program (NMFS designation)	Included in ESU or DPS?**	Primary Hatchery Facility for Program	Purpose (as identified by Action Agencies)	Authorization	Funding	Operator	Integrated or Segregated (Isolated) Program, as identified by hatchery operator in HGMP	Purpose, as identified by hatchery operator in HGMP	Beneficial Effect on Viability (from NMFS draft Hatchery Effects Report)	Risk or Threat to Viability (from NMFS draft Hatchery Effects Report)	Comments
SR Fall Chinook	Fall Chinook (Lyons Ferry Fall Chinook)	Yes	Lyons Ferry	Mitigation	LSRCP	LSRCP/BPA	WDFW	Integrated	Harvest Conservation/recovery Research/education	"+" because it has successfully jumpstarted natural production and improved spatial distribution. Also because the program includes genetic resources from areas taken out of production by the Hells Canyon Dams (i.e., the Marsing and Salmon Falls reaches). Since proposed for ESA protection in 1990, the population has grown from <100 annual returns to between 2100 and 5100. Hatchery intervention has accomplished its mission and successfully jumpstarted fall Chinook production. Acclimation facilities located in natural spawning areas. Pop abundance has been at or above the ESA recovery threshold in 2001and 03 (the Interior Columbia Basin Technical Recovery Team abundance threshold is 3,000 natural-origin spawners). Productivity of natural origin fish has been >1:1.		Expansion of the Lower Granite Dam adult trap (ongoing BPA Project # 2005-002-00) is expected to facilitate an increase in the proportion of natural fish in the broodstock at Lyons Ferry and NPTH and the trapping and removal of out of basin hatchery strays.
SR Fall Chinook	Fall Chinook (NPTH Fall Chinook)	Yes	Nez Perce Tribal	Conservation	Northwest Power Act - Council Fish & Wildlife Program	BPA	NPT	Unidentified	Conservation/recovery	"+" because the program has jump-started production by boosting the number of natural spawners and increasing spatial distribution. All releases are subyearling and all are marked. 400,00 of the intended 1.4 million releases designed to restore extinct early spawning life history form.		2004 UPA project
SR Fall Chinook	Fall Chinook (FCAP Fall Chinook)	Yes	Capt. John/Pittsburg Landing/Big Canyon	Conservation	Northwest Power Act - Council Fish & Wildlife Program	BPA	NPT	Integrated	Harvest; Conservation/recovery Research/education	See Lyons Ferry program.		
SR Sockeye	Sockeye (Snake River Captive Brood)	Yes	Eagle - IDFG Burley Creek - NMFS	Safety-Net	Northwest Power Act - Council Fish & Wildlife Program	BPA	IDFG/ NOAA	Integrated	Conservation/recovery Research/education	"+" for preserving and building Redfish Lake sockeye genetic resources until the factors limiting survival are addressed and for reintroducing sockeye into Alturas and Pettit lakes.		2004 UPA Safety-Net Program
SR Sp/Su Chinook	Spring Chinook (Lookingglass Creek reintroduction))	Yes	Lookingglass	Conservation	LSRCP	LSRCP/BPA	ODFW	Integrated	Harvest Conservation/recovery Research/education	"+" or re-introduction following extirpation. Historic hatchery practices blocked access and extirpated local population. Current reintroduction program is using nearest suitable stock (Catherine Creek).		
SR Sp/Su Chinook	Spring Chinook (Lostine River Captive Brood)	Yes	Bonneville Captive Broodstock Facility Lookingglass Manchester	Safety-Net	Northwest Power Act - Council Fish & Wildlife Program	BPA	ODFW/ NOAA	Integrated	Harvest Conservation/recovery Research/education	"+" because this temporary captive broodstock program is preserving and building genetic resources. Straying from Lookingglass Hatchery Rapid River stock has been eliminated and no longer pose a threat to this population. The program is shifting to conventional smolt program.		2004 UPA Safety-Net Program

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Relevant ESU.	Hatchery Program (NMFS designation)	Included in ESU or DPS?**	Primary Hatchery Facility for Program	Purpose (as identified by Action Agencies)	Authorization	Funding	Operator	Integrated or Segregated (Isolated) Program, as identified by hatchery operator in HGMP	Purpose, as identified by hatchery operator in HGMP	Beneficial Effect on Viability (from NMFS draft Hatchery Effects Report)	Risk or Threat to Viability (from NMFS draft Hatchery Effects Report)	Comments
SR Sp/Su Chinook	Spring Chinook (Lostine River Conventional)	Yes	Lookingglass	Conservation	LSRCP	LSRCP/BPA	ODFW	Integrated	Harvest Conservation/recovery Research/education	"+" Recovery Program preserves genetic resources and boosts the number of natural spawners until factors limiting survival are addressed.		
SR Sp/Su Chinook	Spring Chinook (Catherine Creek Captive Brood)	Yes	Bonneville Captive Broodstock Facility Lookingglass Manchester	Safety-Net	Northwest Power Act Council Fish & Wildlife Program	BPA	ODFW/ NOAA	Integrated	Harvest Conservation/recovery Research/education	"+" because this temporary captive broodstock program is preserving and building genetic resources.		2004 UPA Safety-Net Program
SR Sp/Su Chinook	Spring Chinook (Catherine Creek Conventional)	Yes	Lookingglass	Conservation	LSRCP	LSRCP/BPA	ODFW	Integrated	Harvest Conservation/recovery Research/education	"+" Recovery supplementation program following practices that promote viability in the wild.		
SR Sp/Su Chinook	Spring Chinook (Upper Grande Ronde Captive Broodstock)	Yes	Bonneville Captive Broodstock Facility Lookingglass Manchester	Safety-Net	Northwest Power Act Council Fish & Wildlife Program	BPA	ODFW/ NMFS	Integrated	Harvest Conservation/recovery Research/education	"+" Rescue program Temporary captive broodstock program to preserve and build genetic resources.		2004 UPA Safety-Net Program
SR Sp/Su Chinook	Spring Chinook (Upper Grande Ronde Conventional)	Yes	Lookingglass	Mitigation	LSRCP	LSRCP/BPA	ODFW	Integrated	Harvest Conservation/recovery Research/education	"+" Recovery supplementation program following practices that promote viability in the wild.		
SR Sp/Su Chinook	Spring Chinook (Imnaha River)	Yes	Lookingglass	Mitigation	LSRCP	LSRCP/BPA	ODFW	Integrated	Harvest Conservation/recovery Research/education	"+" for successfully boosting the number of natural spawners.	"-" for continued high hatchery influence that potentially disrupts natural selection. Since the program has successfully jumpstarted natural production, reducing the number of naturally spawning hatchery fish would reduce risk to pop diversity and productivity. Pop abundance at or above recovery threshold in 2001, 02 and 03. The proportion of naturally spawning HOF> proportion of NOF in the hatchery broodstock for 11 of 15 years between 1988 and 2003.	
SR Sp/Su Chinook	Spring Chinook (Big Sheep Creek)	Yes	Lookingglass	Mitigation	LSRCP	LSRCP/BPA	ODFW	Integrated	Harvest Conservation/recovery Research/education	"+" for boosting the number of natural spawners. Surplus adults from the Imnaha program are planted into Big Sheep and Lick Creek.	"-" the longer the program uses Imnaha broodstock that is thought to have different life-history characteristics than Big Sheep Chinook and limit population	
SR Sp/Su Chinook	Spring Chinook (Tucannon conventional)	Yes	Tucannon	Mitigation	LSRCP	LSRCP/BPA	WDFW	Integrated	Harvest Conservation/recovery		"-" for the Umatilla Chinook program because strays can approximate 5% of the natural spawners in the Tucannon	
SR Sp/su Chinook	Spring Chinook (Tucannon captive brood)	Yes	Tucannon	Safety-Net	Northwest Power Act Council Fish & Wildlife Program	BPA	WDFW	Integrated	Conservation/recovery	"+" for preserving and building genetic resources after severe population declines during the mid 1990s. 2006 is the last year that captive broodstock adults will be used for hatchery broodstock.		2004 UPA Safety-Net Program
SR Sp/Su Chinook	Spring Chinook (Clearwater Spring Chinook)	No	Clearwater	Mitigation	LSRCP	LSRCP/BPA	IDFG	Segregated	Harvest Conservation/recovery Research/education			

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Relevant ESU.	Hatchery Program (NMFS designation)	Included in ESU or DPS?**	Primary Hatchery Facility for Program	Purpose (as identified by Action Agencies)	Authorization	Funding	Operator	Integrated or Segregated (Isolated) Program, as identified by hatchery operator in HGMP	Purpose, as identified by hatchery operator in HGMP	Beneficial Effect on Viability (from NMFS draft Hatchery Effects Report)	Risk or Threat to Viability (from NMFS draft Hatchery Effects Report)	Comments
SR Sp/Su Chinook	Summer Chinook (South Fork Salmon River)	Yes	McCall	Mitigation	LSRCP	LSRCP/BPA	IDFG	Integrated	Harvest Conservation/recovery	**Unknown** Too early to determine if Recovery Supplementation has been successful or to determine effects of recent transition to an Isolated program. One way gene flow from hatchery to natural fish is likely until Idaho supplementation study is completed. McCall influence/straying in the Secesh is medium (10-25%) and is highest in large run-size years. Part of the Idaho Supplementation Study to be completed in 2012.	**Unknown**	
SR Sp/Su Chinook	Spring Chinook (Sawtooth Spring Chinook)	Yes	Sawtooth	Mitigation	LSRCP	LSRCP/BPA	IDFG	Integrated	Harvest Conservation/recovery Research/education			
SR Sp/Su Chinook	Spring Chinook (Dworshak NFH Spring Chinook)	No	Dworshak NFH	Mitigation	LSRCP	LSRCP/BPA	USFWS	Segregated	Harvest			
SR Sp/Su Chinook	Spring Chinook (NPTH Spring Chinook)	No	Nez Perce Tribal	Harvest	Northwest Power Act Council Fish & Wildlife Program	BPA	NPT	Integrated	Conservation/recovery Research/education			
SR Sp/Su Chinook	Summer Chinook (Johnson Creek Summer Chinook)	Yes	McCall Hatchery - JCAPE	Safety-Net	Northwest Power Act Council Fish & Wildlife Program	BPA	NPT	Integrated	Conservation/recovery	"+" because this program is designed to preserve summer Chinook salmon genetic resources until factors limiting recovery are addressed. Important supplementation experiment based on all-natural-origin local broodstock. Longer-term effects on productivity and diversity being evaluated.		2004 UPA Safety-Net Program
SR Sp/Su Chinook	Spring Chinook (Salmon River Chinook Captive Rearing - East Fork Salmon River)	Yes	Eagle - IDFG Manchester Lab - NOAA	Safety-Net	Northwest Power Act Council Fish & Wildlife Program	BPA	IDFG/ NMFS	Integrated	Conservation/recovery Research/education	"+" for investigating and improving knowledge of captive broodstock techniques. New genetic analysis is necessary to better establish population status.		2004 UPA Safety-Net Program
SR Sp/Su Chinook	Spring Chinook (Salmon River Chinook Captive Rearing - West Fork Yankee Fork)	Yes	Eagle - IDFG Manchester Lab - NOAA	Safety-Net	Northwest Power Act Council Fish & Wildlife Program	BPA	IDFG/ NMFS	Integrated	Conservation/recovery Research/education	"+" for investigating captive rearing techniques.		2004 UPA Safety-Net Program
SR Steelhead	Steelhead (Imnaha R. Summer Steelhead ODFW Stock #29)	Yes	Wallowa Irrigon	Mitigation	LSRCP	LSRCP/BPA	ODFW	Integrated	Harvest Conservation/recovery Research/education	**Unknown**	**Unknown**, but Broodstock comprised of >10% natural origin fish in only 6 of last 14 years and natural origin fish comprised >50% of the natural spawners in only 2 of last 14 years (high hatchery influence). Surveys indicate little or no straying by Little Sheep program fish.	
SR Steelhead	Steelhead (Wallowa R. Summer Steelhead ODFW Stock #56)	No	Wallowa Irrigon	Mitigation	LSRCP	LSRCP/BPA	ODFW	Segregated	Harvest		Snake River steelhead programs (in general): High stray rates from Snake River steelhead hatchery programs potentially disrupt natural selection process and pose a risk to diversity and productivity of downriver steelhead populations, particularly Deschutes River and John Day populations.	

Attachment B.2.3-3. Action Agencies-Funded Anadromous Artificial Production Programs in the Interior Columbia Region and the Lower Columbia River

Relevant ESU.	Hatchery Program (NMFS designation)	Included in ESU or DPS?**	Primary Hatchery Facility for Program	Purpose (as identified by Action Agencies)	Authorization	Funding	Operator	Integrated or Segregated (Isolated) Program, as identified by hatchery operator in HGMP	Purpose, as identified by hatchery operator in HGMP	Beneficial Effect on Viability (from NMFS draft Hatchery Effects Report)	Risk or Threat to Viability (from NMFS draft Hatchery Effects Report)	Comments
SR Steelhead	Steelhead (Lyons Ferry Summer Steelhead)	No	Lyons Ferry	Mitigation	LSRCP	LSRCP/BPA	WDFW	Segregated	Harvest		Snake River steelhead programs (in general): High stray rates from Snake River steelhead hatchery programs potentially disrupt natural selection process and pose a risk to diversity and productivity of downriver steelhead populations, particularly Deschutes River and John Day populations.	
SR Steelhead	Steelhead (Cottonwood Pond)	No	Lyons Ferry	Mitigation	LSRCP	LSRCP/BPA	WDFW	Segregated	Harvest		"-" because hatchery fish are derived from areas outside the DPS and naturally spawning hatchery fish pose a potential risk to pop diversity and productivity in Cottonwood, Rattlesnake and Menatchee creeks.	
SR Steelhead	Steelhead (Tucannon Summer Steelhead (Lyons Ferry stock))	No	Tucannon	Mitigation	LSRCP	LSRCP/BPA	WDFW	Segregated	Harvest		"-" because non DPS broodstock are isolated from most but not all Tucannon steelhead spawning areas. The existing hatchery weir is 70% effective and the most important habitat is upstream.	
SR Steelhead	Steelhead (Tucannon Summer Steelhead endemic stock)	Yes	Tucannon	Mitigation	LSRCP	LSRCP/BPA	WDFW	Integrated	Conservation/recovery	"+" because the supplementation program is intended to preserve and build genetic resources and boost the number of natural spawners. To early for any significant results.		
SR Steelhead	Steelhead (Clearwater Summer Steelhead)	Yes	Clearwater	Mitigation	LSRCP	LSRCP/BPA	IDFG	Integrated	Harvest Conservation/recovery		Snake River steelhead programs (in general): High stray rates from Snake River steelhead hatchery programs potentially disrupt natural selection process and pose a risk to diversity and productivity of downriver steelhead populations, particularly Deschutes River and John Day populations.	Dworshak NFH, Lolo Creek, and North Fork Clearwater programs are in DPS
SR Steelhead	Steelhead (Sawtooth)	No	Sawtooth	Mitigation	LSRCP	LSRCP/BPA	IDFG	Segregated	Harvest	"-" because naturally spawning hatchery fish are derived from outside the DPS and pose a potential risk to pop diversity and productivity.	Snake River steelhead programs (in general): High stray rates from Snake River steelhead hatchery programs potentially disrupt natural selection process and pose a risk to diversity and productivity of downriver steelhead populations, particularly Deschutes River and John Day populations.	
SR Steelhead	Steelhead (East Fork Salmon River Natural)	Yes	Sawtooth	Mitigation	LSRCP	LSRCP/BPA	IDFG	Integrated	Conservation/recovery	"+" Recovery Program temporarily boosts the number of natural spawners until factors limiting survival are addressed. The population is at about 10% of its abundance goal.	Snake River steelhead programs (in general): High stray rates from Snake River steelhead hatchery programs potentially disrupt natural selection process and pose a risk to diversity and productivity of downriver steelhead populations, particularly Deschutes River and John Day populations.	
SR Steelhead	Steelhead (Salmon River B-Run Steelhead [Magic Valley Summer Steelhead])	No	Magic Valley	Mitigation	LSRCP	LSRCP/BPA	IDFG	Segregated	Harvest		Snake River steelhead programs (in general): High stray rates from Snake River steelhead hatchery programs potentially disrupt natural selection process and pose a risk to diversity and productivity of downriver steelhead populations, particularly Deschutes River and John Day populations.	

Attachment B.2.3-3. Action Agencies-Funded Anadromous Artificial Production Programs in the Interior Columbia Region and the Lower Columbia River

Relevant ESU.	Hatchery Program (NMFS designation)	Included in ESU or DPS?**	Primary Hatchery Facility for Program	Purpose (as identified by Action Agencies)	Authorization	Funding	Operator	Integrated or Segregated (Isolated) Program, as identified by hatchery operator in HGMP	Purpose, as identified by hatchery operator in HGMP	Beneficial Effect on Viability (from NMFS draft Hatchery Effects Report)	Risk or Threat to Viability (from NMFS draft Hatchery Effects Report)	Comments
SR Steelhead	Steelhead (Hagerman NFH Summer Steelhead)	No	Hagerman NFH	Mitigation	LSRCP	LSRCP/BPA	USFWS	Segregated	Harvest		Snake River steelhead programs (in general): High stray rates from Snake River steelhead hatchery programs potentially disrupt natural selection process and pose a risk to diversity and productivity of downriver steelhead populations, particularly Deschutes River and John Day populations.	
SR Steelhead	Steelhead (Dworshak NFH Summer Steelhead)	Yes	Dworshak NFH	Mitigation	Dworshak Dam authorization (mitigation)	Corps/BPA	USFWS	Segregated	Harvest Conservation/recovery	"+" because whatever NF Clearwater genetic resources that remain exist in this program	Snake River steelhead programs (in general): High stray rates from Snake River steelhead hatchery programs potentially disrupt natural selection process and pose a risk to diversity and productivity of downriver steelhead populations, particularly Deschutes River and John Day populations.	Dworshak NFH, Lolo Creek, and North Fork Clearwater programs are in DPS
UCR Spring Chinook	Spring Chinook (Leavenworth NFH Spring Chinook - Carson stock)	No	Leavenworth NFH	Mitigation	Grand Coulee Dam Project, 49 Stat. 1028, August 30, 1935, as part of the Rivers and Harbors Act; reauthorized under the Columbia Basin Act, 57 Stat. 14, March 10, 1943; and the Fish and Wildlife Coordination Act, 60 Stat. 1080, August 14, 1946.	BOR/BPA	USFWS	Segregated	Harvest		"-" because straying from the program poses a potential risk to population diversity and productivity. Hatchery stock is not indigenous to the Wenatchee Basin, not included in the Upper Columbia Spring Chinook ESU, and they may comprise >5% of the natural spawners in areas important to spring Chinook recovery.	
UCR Spring Chinook	Spring Chinook (Entiat NFH Spring Chinook - Carson stock)	No	Entiat NFH	Mitigation	Grand Coulee Dam Project, 49 Stat. 1028, August 30, 1935, as part of the Rivers and Harbors Act; reauthorized under the Columbia Basin Act, 57 Stat. 14, March 10, 1943; and the Fish and Wildlife Coordination Act, 60 Stat. 1080, August 14, 1946.	Reclamation/ BPA	USFWS	Segregated	Harvest		"-" because the program is not well isolated and naturally spawning hatchery fish pose substantial risk to population diversity and productivity. Entiat Hatchery Chinook are not indigenous to the Entiat and not included in the UCR spring Chinook ESU.	
UCR spring Chinook	Spring Chinook (Winthrop NFH Spring Chinook - Methow Composite stock)	Yes	Winthrop NFH	Mitigation Conservation	Grand Coulee Dam Project, 49 Stat. 1028, August 30, 1935, as part of the Rivers and Harbors Act; reauthorized under the Columbia Basin Act, 57 Stat. 14, March 10, 1943; and the Fish and Wildlife Coordination Act, 60 Stat. 1080, August 14, 1946.	Reclamation/ BPA	USFWS	Integrated	Harvest Conservation/recovery	"+" for preserving genetic resources when Chinook returns dropped to unprecedented low numbers and for sustaining naturally spawning and the spatial structure of Chinook until factors limiting Chinook productivity are addressed.	"-" because very few natural origin fish are incorporated into the broodstock program and because combining Methow R and Chewuch R fish for hatchery broodstock reduces pop diversity.	
UCR Spring Chinook	Summer/Fall Chinook - Chief Joseph Dam Hatchery	No	Chief Joseph Dam (design stage)	Harvest	Northwest Power Act - Council Fish & Wildlife Program	BPA	CCT	Integrated	Conservation/recovery Harvest			

Attachment B.2.3-3. Action Agencies-Funded Anadromous Artificial Production Programs in the Interior Columbia Region and the Lower Columbia River

Relevant ESU.	Hatchery Program (NMFS designation)	Included in ESU or DPS?**	Primary Hatchery Facility for Program	Purpose (as identified by Action Agencies)	Authorization	Funding	Operator	Integrated or Segregated (Isolated) Program, as identified by hatchery operator in HGMP	Purpose, as identified by hatchery operator in HGMP	Beneficial Effect on Viability (from NMFS draft Hatchery Effects Report)	Risk or Threat to Viability (from NMFS draft Hatchery Effects Report)	Comments
UCR Steelhead	Steelhead (Winthrop NFH Summer Steelhead - Wells stock)	Yes	Winthrop NFH	Mitigation Conservation	Grand Coulee Dam Project, 49 Stat. 1028, August 30, 1935, as part of the Rivers and Harbors Act; reauthorized under the Columbia Basin Act, 57 Stat. 14, March 10, 1943; and the Fish and Wildlife Coordination Act, 60 Stat. 1080, August 14, 1946.	Reclamation/ BPA	USFWS	Integrated	Harvest Conservation/recovery	"+" for stepping in to preserve genetic resources and boosting the number of naturally spawning fish when natural origin steelhead returns were < 200 fish for 5 of 6 years between 1993 and 1998.	"-" for risks to pop diversity and productivity by collecting broodstock at Wells Dam and then introducing these fish in different areas throughout the Methow Basin. Hatchery origin fish comprise >90% of all natural spawners which also poses risks to pop diversity and productivity.	

UCR=Upper Columbia River; SR=Snake River, DPS=Distinct Population Segment; ESU=Evolutionarily Significant Unit; USFWS=U.S. Fish and Wildlife Service; CRITFC=Columbia River Inter-Tribal Fish Commission; HGMP=Hatchery & Genetic Management Plan; UPA=Updated Proposed Actions; IDF&G=Idaho Department of Fish and Game; NPTH=Nez Perce Tribe; BPA=Bonneville Power Administration; CR=Columbia River; URB=Upriver Brights; NFH=National Fish Hatchery; ODFW=Oregon Department of Fish and Wildlife; PSMFC=Pacific States Marine Fisheries Commission; YIN=Yakama Indian Nation; CTUIR=Confederated Tribes of the Umatilla Indian Reservation; WDFW=Washington Department of Fish and Wildlife; LSRCP=Lower Snake River Compensation Plan; Corps=U.S. Army Corps of Engineers; Reclamation=U.S. Bureau of Reclamation; NMFS=National Marine Fisheries Service

*Table information sources: Hatchery/Harvest Collaboration Workgroup's Draft Hatchery Effects Report, two-page HGMP summaries, Council's APRE website, and State/Federal/PUD hatchery websites. **ESU information from: Endangered and Threatened Species: Final Listing Determinations for 16 ESUs of West Coast Salmon and Final 4(d) Protective Regulations for Threatened Salmonid ESUs. Federal Register, Vol. 70, No. 123. Tuesday, June 28, 2005, and Endangered and Threatened Species: Final Listing Determinations for 10 Distinct Population Segments of West Coast Steelhead. Federal Register, Vol. 71, No.3, Thursday, January 5, 2006.

Attachment B.2.3-4
Hatchery Scientific Review Group Guidelines for Hatchery Operation

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The Action Agencies support and endorse the general guidelines for hatchery operation published by the Hatchery Scientific Review Group (HSRG) in their 2004 Report (HSRG 2004a) and the guidelines in several other peer-reviewed publications (Mobrand et al. 2005, Flagg et al. 2004, and Olson et al. 2004). In particular, we believe the HSRG's operational guidelines for integrated and segregated hatchery programs (HSRG 2004b and 2004c) are important guidelines that should be followed as closely as possible to reduce hatchery impacts on listed salmon and steelhead populations. The Action Agencies agree with the HSRG that a case-by-case analysis of hatchery programs is required when applying these broodstock management guidelines. The HSRG's guidance is summarized in the following:

Genetic and ecological interactions have been at the center of the debate over benefits and risks of hatchery programs [e.g., National Research Council Committee on Protection and Management of Pacific Northwest Anadromous Salmonids (NRC) 1993]. The two options for managing these risks are either to minimize interaction through segregation (isolation) of the hatchery population from the natural population or to manage the hatchery population as an integral, benign component of a composite hatchery-natural population.

All salmon and steelhead hatchery programs must be classified either as integrated or segregated by intent. These classifications lead directly to a series of genetic and ecological management guidelines for each of the two types of programs. How well programs meet this intent will vary; this variation provides an important measure for evaluating the biological risks posed by hatchery programs on natural populations.

1. INTEGRATED PROGRAMS

The terms integrated and segregated describe the intended reproductive relationship of hatchery populations to naturally spawning populations. An integrated hatchery program is associated with a specified natural population from which gene flow occurs. The goal of an integrated program is to demographically increase the abundance of fish representing a natural population (two environments, one gene pool).

Formal Definition: A hatchery program is an ***Integrated Type*** *if the intent is for the natural environment to drive the adaptation and fitness of a composite population of fish that spawns both in a hatchery and in the wild.*

For a natural/hatchery composite population at equilibrium (Ford 2002), the influence of the hatchery and natural environments on the adaptation of the composite population is determined by the proportion of natural-origin broodstock in the hatchery (pNOB[1]) and the proportion of hatchery-origin fish in the natural spawning escapement (pHOS). The larger the ratio pNOB/(pHOS+pNOB), also called Proportion of Natural Influence (PNI), the greater the strength of selection in the natural environment relative to that of the hatchery environment. In order for the natural environment to dominate selection, this ratio must exceed 0.5 (Campton, Busack and Currens, personal communication). Furthermore, the greater the difference between the hatchery and natural stock components (e.g., in run timing) and the "less natural" the hatchery environment (e.g., longer hatchery rearing), the larger the ratio must be to reduce the effects of hatchery selection.

[1] Terminology: NOR = Natural Origin Return, HOR = Hatchery Origin Return, NOB = Natural Origin fish included in hatchery Broodstock, PNI = Proportion of Natural Influence, and HOS = Hatchery Origin fish in the natural Spawning escapement.

2. OPERATIONAL GUIDELINES FOR INTEGRATED PROGRAMS

The following are operational guidelines for integrated hatchery programs:

1. The targeted value of pNOB/(pHOS+pNOB) should be based upon the current status of the stock, the goals for the stock, and involves a benefit versus risk judgment. For any fixed pNOB, the smaller the pHOS, the stronger the selective forces for the natural environment.
2. The proportion of natural-origin fish in the broodstock must exceed the proportion of hatchery-origin fish on the spawning grounds (pNOB>pHOS) for the natural environment to drive adaptation, which is equivalent to pNOB/(pHOS+pNOB), or Proportion of Natural Influence (PNI)>0.50.
3. pNOB/(pHOS+pNOB), or PNI, for integrated programs with stocks of moderate or high biological significance and viability (or goals to maintain or improve the biological significance and viability of the stock) should be greater than 0.7 to ensure high levels of natural dominance.
4. pNOB should be a minimum of 10% to avoid divergence of the hatchery population from the natural component, even when pHOS is zero.
5. A general rule of thumb is that the total number of adults (hatchery- and natural-origin) used for broodstock cannot exceed the total number of natural-origin escapement.
6. Hatchery fish should be reared under conditions that deviate as little as possible from those experienced by the natural population component, to minimize the effects of selective forces in the hatchery:
   a. Rear in a hatchery environment that allows synchronization of adult maturation, incubation and emergence, and out-migration with natural populations.
   b. Use rearing protocols that produce juvenile fish similar to natural populations in growth rate and size, to reduce competition with and predation on natural stocks, and to maintain the age structure of the natural population.
   c. Rear fish at reduced densities in enriched environments, to produce a fish with cryptic coloration, territorial fidelity and behavior similar to naturally-produced fish.
   d. Release fish volitionally during the out-migration timing of the natural stock.
7. The size of the program should take into account the quantity and quality of habitat available for juveniles and adult spawners, and the effect of the hatchery program on natural stocks.
8. Use marks, tags or other methods to distinguish natural- and hatchery-origin fish among natural spawners, in hatchery broodstocks and in harvests.
9. Take into consideration the potential selective impacts of harvest (for example, size selectivity) on the long-term viability of integrated programs.

3. SEGREGATED PROGRAMS

Formal Definition: A hatchery program is a ***Segregated Type*** *if the intent is for the hatchery population to represent a distinct population that is reproductively isolated from naturally-spawning populations.*

Hatchery programs are classified as segregated if the hatchery population is propagated as a genetically discrete or segregated population relative to naturally spawning populations. The principal intent of a segregated program is to create a new, hatchery-adapted population to meet goals for harvest or other purposes (research, education, etc.). Hatchery broodstocks (and programs) are considered genetically segregated if the broodstock is maintained primarily or exclusively from adults returning back to the hatchery. As a consequence, little or no gene flow from a natural population to the hatchery broodstock is intended to occur in a segregated program.

Natural spawning of fish from segregated programs may pose genetic and ecological risks to natural-spawning populations. The risks that segregated hatchery programs pose to natural populations depend on the status and goals for the natural populations, the extent to which hatchery-origin fish interact genetically and ecologically with natural-origin fish, and on the amount of genetic and phenotypic divergence between the hatchery and natural populations.

4. OPERATIONAL GUIDELINES FOR SEGREGATED PROGRAMS

1. Each hatchery program should include a detailed genetic management plan for broodstock that outlines protocols, etc.
2. Rear fish in a manner and/or at a location that minimizes potential straying and opportunities for natural spawning.
3. Release fish in areas where opportunities to capture non-harvested adults are maximized, thus minimizing genetic risks to natural populations.
4. Ensure adult production from segregated programs is commensurate with harvest opportunities.
5. Take into consideration the potential selective impacts of harvest (for example, size selectivity) on the long-term viability of segregated programs.
6. Ensure hatchery-origin adults constitute no more than five percent of the naturally-spawning population.
7. Use marks, tags or other methods to distinguish natural- and hatchery-origin fish among natural spawners, in hatchery broodstocks and in harvests.
8. Avoid unintentional inclusion of natural-origin adults in segregated broodstocks.
9. Minimize the effects of predation and competition on naturally-spawning stocks when designing hatchery programs.

We expect the Columbia River Basin HSRG to apply these guidelines during their review of Columbia River Basin hatchery programs and to make recommendations to hatchery operators, co-managers, and funding agencies for improving broodstock management and operation of integrated or segregated programs, as appropriate.

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Section B.2.4—Harvest Action

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ACRONYMS AND ABBREVIATIONS

BiOp	Biological Opinion
BPA	Bonneville Power Administration
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FCRPS	Federal Columbia River Power System
NMFS	National Marine Fisheries Service
PIT	passive integrated transponder
TRT	Technical Recover Team

B.2.4 HARVEST ACTION

B.2.4.1 Introduction

The Federal Action Agencies (Action Agencies) remain committed in their efforts towards reversing the decline of Endangered Species Act (ESA)-listed salmonid species in the Columbia River Basin. The Action Agencies will pursue specific strategies (see Section B.2.4.2) that directly or indirectly reduce the take of ESA-listed anadromous fish species in the near term and will advance harvest reforms, for application over the longer term.

Both existing and future harvest reform measures have the potential for immediate and long-term benefits to listed Evolutionarily Significant Units (ESUs), including enabling continued tribal and non-tribal harvest of stronger stocks. The Action Agencies' harvest strategies seek to improve adult life-stage survival through measures that will directly or indirectly reduce the take of listed species in the near term and will advance harvest reforms, for application over the longer term.

The Federal Columbia River Power System (FCRPS) Biological Opinion (BiOp) Remand Process offered harvest managers and the Action Agencies an opportunity to discuss and propose actions to benefit listed ESUs. The Action Agencies' proposed consideration of harvest alternatives that reduced harvest impacts on the natural spawning component of the Upper Columbia River Spring Chinook Salmon and Snake River Spring/Summer Chinook Salmon ESUs to boost their status through improvement in adult life-stage survival. However, the process did not yield agreement on harvest reforms that will produce further reduction of impacts upon these listed ESUs. The *U.S. v. Oregon* parties indicated that within their own court ordered proceedings, reform in the management of fall Chinook salmon was occurring through the development of abundance-based management for those ESUs affected during those specific fisheries (fall Chinook salmon and summer steelhead).

The Collaboration Process produced proposals to change fishery monitoring and data systems that improve the degree of resolution required to monitor the status of listed populations during the prosecution of fisheries. The harvest managers acknowledged that improvements to the existing harvest monitoring and evaluation program could be made to decrease error and uncertainty in the measurement of harvest rates. While these activities do not directly reduce impacts to listed ESUs, they do provide managers and researchers with more accurate information on the status of natural populations and provide a higher level of certainty that fishery conservation objectives are being attained.

B.2.4.2 Harvest Strategies

The Action Agencies have identified three specific harvest strategies that are either ongoing or will be implemented for the Harvest Action (Figure B.2.4-1):

- Harvest Strategy 1 – Fishery Conservation Effectiveness Programs
- Harvest Strategy 2 – Potential Alternative/Terminal Fishing Locations
- Harvest Strategy 3 – Develop Fishing Techniques to Enable Fisheries to Target Non-listed Fish While Reducing Harvest-Related Mortality on ESA-Listed Species

Figure B.2.4-1. Harvest Approaches to Improving Adult Life-Stage Survival

The Action Agencies acknowledge that the development and implementation of the harvest strategies will require collaboration with harvest managers and constituent fishery groups to ensure economic, social, and cultural issues are addressed.

B.2.4.2.1 Harvest Strategy 1: Fishery Conservation Effectiveness Programs

Harvest reductions produce immediate increases in spawning escapement, thereby reducing the near-term risks of extinction. Under Harvest Strategy 1, the Action Agencies will pursue opportunities to ensure harvest is effective in meeting conservation objectives for reducing harvest impacts on listed species, consistent with the 2000 BiOp (National Marine Fisheries Service [NMFS] 2000a). These opportunities may include advances in stock identification methods, monitoring, run-size forecasts, and in-season management to reduce uncertainty in harvest impacts to listed fish and ensure the intended increased abundance to the spawning grounds and biological benefits are achieved.

The Action Agencies support increased in-season monitoring of catch, encounters, and escapement of fish within the Columbia River Basin because even low levels of mortality can affect the prospects for survival and recovery. Therefore, accurate and precise estimates of incidental mortalities are essential for determining the extent to which selective fisheries can accomplish their intended purposes.

The Action Agencies support the deployment of passive integrated transponder (PIT)-tag detectors for fisheries sampling and the expanded deployment of PIT-tag detectors in terminal areas. In addition, the Action Agencies will assist in the development of a plan to add PIT-tag detections in mainstem Columbia River fisheries. The potential benefit of this monitoring is providing an independent assessment of harvest impacts and stock composition in the fisheries.

The information obtained from the PIT-tag program will be helpful in decreasing the uncertainty in measurement of adult survival through the FCRPS. The Action Agencies are working with fisheries managers to determine the specific quantity of detectors and modification of sampling protocols to incorporate this additional data collection.

Other opportunities may include the use of conservation easements or catch agreements that reimburse commercial harvesters for reducing their catch with appropriate pass-through measures that provide additional quantifiable adult life-stage improvement for listed ESUs.

B.2.4.2.2 Potential Alternative/Terminal Fishing Locations

Fisheries can be located in areas and during time periods that minimize the harvest of non-target stocks to the extent possible, subject to various constraints. Terminal fisheries can, in some cases, provide alternative harvest opportunities to mixed stock fisheries.

The Action Agencies will address potential alternative/terminal fishing locations and seasonal time periods where targeted fish can be accessed with minimal impacts to listed salmon and steelhead. Utilization of existing off-channel sites in the lower Columbia River will be continued and enhanced. In addition, fishery managers will develop new locations and strategies.

The Action Agencies support the Colville Tribe proposal *Evaluation of Live Capture Selective Fishing Gea*r within the Northwest Power and Conservation Council's solicitation process (BPA No. 200724900). This project is consistent with this harvest strategy in that it proposes to place selective gear in a specific location, the Okanogan River, where the percentage of known origin fish is high and will aim to remove non-localized stocks to improve Interior Columbia Basin Technical Recovery Team (TRT) life-stage viability criteria.

B.2.4.2.3 Harvest Strategy 3: Develop Fishing Techniques to Enable Fisheries to Target Non-Listed Fish While Reducing Harvest-Related Mortality on ESA-Listed Fish

Achieving greater catch selectivity is the most likely and immediate source of relief from tight harvest restrictions, either through use of more selective fishing gear or by expanding fishing opportunities in known-stock, terminal areas (NMFS 2000b, pp. 38, 39, 48), or by specific time, area, and gear management in the mainstem. Accurate and precise estimates of incidental mortalities will be essential for determining the extent to which selective fisheries can accomplish their intended purposes.

The Action Agencies will support the development of live-capture selective fishing to assist in advancing protection of weak, ESA-listed stocks and other natural-origin salmon. The purpose of this strategy is to enable the development and deployment of selective fishing gear and methods so some level of fishing can continue even when listed fish are present. For example, the Action Agencies will support the Colville Tribe-sponsored project proposal described under Harvest Strategy 2. The study will evaluate various fish trap designs in both tributary (Okanogan River) and mainstem Columbia River fisheries.

The potential for new live-capture selective fisheries gear to provide both increased harvest and increased survival of depressed stocks can be significant. Conservation and harvest benefits increase considerably with lower catch/release mortalities and higher composition of externally marked fish in the fishery. The Colville Tribe proposal describes the potential of up to 95 percent or greater reduction in harvest impacts to listed species resulting from the implementation of selective gear and methods. The potential reduction in ESA impacts will be for application to fisheries that impact ESA fish.

The Colville Tribe study will also address two other objectives, the ability to reduce the proportion of hatchery-origin salmon in a natural spawning population and the ability to collect local broodstock for artificial propagation programs. The Action Agencies will also support these objectives.

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Section B.2.5—Predation Management Action

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ACRONYMS AND ABBREVIATIONS

Corps	U.S. Army Corps of Engineers
DPS	Distinct Population Segment
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FCRPS	Federal Columbia River Power System
FEIS	Final Environmental Impact Statement
FPOM	Fish Passage Operations and Maintenance
FPP	Fish Passage Plan
MMPA	Marine Mammal Protection Act
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NPMP	Northern Pikeminnow Management Program
NOAA	National Oceanic and Atmospheric Administration
NWR	National Wildlife Refuge
ODFW	Oregon Department of Fish and Wildlife
PCRSF	Pacific Coast Salmon Recovery Fund
PIT	passive integrated transponder
RM	river mile
RM&E	research, monitoring, and evaluation
ROD	Record of Decision
RPA	Reasonable and Prudent Alternative
SLED	sea lion excluder device
UPA	Updated Proposed Action
WDFW	Washington Department of Fish and Wildlife

B.2.5 PREDATION MANAGEMENT ACTION

B.2.5.1 Introduction

The Action Agencies remain committed in their efforts towards reversing the decline of salmonid species in the Columbia River Basin that are listed under the Endangered Species Act (ESA). The Action Agencies are committed to providing actions that will reduce mortality from predators of ESA-listed juvenile and adult anadromous fish. As such, the Action Agencies have developed and will continue to implement predation management strategies involving piscivorous fish (fish that prey on other fish), avian (birds) species, and marine mammals.

The Action Agencies have identified three specific predation management strategies that will be implemented (Figure B.2.5-1):

- Predation Management Strategy 1—Implement Piscivorous Predation Control Measures to Increase Survival of Juvenile Salmonids in the Lower Snake and Columbia River
- Predation Management Strategy 2—Implement Avian Predation Control Measure to Increase Survival of Juvenile Salmonids in the Lower Snake and Columbia River
- Predation Management Strategy 3—Implement Marine Mammal Control Measures to Increase Survival of Adult Salmonids at Bonneville Dam

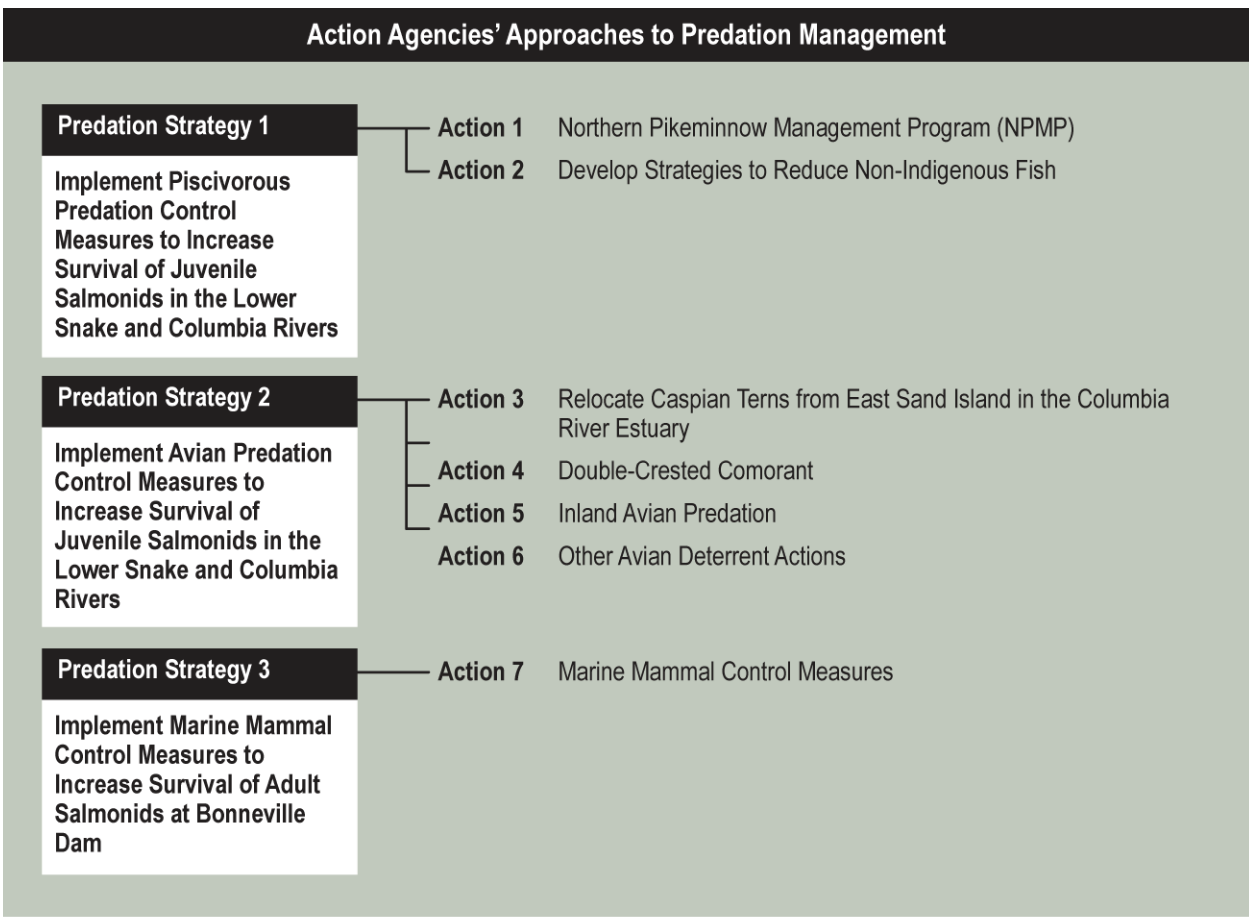

Figure B.2.5-1. Approaches to Predation Management

Underlying each of these strategies are seven actions that are either already underway or will be implemented. The following predation control actions will be implemented to reduce mortality and improve survival of juvenile and adult anadromous fish.

B.2.5.2 Strategy 1 – Implement Piscivorous Predation Control Measures to Increase Survival of Juvenile Salmonids in the Lower Snake and Columbia River

This strategy will involve two actions:

- Predation Management Action 1 – Northern Pikeminnow Management Program (NPMP)
- Predation Management Action 2 – Develop Strategies to Reduce Non-Indigenous Fish

The following paragraphs describe these two actions.

Action 1 - Northern Pikeminnow Management Program (NPMP)

The Action Agencies will continue to annually implement the base program and continue the general increase in the reward structure in the northern pikeminnow sport-reward fishery consistent with the increase starting in 2004. To better evaluate the effects of the NPMP, BPA will increase the number of tagged fish.

The Action Agencies will evaluate the effectiveness for focused removals of pikeminnow at The Dalles and John Day dams and implement as warranted. Additional scoping of other mainstem dams will be based upon this evaluation and adaptive management principles.

The objective of the NPMP is to increase survival of outmigrating juvenile salmon and steelhead by reducing the number of larger, predatory pikeminnow throughout the mainstem Columbia and Snake rivers. There is a direct relationship between numbers of pikeminnow removed and reduced predation losses; similarly, there is a direct relationship among rewards, angler participation, and catch of pikeminnow.

The primary method of the NPMP for catching northern pikeminnow is a sport-reward fishery. BPA provides and pays a reward for each qualifying fish caught within the mainstem Columbia and Snake rivers. BPA annually sets the budget level for the NPMP and administers the program through a contract with the Pacific States Marine Fisheries Commission with subcontracts awarded to implement various program components to the Oregon Department of Fish and Wildlife (ODFW) and the Washington Department of Fish and Wildlife (WDFW).

Implementation of the NPMP during the past 16 years shows that increased rewards result in increased participation by individuals endeavoring to catch this fish, increased dedication by those skilled at catching the fish, and, as a result, increased catch of this predator. Increased rewards in the early years of the program and in 2001 resulted in increased participation and catch. Evaluation of the NPMP indicates that as a result of cumulative removals since program inception, a 25 percent reduction in pikeminnow predation has occurred (Friesen and Ward 1999). This means that 2 to 4 million juvenile salmon annually survive that would otherwise have been eaten by this predator. The benefits of pikeminnow removals affect all ESA-listed and non-listed yearling and sub-yearling salmonids that use the mainstem Columbia and Snake rivers as outmigration corridors. The benefit is largest for sub-yearling migrants. Additionally, biologists have not observed other fish predators compensating for the large number of pikeminnow removed, which could offset the benefit.

In 2006, the Action Agencies continued implementing a general increase in the reward structure started in the summer of 2004. Average exploitation rates (the percentage of the targeted size fish annually removed) in the NPMP, notwithstanding the increased incentives in 2001 and in 2004 to 2005, have averaged approximately 11 percent for the last 16 years.

The observed exploitation rate on northern pikeminnow since increasing the monetary incentives has averaged 18 percent, an improvement of more than 50 percent. Program evaluators will model estimates of the increased exploitation rate's additional effect on reduction in predator mortality during the 2006-2007 off-season. This increase above the baseline, once estimated and quantified, would be above and beyond the base benefits assumed by many analytical analyses. Therefore, the marginal benefit of any increase in exploitation rate resulting from increases in program incentives should be separate and above base-period benefits.

Action 2 - Develop Strategies to Reduce Non-Indigenous Fish

The Action Agencies will work with States and Tribes to coordinate the formation of a workshop to review, evaluate, and develop strategies to reduce non-indigenous piscivorous predation.

Management of non-indigenous species of predacious fish has long been identified as a potential measure to increase the survival of outmigrating juvenile salmonids. It is likely that development and implementation of non-indigenous predation management would not result in biological benefit measured on a system-wide scale. Therefore, the performance metric used to measure benefit would be specific to the local removals. Site-specific removals could have positive effects on reservoir mortality and/or passage survival, proportional to the relative density of the stock within a particular reach. For instance, smallmouth bass management in Lower Granite Reservoir would have a disproportionate benefit for sub-yearling Snake River Chinook Salmon pool mortality, but no benefit for Snake River Sockeye Salmon.

The Action Agencies cannot implement any non-indigenous fish program without the collaboration and approval of the States and Tribes with management authority over this resource. Therefore, further examination of this issue particularly with the States of Oregon and Washington is needed.

B.2.5.3 Strategy 2 – Implement Avian Predation Control Measure to Increase Survival of Juvenile Salmonids in the Lower Snake and Columbia River

The management of avian predators includes four actions:

- Predation Management Action 3 – Relocate Caspian terns from East Sand Island in the Columbia River Estuary
- Predation Management Action 4 –Double-Crested Cormorant
- Predation Management Action 5 – Inland Avian Predation
- Predation Management Action 6 – Other Avian Deterrent Actions

The following paragraphs describe these four actions.

Action 3 - Relocate Caspian Terns from East Sand Island in the Columbia River Estuary

The Action Agencies will carry out Caspian tern management actions within the western region (California and Oregon) to effect redistribution of a majority of the Caspian terns from the Columbia River estuary. Alternative nesting locations are described below. Once alternative habitat alterations are complete, East Sand Island tern habitat will be reduced from 6.5 to 1.5 to 2 acres. It is predicted that the target acreage on East Sand Island will be achieved in approximately 2010.

Site	Acres	Proposed Year of Creation	Proposed Year in which Target Acreage is Achieved
Fern Ridge Lake	1	2007/2008	2007/2008
Summer Lake	1.5	2008	2008
Crump Lake	1	2009	2009
Brooks Island (San Francisco Bay)	2	2008/2009	2008/2009
Hayward Regional Shoreline (San Francisco Bay)	0.5	2008/2009	2008/2009
Don Edwards NWR (San Francisco Bay)	0.5-1	2009	2009

Caspian terns are a piscivorous species that have pioneered nesting colonies on islands in the Columbia River estuary. Currently, through implementation of management practices, their nesting activities have been confined to East Sand Island. The colony on East Sand Island supports approximately two-thirds of the North American population of Caspian terns and is significantly larger than normal for the species. The Columbia River estuary population of this species has been the focus of intensive research actions to address their predation on juvenile salmonids and their habitat/population management. A Final Environmental Impact Statement (FEIS), *Caspian Tern Management to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary,* was issued in January 2005. The FEIS was prepared jointly by the U.S. Fish and Wildlife Service (USFWS) (lead), Corps, and National Marine Fisheries Service (NMFS, also called National Oceanic and Atmospheric Administration [NOAA] Fisheries).

The Action Agencies proposed in the 2004 Updated Proposed Action (UPA) to carry out Caspian tern management actions within the western region (California and Oregon) to effect redistribution of a majority of the Caspian terns from the Columbia River estuary. Dispersion of most of the Caspian tern population to locales (5 of 6) outside the Columbia River Basin would substantially reduce predation losses of juvenile salmonids in the Columbia River estuary and increase their escapement to the Pacific Ocean. Adult salmon returns are expected to increase concomitant with the increased escapement of juvenile salmonids to the Pacific Ocean.

Caspian tern management actions would be done in a manner consistent with the preferred alternative identified in the FEIS, with modification attributable to the NMFS Biological Opinion. The USFWS and the Corps signed separate Records of Decision (RODs) adopting the USFWS plan (modified preferred alternative) for managing Caspian terms in the lower Columbia River on November 20 and November 22, 2006, respectively. NMFS completed the Biological Opinion for the proposed action on February 16, 2006.

The preferred alternative in the FEIS has been modified by dropping Dungeness National Wildlife Refuge (NWR), Washington, from the alternative site list due to NMFS' concerns over Caspian tern impacts to Puget Sound Chinook Salmon and Hood Canal Summer-run Chum Salmon ESUs. The modified preferred alternative would reduce Caspian tern nesting habitat on East Sand Island, Oregon from approximately 6.5 acres to 1.5 to 2 acres (versus the 1 to 1.5 acres identified in the FEIS). Adaptive management would be undertaken such that tern nesting habitat acreage on East Sand Island could be reduced to 1 to 1.5 acres per the original preferred alternative, if terns initiate nesting on a suitable site in the future.

The modified preferred alternative relies on habitat management and social attraction measures at six alternate nesting locations to reduce the tern colony in the Columbia River estuary. These alternative nesting locations are located at Fern Ridge Lake (1 acre), Summer Lake (1.5 acre), and Crump Lake (1 acre) in Oregon; and Brooks Island (2 acre), Hayward Regional Shorelines (~0.5 acre), and Don Edwards NWR, San Francisco Bay, California (0.5 to 1.0 acre). Habitat development at these locations would entail construction of islands and/or modification of existing islands to provide a bare ground substrate suitable for nesting Caspian terns. All locations, except Fern Ridge Lake, are outside the Columbia River Basin.

In conjunction with this increase of suitable nesting habitat outside of the Columbia River Basin, the Corps would reduce the available nesting habitat at East Sand Island from approximately 6.5 acres to 1.5 to 2 acres. Alternative habitat would be developed prior to reduction of nesting habitat on East Sand Island at a ratio of 2 acres of alternative habitat developed to 1 acre of nesting habitat reduced. The reduction in habitat acreage at East Sand Island would be accomplished by discontinuing maintenance actions and allowing for vegetative succession to render the acreage unsuitable for nesting Caspian terns. The balance of nesting habitat at East Sand Island would be maintained in order to continue to provide proper habitat conditions for Caspian terns.

Redistribution of the Columbia River Caspian tern population is predicated upon their documented impact to juvenile salmonids in the estuary. Roby et al. (2003) estimated that in 1998 Caspian terns nesting at Rice Island [river mile (RM) 21], consumed approximately 12.6 million (~13 percent) of the 96.6 million juvenile salmonids that reached the Columbia River estuary. Collis et al. (1998) reported that an analysis of over 36,000 smolt passive integrated transponder (PIT) tags recovered from the Rice Island tern colony in 1998 demonstrated that over 13.5 percent of all PIT-tagged steelhead smolts reaching the estuary were consumed by Caspian terns (see Appendix F to the Comprehensive Analysis).

Research information from 1997 to 1998 led to initial efforts by the resource agencies and the Action Agencies to move the Caspian terns to East Sand Island based upon the hypothesis that a more diverse array of prey species would be present at Columbia River RM 5 where marine fish species are prevalent. By 2001, all Caspian terns nesting in the Columbia River estuary had been relocated to East Sand Island through habitat development there. Annual operation and maintenance actions (tillage and social facilitation with tern decoys and sound systems playing recorded tern colony vocalizations) have succeeded in keeping the tern colony at East Sand Island through 2005.

Juvenile salmonids comprised 16.8 percent to 46.5 percent of the Caspian tern diet at East Sand Island during the 1999 to 2005 timeframe versus 72.7 percent to 89.6 percent juvenile salmonids in the diet for terns at Rice Island between 1997 and 2000 (Collis et al. 2006). Research results demonstrate that moving Caspian terns from Rice Island, where fresh water dominates, to East Sand Island where marine waters dominate, substantially reduced the number of juvenile salmonids harvested by the terns. Ocean productivity also appears to influence take of juvenile salmonids by Caspian terns at East Sand Island with good ocean productivity, and therefore increased populations of marine fishes, resulting in a reduced harvest of juvenile salmonids by the terns.

Demonstration that habitat management and social facilitation could result in relocation of nesting Caspian terns and that management practices of this nature could have a substantial impact on prey resource utilization played an integral role in the development of the preferred alternative in the FEIS. Attainment of the original projected colony size for East Sand Island terns (2,500 to 3,125 pairs) described in the preferred alternative of the FEIS is contingent upon implementation of the modified preferred alternative plus adoption of adaptive management strategies to address the removal of the Dungeness NWR as an alternative management site. The scenario laid forth in the modified preferred alternative would reduce the Caspian tern colony in the Columbia River estuary from an average population of 9,093 nesting pairs (as determined from 2000 to 2005) to 3,125 to 4,375 nesting pairs.

Action 4 - Double-Crested Cormorant

The Action Agencies will develop a cormorant management plan encompassing additional research, development of a conceptual management plan, and implementation of actions if warranted in the estuary.

The Columbia River estuary population of double-crested cormorant has been the focus of recent research actions to evaluate their predation on juvenile salmonids. The proposed predation management for this species encompasses additional research, development of a conceptual management plan, National Environmental Policy Act (NEPA) clearances, implementation (if warranted) of a management plan, and research, monitoring, and evaluation (RM&E). Further research is required to provide a stronger foundation for the bioenergetics model used to predict general juvenile salmonid consumption. Research requirements include refinement of PIT-tag detection and loss estimates in order to address impacts on salmonids, in general, and for specific Evolutionarily Significant Unites (ESUs) or Distinct Population Segments (DPS, an equivalent term often used for steelhead). Minimal research has been conducted to date on double-crested cormorant habitat/population management in the Columbia River estuary; more research is required before a conceptual management plan can be developed and evaluated per NEPA requirements.

Double-crested cormorants are a piscivorous species that have pioneered breeding colonies into the Columbia River estuary. Since 1989, when less than 100 pairs were present on East Sand Island, the breeding population of this species has increased there to 12,500 pairs in 2004 (Collis et al. 2005), the largest colony in North America. Estimated juvenile salmonid consumption by this species in 2004 was 6.4 million fish (range 2.5 to 10.3 million), a 25 percent increase over the 2003 estimate of 5.2 million smolts (Collis et al. 2005). Their predation level, coupled with that for Caspian terns, generated an estimated loss of 10 million juvenile salmonids in the estuary for 2004 (Collis et al. 2005). Steelhead, coho salmon, and sub-yearling and yearling Chinook salmon comprised the salmonids in their diet in 2004; sub-yearling Chinook salmon represented the largest proportion of salmonids (Collis et al. 2005). ESU-specific data are not available.

Conceptually, management efforts directed toward double-crested cormorants nesting in the Columbia River estuary could achieve additional gains, perhaps comparable to or even greater than those associated with the proposed Caspian tern management. Further research efforts are necessary to lead to an EIS, developed in conjunction with USFWS, that addresses potential population and habitat management actions for double-crested cormorants. Research into cormorant predation on juvenile salmonids, an evaluation of management needs, and an in-depth analysis of the regional double-crested cormorant population (range, population dynamics, and status) would support completion of the environmental review requirements for determination of future management actions, if warranted.

The double-crested cormorant nesting period begins in late April and continues to the end of August, coinciding with the principal juvenile salmonid outmigration period. Reductions in cormorant predation rates have the potential to benefit the majority of the listed and non-listed yearling salmonids as well as some sub-yearling salmonids that migrate through the Columbia River estuary during that time. This would include the following ESUs/DPSs:

- Snake River Spring/Summer Chinook Salmon ESU
- Snake River Fall Chinook Salmon ESU
- Upper Columbia River Spring Chinook Salmon ESU
- Upper Willamette River Chinook Salmon ESU
- Lower Columbia River Chinook Salmon ESU
- Snake River Steelhead DPS
- Upper Columbia River Steelhead DPS
- Mid-Columbia River Steelhead DPS
- Upper Willamette River Steelhead DPS
- Lower Columbia River Steelhead DPS
- Snake River Sockeye Salmon ESU
- Lower Columbia River Coho Salmon ESU

Double-crested cormorants nesting in the estuary have little to no effect on Columbia River chum salmon (Roby 2006). Chum salmon juveniles outmigrate early, generally prior to arrival of most Caspian terns and double-crested cormorants and usually at a smaller size than other juvenile salmonid outmigrants (Lyons 2007). There is little or no evidence of juvenile chum salmon in Caspian tern and double-crested cormorant diet investigations in the Columbia River estuary (Lyons 2007).

Action 5 - Inland Avian Predation

The Action Agencies will develop an avian management plan for Corps-owned lands and associated shallow-water habitat.

Caspian Tern

Of the inland Caspian tern colonies, the one on Crescent Island in the mid-Columbia River is the largest of its kind on the Columbia Plateau. Located below the confluence of the Snake and Columbia rivers, the tern colony on Crescent Island consists of approximately 500 breeding pairs and interacts with up to 10,000 gulls also found on Crescent Island.

Salmonid smolts represented about 68 percent, 70 percent, and 65 percent of the tern diet on Crescent Island in 2003, 2004, and 2005, respectively. Consumption of both Snake River and Columbia River juvenile salmonids by the Crescent Island tern colony was estimated at approximately 440,000, 470,000, and 440,000 smolts in 2003, 2004, and 2005, respectively. These are minimum consumption estimates and do not include kleptoparasitism (i.e., stealing items, such as food or nest materials, from other individuals) by the California gull colony surrounding the tern colony on Crescent Island.

Snake River Steelhead incurred the highest predation rate at 34.7 percent and 16.7 percent in 2004 and 2005 when corrected for PIT-tag collision, detection efficiency, and PIT-tag deposition (Collis et al. 2005). It is important to note that these are minimum predation rates based on the proportion of PIT-tagged smolts last detected at Lower Monumental Dam and subsequently recovered on the Crescent Island tern colony (Collis et al. 2005).

Because of low flow years in 2003 and 2004, it is estimated approximately 96 percent to 98 percent of the Snake River steelhead smolts above Lower Granite Dam were transported via barge and were not susceptible to predation from terns at Crescent Island. Thus, considering the percentage of steelhead barged, the predation rates presented in the above paragraph were only on an estimated 2 to 4 percent of the total Snake River Steelhead population.

However, recent and future expected transportation operations will have a "spread-the-risk" transport/in-river migration operation in which more steelhead migrate in-river. Data cited above for 2003 and 2004 reflect estimated losses when most fish were transported; it is unclear whether predation rates would significantly change relative to the proportion of juvenile salmonids left in-river to migrate past the Crescent Island tern colony.

The Corps will develop and implement an avian management plan for Corps-owned lands, including avian colonies on Crescent Island, and associated shallow-water habitat. The development and implementation of avian management plan(s) will be preceded by a thorough analysis of avian predator diets, predation rates, and overall effects of current avian predation on various salmonid ESUs. This will be a comprehensive plan developed in collaborative discussion with the USFWS.

The primary objective of this plan will be to improve ESA-listed anadromous fish survival for fish rearing and migrating through the lower Snake and Columbia rivers. Research in support of this plan will continue with 2007 studies to determine the impact of Caspian tern predation on juvenile salmon under a range of system operations, with a potential for future research as needed. In addition, efforts are underway to better estimate the species/ESU-specific impacts of tern predation.

Until it is determined that management is warranted and a management alternative is selected, it is difficult to determine the potential benefit of this action. Reductions in tern predation rates have the potential to benefit the majority of the listed and non-listed yearling salmonids as well as some sub-yearling salmonids that migrate near Crescent Island during the Caspian tern nesting period, which begins in early April and continues to the end of July. This would include the following ESUs/DPSs:

- Snake River Spring/Summer Chinook Salmon ESU
- Snake River Fall Chinook Salmon ESU
- Upper Columbia River Spring Chinook Salmon ESU
- Snake River Steelhead DPS
- Upper Columbia River Steelhead DPS
- Mid-Columbia River Steelhead DPS
- Snake River Sockeye Salmon ESU

Double-Crested Cormorant

In recent years, the number of double-crested cormorants has been increasing throughout the mid-Columbia region. The number of nesting pairs of cormorants on Foundation Island in the McNary pool increased 14 percent from 2005 to 2006. In 2006, a small, but new, colony of cormorants was located on the railroad bridge on the Snake River across from Lyons Ferry Hatchery. Cormorants are now regularly observed over-wintering at all lower Snake River projects. In the spring of 2007, approximately 60 to 70 cormorants were observed roosting along the Snake River in Lewiston, Idaho. Monitoring of cormorants in the Potholes, Moses Lake, and Yakima River also show an increase in cormorant numbers.

In 2006, PIT-tags were recovered at the Foundation Island cormorant colony in order to estimate smolt predation rates. Cormorants nest in trees on Foundation Island, making PIT-tag detection difficult, and thereby underestimating predation. A total of 3,505 PIT-tags from the 2006 migration were recovered on Foundation Island. Based on the limited Foundation Island PIT-tag data, cormorants consumed a minimum estimated 0.89 percent of all the PIT-tagged smolts interrogated passing Lower Monumental Dam from April through July 31. The estimated Foundation Island cormorant predation rates on hatchery Snake River Steelhead smolts was 2.8 percent and predation rates for PIT-tagged Fall Chinook Salmon from the Yakima River were estimated at 2.0 percent. These are minimum predation rates and are not corrected for the proportion of ingested PIT-tags not deposited on the colony, including uncertainties regarding PIT-tag detection efficiency and deposition rate.

The Corps will develop and implement an avian management plan for Corps-owned lands. This will be a comprehensive plan that will include avian colonies on Foundation Island, other cormorant roosting sites, and associated shallow-water habitat. Alternatives will be developed and evaluated in collaboration with the USFWS. Research to determine the impact of double-crested cormorant predation on salmonids in the Columbia River Basin is continuing in 2007, with a potential for future research, as needed. In addition, efforts are underway to better estimate the species/ESU-specific impacts of cormorant predation.

Until it is determined that cormorant management is warranted and a management alternative is selected, it is difficult to determine the potential benefit of action. The double- crested cormorant nesting period begins in late April and continues to the end of August, coinciding with the principal juvenile salmonid outmigration period. Reductions in cormorant predation rates have the potential to benefit the majority of the listed and non-listed yearling salmonids as well as some sub-yearling salmonids that migrate near Foundation Island during that time. This would include the following ESUs/DPSs:

- Snake River Spring/Summer Chinook Salmon ESU
- Snake River Fall Chinook Salmon ESU
- Upper Columbia River Spring Chinook Salmon ESU
- Snake River Steelhead DPS
- Upper Columbia River Steelhead DPS
- Mid-Columbia River Steelhead DPS
- Snake River Sockeye Salmon ESU

The 3-year goal is to begin development of a comprehensive management strategy for populations of avian predators (including cormorants) on lands under Corps management authorities. Research will continue to provide information necessary to evaluate potential avian management alternatives (including cormorants on Foundation Island and other locations).

Once management alternatives have been determined, and implementation of the management plan is ongoing, the performance metrics will be defined in the management plan. To provide information in support of the plan, the goal is to estimate stock-specific predation rates on juvenile salmonids, and determine if regional management actions are warranted. The Action Agencies will conduct collaborative discussions with the USFWS during the research phase. If, at the end of the research phase, it is determine management actions are warranted, the Action Agencies will begin environmental documentation associated with potential management alternatives on cormorants within the Columbia River Basin.

Action 6 - Other Avian Deterrent Actions

The Corps will continue to implement and improve avian deterrent programs at all lower Snake and Columbia River dams. This program will be coordinated through the Fish Passage Operations and Maintenance Team and included in the Fish Passage Plan.

Avian deterrent actions are ongoing at each of the dams. The Corps will continue to implement and improve avian predation deterrent programs at all lower Snake and Columbia River dams. This program will continue to be coordinated with the Fish Passage Operations and Maintenance Team (FPOM) and included in the annual Fish Passage Plan (FPP).

B.2.5.4 Strategy 3 – Implement Marine Mammal Control Measures to Increase Survival of Adult Salmonids at Bonneville Dam

This strategy includes one action:

- Predation Management Action 7 – Marine Mammal Control Measures

The following paragraphs describe this action.

Action 7 – Marine Mammal Control Measures

The Corps will install and improve as needed sea lion excluder gates at all main adult fish ladder entrances at Bonneville Dam annually. In addition, the Corps will continue to support land and water-based harassment efforts by NMFS, ODFW, WDWF, and the Tribes to keep sea lions away from the area immediately downstream of Bonneville Dam.

The Action Agencies have developed an experimental strategy to address fish predation by pinnipeds at or near Bonneville Dam. Studies conducted by the Corps at Bonneville Dam from 2002 to 2005 estimate the amount of fish eaten by sea lions has increased nearly every year since studies were undertaken by the Corps. Pinnipeds consumed from 0.3 percent of the annual spring salmon run in 2002, to 1.1 percent in 2003, to 2.2 percent in 2004, to 3.4 percent in 2005, to 2.8 percent in 2006. The studies also suggest the sea lions are arriving earlier and staying later at Bonneville Dam each year, with approximately 100 individuals annually being present. In addition, the sea lion efficiency in catching salmon and lamprey has increased annually and an increased level of boldness has been observed, with several pinnipeds entering the adult fishways and hauling out near the project.

In 2005, pinnipeds were observed inside the adult fishways, causing concern for predation and potential delay of adult salmon passage. There is an increasing trend to this problem. In response, the Corps designed sea lion excluder devices (SLEDs) to keep sea lions out of the fish ladders. The Corps also has been working closely with NMFS and the States to develop a management strategy, including various techniques to haze sea lions in the area.

In 2006, the Corps installed SLEDs at all fishway entrances at Bonneville Dam and deployed acoustic deterrents from the dam structure immediately adjacent to fish ladder entrances to give fish a potential refuge from sea lion presence at the entrances of the ladder where fish tend to pause/congregate.

The Action Agencies will continue actions at the projects to:

- Provide and improve SLEDs to limit ability to enter fishways;
- Use acoustic deterrent devices to attempt to move sea lions from immediate adult ladder entrances, away from project facilities, and out of the navigation lock;
- Support and participate in efforts to keep sea lions away from the area immediately downstream of Bonneville Dam; and
- Continue working with the States and provide support for harassment activities downstream of Bonneville Dam.

The States of Oregon and Washington are pursuing Federal authorization through Section 120 of the Marine Mammal Protection Act to lethally remove individual problem animals, if necessary, to protect ESA-listed salmon. The Corps will assist in this effort by documenting activities of individually identifiable pinnipeds near Bonneville Dam and provide assistance and support for the removal of animals as authorized through the Marine Mammal Protection Act (MMPA).

The Action Agencies will document the spatial and temporal distribution of sea lion predation attempts, estimate predation rates, and estimate overall seal lion abundance in order to assess the effects of a combination of deterrent actions (such as exclusion gates, acoustics, and harassment methods and locations) on spring runs of adult anadromous fish passing Bonneville Dam. This information will be shared with the States and NMFS in order to coordinate future plans and activities to reduce pinniped impacts to spring Chinook salmon and steelhead.

No specific quantifiable benefits are used in the benefits analysis derived from pinniped actions as a result of the current action described above. However, it is anticipated that specific harassment actions, installation of SLEDS, and acoustic deterrents will provide benefits to spring-run anadromous fish for all ESUs as well as white sturgeon immediately below Bonneville. Pending the outcome of the States seeking Federal authorization on sea lion removal through Section 120 of the MMPA, it is expected that survival improvements from 1 to 2 percent in adult spring Chinook salmon survival below Bonneville Dam are likely. However, because the States would undertake these measures, they are not included in the Federal Columbia River Power System (FCRPS) benefits analysis.

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Section B.2.6—Research, Monitoring, and Evaluation Action

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ACRONYMS AND ABBREVIATIONS

AFEP	Anadromous Fish Evaluation Program
BA	Biological Assessment
BMP	best management practice
BPA	Bonneville Power Administration
CBFWA	Columbia Basin Fish and Wildlife Authority
COMPASS	Comprehensive Fish Passage Model
Council	Northwest Power and Conservation Council
DPS	Distinct Population Segment
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FCRPS	Federal Columbia Power System
FY	fiscal year
MOU	Memorandum of Understanding
NED	Northwest Environmental Data
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
PIT	passive integrated transponder
PNAMP	Pacific Northwest Aquatic Monitoring Partnership
RM&E	research, monitoring, and evaluation
SAR	smolt-to-adult return
SCT	System Configuration Team
TGD	total dissolved gas
TMT	Technical Management Team

B.2.6 RESEARCH, MONITORING, AND EVALUATION ACTION

The overall research, monitoring, and evaluation (RM&E) objective is to provide information needed to support planning and adaptive management and demonstrate accountability related to the implementation of Federal Columbia River Power System (FCRPS) Endangered Species Act (ESA) hydropower and offsite actions for all Evolutionarily Significant Units (ESUs) or Distinct Population Segments (DPSs, an equivalent term used for steelhead). The Action Agencies will undertake RM&E through project implementation and compliance monitoring, status monitoring, action effectiveness research, and critical uncertainties research in the following nine areas:

1. Monitor the status of selected fish populations related to FCRPS Actions.
2. Hydrosystem RM&E
3. Tributary Habitat RM&E
4. Estuary and Ocean RM&E
5. Harvest RM&E
6. Hatchery RM&E
7. Predation Management RM&E
8. Coordination and Data Management RM&E
9. Project Implementation and Compliance Monitoring RM&E

Each of the nine areas is identified as a strategy in the following discussion. Each strategy consists of one or more specific actions. These are summarized in the following sections. A conceptual overview of the overall RM&E Action is presented in Figure B.2.6-1.

The RM&E will address the following management questions related to FCRPS ESA actions:

- Are actions being implemented as proposed? (Addressed through Project Implementation and Compliance Monitoring)
- Are performance standards and targets for each ESA listed ESU or DPS being achieved? What is the effectiveness of specific types of actions in addressing limiting factors? (Addressed through Status and Effectiveness Monitoring)
- Are there management questions or limiting factors that require further understanding? (Addressed Through Critical Uncertainties Analysis)

The RM&E Actions have and will continue to be coordinated through Regional RM&E Collaboration Processes and are also intended to be consistent with the National Marine Fisheries Service (NMFS, also called National Oceanic and Atmospheric Administration [NOAA Fisheries) RM&E Guidance for Recovery Planning and Delisting. The Action Agencies currently fund extensive RM&E programs for the FCRPS, totaling more than $75 million per year. Implementation of these RM&E Actions will continue to be coordinated through existing program project selection and funding processes including those of the Northwest Power and Conservation Council (Council) and the Corps' Anadromous Fish Evaluation Program (AFEP).

Action Agencies' Approaches to Research, Monitoring, and Evaluation (RM&E)

- **RM&E Strategy 1 – Monitor Status of Selected Fish Populations Related to FCRPS Actions**
  - **Action 1** Fish Population Status Monitoring
  - **Action 2** Collaboration Regarding Fish Population Status Monitoring
- **RM&E Strategy 2 – Hydrosystem RM&E**
  - **Action 3** Monitor and Evaluate Fish Performance within the FCRPS
  - **Action 4** Monitor and Evaluate Mitigation Characteristics and River Condition
  - **Action 5** Monitor and Evaluate Effects of Configuration and Operation Actions
  - **Action 6** Investigate Hydro Critical Uncertainties
- **RM&E Strategy 3 – Tributary Habitat RM&E**
  - **Action 7** Monitor and Evaluate Tributary Habitat Conditions and Limiting Factors
  - **Action 8** Evaluate the Effectiveness of Tributary Habitat Actions
- **RM&E Strategy 4 – Estuary Habitat RM&E**
  - **Action 9** Monitor and Evaluate Fish Performance in the Estuary and Plume
  - **Action 10** Monitor and Evaluate Migration Characteristics and Estuary/Ocean Conditions
  - **Action 11** Monitor and Evaluate Habitat Actions in the Estuary
  - **Action 12** Investigate Estuary/Ocean Critical Uncertainties
- **RM&E Strategy 5 – Harvest RM&E**
  - **Action 13** Fund Selected Harvest Investigations
- **RM&E Strategy 6 – Hatchery RM&E**
  - **Action 14** Monitor Hatchery Effectiveness
  - **Action 15** Investigate Hatchery Critical Uncertainties
- **RM&E Strategy 7 – Predation Management RM&E**
  - **Action 16** Monitor and Evaluate the Caspian Tern Population in the Columbia River Estuary
  - **Action 17** Monitor and Evaluate the Double-Crested Cormorant Population in the Columbia River Estuary
  - **Action 18** Monitor and Evaluate Inland Avian Predation
  - **Action 19** Monitoring Related to Marine Mammal Predation
  - **Action 20** Monitoring Related to Piscivorous (Fish) Predation
- **RM&E Strategy 8 – Coordination and Data Management**
  - **Action 21** Coordination
  - **Action 22** Data Management
- **RM&E Strategy 9 – Implementation and Compliance Monitoring**
  - **Action 23** Implementation and Compliance Monitoring

Figure B-2.6-1. Research, Monitoring, and Evaluation Action Summary

The following RM&E Actions will be funded within those programs, while advancing the goal of shifting a greater percentage of spending in these programs to on-the-ground mitigation actions that provide direct benefits to salmon and steelhead. To accomplish this balancing of on-the-ground actions with RM&E and data management, prioritization of these new RM&E activities, with some potential reprioritization of existing activities, may be desirable. RM&E funding might also be leveraged through cost-sharing arrangements with other Federal and State agencies.

The Action Agencies have identified measures that will be monitored to assess progress towards achievement of performance standards (benchmarks) and performance targets (longer-term goals) to inform adaptive management actions. Two aspects of performance will be monitored:

- **Programmatic performance** will be tracked through project implementation and compliance monitoring.
- **Biological and environmental performance** will be tracked and evaluated through status monitoring, action effectiveness research, and critical uncertainty research in combination with existing and developing quantitative models. Performance standards will be monitored to ensure accountability and adherence to proposed actions. Biological performance targets will be evaluated over longer time periods as new information and learning is applied through analytical models. Targets allow us to check for progress toward expected life stage survival improvements and trends in evolutionarily significant unit (ESU) or population performance. Performance targets inform longer-term adaptive management decisions and prioritization of options across populations with different relative needs.

Performance standards will be monitored frequently to ensure accountability and adherence to actions with potential contingencies or other time-critical corrective actions. Performance targets will be evaluated over longer time periods as new information and learning is applied through analytical models to check for progress toward expected life stage survival improvements and trends in population performance. Performance targets will inform longer-term adaptive management decisions and prioritization of options across populations with different relative needs.

The Action Agencies have identified nine specific strategies and their underlying actions (23) that are either ongoing or will be implemented for the RM&E Action (Figure B.2.6-1):

RM&E Strategy 1—Monitor the Status of Selected Fish Population Related to FCRPS Actions

- Action 1: Fish Population Status Monitoring
- Action 2: Collaboration Regarding Fish Population Status Monitoring

RM&E Strategy 2—Hydrosystem RM&E

- Action 3: Monitor and Evaluate Fish Performance within the FCRPS
- Action 4: Monitor and Evaluate Migration Characteristics and River Condition
- Action 5: Monitor and Evaluate Effects of Configuration and Operation Actions
- Action 6: Investigate Hydrosystem Critical Uncertainties

RM&E Strategy 3—Tributary Habitat RM&E

- Action 7: Monitor and Evaluate Tributary Habitat Conditions and Limiting Factors
- Action 8: Evaluate the Effectiveness of Tributary Habitat Actions

RM&E Strategy 4— Estuary and Ocean RM&E

- Action 9: Monitor and Evaluate Fish Performance in the Estuary and Plume
- Action 10: Monitor and Evaluate Migration Characteristics and Estuary/Ocean Conditions
- Action 11: Monitor and Evaluate Habitat Actions in the Estuary
- Action 12: Investigate Estuary/Ocean Critical Uncertainties

RM&E Strategy 5—Harvest RM&E

- Action 13: Fund Selected Harvest Investigations

RM&E Strategy 6—Hatchery RM&E

- Action 14: Monitor Hatchery Effectiveness
- Action 15: Investigate Hatchery Critical Uncertainties

RM&E Strategy 7—Predation Management RM&E

- Action 16: Monitor and Evaluate the Caspian Tern Population in the Columbia River Estuary
- Action 17: Monitor and Evaluate the Double-Crested Cormorant Population in the Columbia River Estuary
- Action 18: Monitor and Evaluate Inland Avian Predators
- Action 19: Monitoring Related to Marine Mammal Predation
- Action 20: Monitoring Related to Piscivorous (Fish) Predation

RM&E Strategy 8—Coordination and Data Management RM&E

- Action 21: Coordination
- Action 22: Data Management

RM&E Strategy 9—Project Implementation and Compliance Monitoring RM&E

- Action 23: Implementation and Compliance Monitoring

The following describes each of these strategies and their underlying actions:

B.2.6.1 RM&E Strategy 1—Monitor the Status of Selected Fish Populations Related to FCRPS Actions

RM&E Strategy 1: Monitor Status of Selected Fish Populations Related to FCRPS Actions

Funding Source(s): Bonneville Power Administration (BPA) Fish and Wildlife Program direct funding, Corps Operation and Maintenance and Columbia River Mitigation Program, and Reclamation Congressional appropriations for Columbia/Snake Salmon Recovery.

Rationale: Monitoring status of selected populations supports future examination of recovery and survival metrics and trends for All-Hs, including actions by the FCRPS and others.

What's New: Review projects for potential modifications to increase focus and value for existing Action Agencies status monitoring, and expansion to address a critical deficiency in regional monitoring of Snake River B-Run Steelhead; strengthened commitments to collaboration.

Management Questions: The primary management questions regarding information on fish populations for the FCRPS are as follows:

- What are the abundance, productivity, and spatial distribution of ESA-listed populations affected by the FCRPS?
- What is the proportion of ESA-listed populations that are of hatchery origin?

The Action Agencies will be using population performance information reported in the periodic population status reports from NMFS and in annual abundance estimates in the Columbia Basin Fish and Wildlife Authority's (CBFWA) State of the Resource reports to provide context for performance of FCRPS actions in aggregate with other regional actions and environmental conditions. We expect these status reports will continue to provide performance measures for trends in abundance and productivity and assessment of spatial diversity conditions.

The Action Agencies will also be funding specific status monitoring related to FCRPS actions. These projects are undergoing review and potential modifications to increase their focus and value for monitoring critical populations, and they are being expanded to address a critical deficiency in the regional monitoring of Snake River B-Run Steelhead.

See Table 8, Attachment B.2.6-1 for specific projects that are currently being implemented during the fiscal year (FY) 2007 to FY 2009 period that contribute information to regional assessments of fish population status. Additional fish population status monitoring is also obtained as ancillary information under several projects listed under the hydrosystem, habitat, and hatchery project tables also in Attachment B.2.6-1.

Performance Measures: Population-specific performance measures include fish abundance, average recruits per spawner, lambda (annual population growth rate), abundance trends, and population viability extinction risks. The majority of these performance measures and associated monitoring actions are being implemented through the programs and mandated responsibilities of regional fish management agencies. A subset of these fish population performance measures are currently obtained from Action Agencies-funded projects.

Action 1: Fish Population Status Monitoring

The Action Agencies will enhance existing fish population status monitoring performed by fish management agencies through the following specific actions. In addition, ancillary population status and trend information is being obtained through several ongoing habitat and hatchery improvement projects (see the Fiscal Year 2007 to 2009 project tables in B.2.6-1).

- Implement and maintain the Columbia River Basin passive integrated transponder (PIT)-Tag Information System. (Annually)
- Monitor adult returns at mainstem hydroelectric dams using both visual counts and the PIT-tag detection system (see Hydrosystem section). (Annually)
- Monitor juvenile fish migrations at mainstem hydro electric dams using smolt monitoring and the PIT-tag detection system (see Hydrosystem section). (Annually)
- Fund status and trend monitoring as a component of the pilot studies in the Wenatchee, Methow, and Entiat river basins in the Upper Columbia River, the Lemhi and South Fork Salmon river basins, and the John Day River Basin to further advance the methods and information needed for assessing the status of fish populations. (Initiate in FY 2007 to 2009 Project Funding)
- Provide additional status monitoring to ensure a majority of Snake River B-Run Steelhead populations are being monitored for population productivity and abundance. (Initiate by FY 2009)
- Review and modify existing Action Agencies' fish population status monitoring projects to improve their compliance with regional standards and protocols, and ensure they are prioritized and effectively focused on critical performance measures and populations. (Initiate in FY 2008)
- Fund marking of hatchery releases from Action Agencies funded facilities to enable monitoring of hatchery-origin fish in natural spawning areas and the assessment of status of wild populations. (Annually)
- Report available information on population viability metrics in annual and comprehensive evaluation reports. (Initiate in FY 2008)

Action 2: Collaboration Regarding Fish Population Status Monitoring

The Action Agencies will enhance existing fish population status monitoring performed by fish management agencies through the following collaboration commitments:

- Support the coordination, data management, and annual synthesis of fish population metrics through Regional Data Repositories and reports such as the CBFWA State of the Resource reports. (Annually)
- Facilitate and participate in an ongoing collaboration process to develop a regional strategy for status and trend monitoring for key ESA fish populations and an associated regional agreement for joint funding and implementation. This monitoring strategy will be coordinated with the status monitoring needs and strategies being developed for hydrosystem, habitat, hatchery, harvest, and estuary/ocean. (Initiate in FY 2008)
- Provide cost-shared funding support and staff participation in regional coordination forums such as the Pacific Northwest Aquatic Monitoring Partnership (PNAMP) fish population monitoring workgroup and the Northwest Environmental Data Network to advance regional standards and coordination for more efficient and robust monitoring and information management. (Annually)

B.2.6.2 RM&E Strategy 2—Hydrosystem RM&E

RM&E Strategy 2: Hydrosystem RM&E

Funding Source(s): Corps Operation and Maintenance and Columbia River Fish Mitigation Program funding. BPA – direct funding.

Rationale: Evaluating the effectiveness of hydrosystem actions and critical uncertainties is a central feature of the FCRPS ESA responsibilities.

What's New: Additional actions that include PIT-tagging of Upper Columbia River Chinook Salmon and Steelhead and Snake River Sockeye Salmon, if feasible.

Management Questions: The following are the primary management questions with respect to FCRPS hydrosystem passage actions. Hydrosystem RM&E Actions described in this section are focused on providing information needed to answer these questions to support ongoing and adaptive management decisions.

- Are salmon and steelhead meeting juvenile and adult hydrosystem passage performance standards and targets?
- Is each project in the hydropower system safely and efficiently passing adult and juvenile migrants?
- What are the most effective configurations and operations for achieving desired performance standards and targets in the FCRPS?
- What is the post-Bonneville mortality effect of changes in fish arrival timing and transportation to below Bonneville?
- Under what conditions does in-river passage provide greater smolt-to-adult return (SAR) rates than transport?

See Table 1, Attachment B.2.6-1 for specific projects that have been currently identified for implementation in the FY 2007 to FY 2009 period for Hydrosystem RM&E. Additional, more detailed information supporting the identification of Hydrosystem RM&E Actions is provided in Attachment B.2.6-2.

Performance Measures: The Action Agencies' strategy is to support performance monitoring and adaptive management related hydropower actions. Performance standards have been identified for average juvenile dam survival for run-of-river spring and summer migrants and adult hydro system survival. Hydrosystem Action programmatic standards have also been identified and will be annually monitored with project implementation monitoring. The expected increase in total juvenile system survival associated with the Hydrosystem Action has been identified as a long-term performance target. This performance target will be assessed in the future using the same modeling approach used to assess the benefit of actions within the BA, but using actual operations and configurations in place in 2012 and 2015, at the time of the comprehensive evaluation. These estimates will be based on the Comprehensive Fish Passage Model (COMPASS), calibrated and validated by the most recent years' empirical survival data.

Juvenile Dam Passage Performance Standards—The Action Agencies juvenile performance standards are an average across Snake River and Lower Columbia River dams of 96 percent average dam passage survival for spring Chinook and Steelhead and 93 percent average across all dams for Snake River subyearling Chinook. Dam passage survival is defined as survival from the face of the dam to a standardized reference point in the tailrace (see Attachment B.2.6-2).

Juvenile System Survival Performance Targets—The Action Agencies juvenile system survival performance targets estimate the expected increase in juvenile fish survival through the hydrosystem (system survival to below Bonneville Dam) that are associated with the proposed hydrosystem actions, relative to the 2004 base level (see Appendix B to the Comprehensive Analysis, COMPASS Tables). These relative survival improvements will be used as the biological performance target as the basis for performance tracking.

Adult Performance Standards--The Action Agencies adult performance standards will track and confirm that the current high levels of adult survival are maintained (see Table 1 in Attachment B.2.6-2).

Action 3: Monitor and Evaluate Fish Performance within the FCRPS

The Action Agencies will monitor the following biological responses and/or environmental attributes involved in passage through the hydrosystem, and report these estimates on an annual basis:

- Monitor and evaluate juvenile salmonid dam survival rates for a subset of FCRPS projects.
- Monitor and evaluate juvenile salmonid system survival through the FCRPS, including estimates of differential post-Bonneville survival of transported fish relative to in-river fish (D-value) as needed.
- Monitor and evaluate adult salmonid system survival upstream through the FCRPS.
- Provide additional PIT-tag marking of Upper Columbia River populations to provide ESU specific estimates of juvenile and adult survival through the Federal mainstem dams.
- Assess the feasibility of PIT-tag marking of Snake River Sockeye Salmon for specific survival tracking of this ESU through the FCRPS.
- Develop an action plan for conducting hydrosystem status monitoring (analytical approaches, tagging needs, methods, and protocols) in ongoing collaboration with the State and Federal fishery agencies and Tribes. This will be done in coordination with status monitoring needs and strategies being developed for estuary/ocean, habitat, hatcheries, and harvest. (Initiate in FY 2009)

Monitoring adult passage counts is a cornerstone monitoring activity that must be performed on annual basis. Adult fish counting is typically performed 16 hours per day, during daylight hours, by either video or visual counting methods, at all of the Corps' projects that pass fish. Adult fish counting will continue at a minimum on the schedule presented in Table 2 in Attachment B.2.6-2.

Action 4: Monitor and Evaluate Migration Characteristics and River Condition

The Action Agencies will monitor and evaluate the following biological and physical attributes of anadromous fish species migrating through the FCRPS on an annual basis:

- Monitor and estimate the abundance of smolts passing index dams.
- Monitor and describe the migration timing of smolts at index dams, identify potential problems, and evaluate implemented solutions.
- Monitor and document the condition (e.g., descaling, injury, gas bubble trauma) of smolts at index dams identify potential problems, and evaluate implemented solutions.
- Monitor and enumerate adult salmonids passing through fishways in the FCRPS, identify potential problems, and evaluate implemented solutions.

- Monitor and describe the migration timing of adults at dams in the FCRPS, identify potential problems, and evaluate implemented solutions.
- Monitor and evaluate the total dissolved gas (TDG), temperature, turbidity, and flow at projects in the FCRPS relative to performance objectives.

Action 5: Monitor and Evaluate Effects of Configuration and Operation Actions

The Action Agencies will monitor and evaluate the numerous operations and configurations implemented at projects in the FCRPS. These project evaluations will be conducted following modifications to configurations or operations. For project-specific information on configuration or operational changes, see B.2.1, Hydro Action.

- Monitor and evaluate the effects of existing spillways, modifications, and operations on smolt survival.
- Monitor and evaluate the effectiveness of traditional juvenile bypass systems and modifications to such, on smolt survival and condition.
- Monitor and evaluate the effectiveness of surface bypass structures and modifications on smolt survival and condition.
- Monitor and evaluate the effectiveness of turbine operations and modifications on smolt survival and condition.
- Monitor and evaluate overall dam passage with respect to modifications at projects.
- Monitor and evaluate the effectiveness of the juvenile fish transportation program and modifications to operations.
- Monitor and evaluate the effects of environmental conditions affecting juvenile fish survival.
- Monitor and evaluate the effectiveness of reducing predation towards improving juvenile fish survival.
- Investigate, evaluate and deploy alternative technologies and methodologies for fish passage and the RM&E Action.
- Determine if actions directed at benefiting juveniles have an unintended effect on migrating adults (e.g., certain spill operations).
- Install and maintain adult PIT-tag detectors in fish ladders at key dams in the FCRPS.
- Assess the feasibility of developing PIT-tag detectors for use in natal streams and tributaries as appropriate to support more comprehensive and integrated All-H monitoring designs and assessments of stray rates.
- Monitor and evaluate the effects of fish ladder operations and configurations on adult passage rates.

Action 6: Investigate Hydro Critical Uncertainties

The Action Agencies will fund selected research directed at resolving critical uncertainties that are pivotal in lifecycle model analyses. These actions include:

- Investigate and quantify delayed differential effects (D-value) associated with the transportation of smolts in the FCRPS as needed. (Initiate in FY 2007 to 2009 Projects)
- Investigate the post-Bonneville mortality effect of changes in fish arrival timing and transportation to below Bonneville. (Initiate in FY 2007 to 2009)
- Conduct a workshop every other year with members of the Independent Scientific Advisory Board (ISAB) to review current research and monitoring approaches on post Bonneville mortality for transported and non-transported fish. (Initiate in FY 2009)

- Investigate, describe and quantify key characteristics of the early life history of Snake River Fall Chinook Salmon in the mainstem Snake, Columbia, and Clearwater rivers. (Initiate in FY 2007 to 2009 Project)
- Investigate effects of adult passage experience in the FCRPS on pre-spawning mortality. (Initiate in FY 2009)

B.2.6.3 RM&E Strategy 3—Tributary Habitat RM&E

RM&E Strategy 3: Tributary Habitat RM&E

Funding Source(s): BPA – direct funding; Bureau Columbia Basin Salmon Recovery funding

Rationale: Evaluating the effectiveness of habitat actions that are being implemented as offsite mitigation for dam effects is a central feature of the FCRPS ESA responsibilities.

What's New: Additional actions.

Management Questions: The following are the primary management questions with respect to tributary habitat offsite mitigation actions. The RM&E Actions described in this section are focused on providing information needed to answer these questions to support ongoing and adaptive management decisions.

- Are tributary habitat actions achieving the expected biological and environmental performance targets?
- What are the relationships between tributary habitat actions and fish survival or productivity increases? What actions are most effective?
- What are the limiting factors or threats preventing the achievement of desired habitat or fish performance objectives?

See Table 2, Attachment B.2.6-1 for specific projects that have been currently identified for implementation in the FY 2007 to FY 2009 period for Tributary Habitat RM&E. Additional, more detailed information supporting the identification of Tributary Habitat RM&E Actions is provided in Attachment B.2.6-3.

Performance Measures: Survival and productivity benefits for the aggregate of tributary habitat actions that are expected to be implemented in the periods FY 2007 to 2009 and for FY 2010 to 2017 have been estimated for individual populations and used within the biological assessment. These estimated tributary habitat benefits provide the long-term biological performance targets for individual populations. In addition, potential changes in limiting factors and overall habitat condition resulting from habitat actions implemented within the two time periods have been estimated based on local biologist input.

Programmatic-level performance standards have been set for annual tracking of project implementation (linked to expected changes in limiting factors and their habitat) projected for the periods FY 2007 to 2009 and for FY 2010 to 2017, which were used to estimate the long-term survival benefits. RM&E will be used to confirm and improve our understanding of the relationships between different habitat actions, the environment, and the survival and productivity performance measures. As this information is developed and relationships and models are updated, the Action Agencies will reconfirm the modeling estimates of expected survival improvements associated with actions.

Action 7: Monitor and Evaluate Tributary Habitat Conditions and Limiting Factors

The Action Agencies will:

- Implement research in select areas of the pilot study basins (Wenatchee, Methow and Entiat river basins in the Upper Columbia River, the Lemhi and South Fork Salmon river basins, and the John Day River Basin) to quantify the relationships between habitat conditions and fish productivity (limiting factors) to improve the development and parameterization of models used in the planning and implementation of habitat projects. These studies will be coordinated with the influence of hatchery programs in these habitat areas.
- Implement habitat status and trend monitoring as a component of the pilot studies in the Wenatchee, Methow and Entiat river basins in the Upper Columbia River, the Lemhi and South Fork Salmon river basins, and the John Day River Basin. (Initiate in FY 2007 to 2009 Projects)
- Facilitate and participate in an ongoing collaboration process to develop a regional strategy for limited habitat status and trend monitoring for key ESA fish populations and an associated regional memorandum of understanding (MOU) for joint funding and implementation. This monitoring strategy will be coordinated with the status monitoring needs and strategies being developed for hydropower, habitat, hatchery, harvest, and estuary/ocean. (Initiate in FY 2008)

Action 8: Evaluate the Effectiveness of Tributary Habitat Actions

The Action Agencies will evaluate the effectiveness of habitat actions through RM&E projects that support the testing and further development of relationships and models used for estimating habitat benefits. These evaluations will be coordinated with hatchery effectiveness studies.

- Action effectiveness pilot studies in the Entiat River Basin to study treatments to improve channel complexity and fish productivity. (Initiate in FY 2007 to 2009 Projects)
- Pilot study in the Lemhi River Basin to study treatments to reduce entrainment and provide better fish passage flow conditions. (Initiate in FY 2007 to 2009 Projects)
- Action effectiveness pilot studies in Bridge Creek of the John Day River Basin to study treatments of channel incision and its effects on passage, channel complexity, and consequentially fish productivity. (Initiate in FY 2007 to 2009 Projects)
- Project and watershed level assessments of habitat, habitat restoration and fish productivity in the Wenatchee, Methow and John Day basins. (Initiate in FY 2007 to 2009 Projects)
- Incorporate research and monitoring results within existing and newly developed habitat relationships and models. (Initiate in FY 2008)

B.2.6.4 RM&E Strategy 4—Estuary and Ocean RM&E

RM&E Strategy 4: Estuary and Ocean RM&E

Funding Source(s): BPA – direct funding; Corps appropriations through Section 536 of the Water Resources Development Act of 1999 and Columbia River Fish Mitigation Program

Rationale: Evaluating the effectiveness of habitat actions that are being implemented as offsite mitigation for dam effects is a central feature of the FCRPS ESA responsibilities.

What's New: Several new actions

Management Questions: The estuary/ocean RM&E presented in this appendix draws on the *Plan for Research, Monitoring and Evaluation of Salmon in the Columbia River Estuary* (Estuary/Ocean RM&E Subgroup 2004) and the *Research, Monitoring and Evaluation – Conceptual Framework Outline* (Sovereign Collaboration Group 2006). The following are the primary management questions with respect to Estuary Habitat actions. The RM&E Actions described in this section are focused on providing information needed to answer these questions to support ongoing and adaptive management decisions.

- Are aquatic, riparian, and upland estuary habitat actions achieving the expected biological and environmental performance targets?
- Are the offsite habitat actions in the estuary improving juvenile salmonid performance and which actions are most effective at addressing the limiting factors preventing achievement of habitat, fish, or wildlife performance objectives?
- What are the limiting factors or threats in the estuary/ocean preventing the achievement of desired habitat or fish performance objectives?

See Table 3, Attachment B.2.6-1 for specific projects that have been currently identified for implementation in the FY 2007 to FY 2009 period for Estuary and Ocean RM&E. Additional, more detailed information supporting the identification of Estuary and Ocean RM&E Actions is provided in Attachment B.2.6-4.

Performance Measures: Performance measures for the Columbia River Estuary include reach survival, life history diversity, growth rates, and predation rates of juvenile salmonids and the bathymetry, topography, connectivity, and hydrology of estuary habitats. Survival benefits for actions implemented in the periods FY 2007 to 2009 and for FY 2010 to 2017 for estuary habitat actions have been estimated for stream and ocean-type life histories and used within the biological assessment based on methods discussed and developed in the Remand Collaboration Process. These estimated benefits provide the long-term performance targets.

Performance standards have also been set for annual tracking of project implementation projected for the periods FY 2007 to 2009 and for FY 2010 to 2017 used to estimate the long-term survival benefits. RM&E will be used to confirm and improve our understanding of the relationships between different estuary habitat actions, the environment and the survival and productivity performance measures. As this information is developed and relationships and models are updated, the Action Agencies will reconfirm the modeling estimates of expected survival improvements associated with actions. Specific performance standards, contingencies, and performance targets for estuary habitat actions are identified in more detail in the Accounting and Adaptive Management section.

Action 9: Monitor and Evaluate Fish Performance in the Estuary and Plume

The Action Agencies will monitor biological responses and/or environmental attributes, and report in the following areas:

- Monitor and evaluate smolt survival and/or fitness in select reaches from Bonneville Dam through the estuary. (Initiate in FY 2007 to 2009 Projects)
- Develop an index and monitor and evaluate life history diversity of salmonid populations at representative locations in the estuary. (Initiate in FY 2007 to 2009 Projects)
- Monitor and evaluate juvenile salmonid growth rates and prey resources at representative locations in the estuary and plume. (Initiate in FY 2007 to 2009 Projects)
- Monitor and evaluate temporal and spatial species composition, abundance, and foraging rates of juvenile salmonid predators at representative locations in the estuary and plume. (Initiate in FY 2007 to 2009 Projects)

Action 10: Monitor and Evaluate Migration Characteristics and Estuary/Ocean Conditions

The Action Agencies will monitor and evaluate selected ecological attributes of the estuary, which will include the following:

- Map bathymetry and topography of the estuary as needed for RM&E. (Initiate in FY 2007 to 2009 Projects)
- Establish a hierarchical habitat classification system based on hydro-geomorphology, ground-truth it with vegetation cover monitoring data, and map existing habitats. (Initiate in FY 2007 to 2009 Projects)
- Develop an index of habitat connectivity and apply it to each of the eight reaches of the study area. (Initiate in FY 2007 to 2009 Projects)
- Tabulate the amount of absolute acreage by habitat type that is restored or protected every year. (Initiate in FY 2007 to 2009 Projects)
- Evaluate migration through and use of a subset of various shallow-water habitats from Bonneville Dam to the mouth towards understanding specific habitat use and relative importance to juvenile salmonids. (Initiate in FY 2007 to 2009 Projects)
- Monitor habitat conditions periodically, including water surface elevation, vegetation cover, plant community structure, substrate characteristics, dissolved oxygen, temperature, and conductivity, at representative locations in the estuary as established through RM&E. (Initiate in FY 2007 to 2009 Projects)

Action 11: Monitor and Evaluate Habitat Actions in the Estuary

The Action Agencies will monitor and evaluate the effects of a representative set of habitat projects in the estuary, as follows:

- Develop a limited number of reference sites for typical habitats (e.g., tidal swamp, marsh, island, and tributary delta, to use in action effectiveness evaluations). (Initiate in FY 2007 to 2009 Projects)
- Evaluate the effects of selected individual habitat restoration actions at project sites relative to reference sites and evaluate post-restoration trajectories based on project-specific goals and objectives. (Initiate in FY 2007 to 2009 Projects)
- Develop and implement a methodology to estimate the cumulative effects of habitat conservation and restoration projects in terms of cause-and-effect relationships between ecosystem controlling factors, structures, and processes affecting salmon habitats and performance. (Initiate in FY 2007 to 2009 Projects)

Action 12: Investigate Estuary/Ocean Critical Uncertainties

The Action Agencies will fund selected research directed at resolving critical uncertainties that are pivotal in understanding estuary and ocean effects, including the following:

- Continue work to define the ecological importance of the tidal freshwater, estuary, plume, and nearshore ocean environments to the viability and recovery of listed salmonid populations in the Columbia River Basin.
- Continue work to define the causal mechanisms and migration/behavior characteristics affecting survival of juvenile salmon during their first weeks in the ocean.

- Investigate the importance of early life history of salmon populations in tidal fresh water of the lower Columbia River.
- Continue development of a hydrodynamic numerical model for the estuary and plume to support critical uncertainties investigations.

B.2.6.5 RM&E Strategy 5—Harvest RM&E

RM&E Strategy 5: Harvest RM&E

Funding Source(s): BPA – direct funding

Rationale: Evaluating improved harvest actions that would allow more natural fish to spawning grounds is a feature of the FCRPS action.

What's New: Additional action.

Management Questions: Key management questions related to FCRPS-sponsored harvest improvements are:

- What is the effect of acquiring more accurate and precise in-river harvest estimates on the resultant estimates of straying and adult passage survival?
- Can selective fisheries targeting hatchery fish or healthy populations reduce impacts on ESA-listed populations?

See Table 4, Attachment B.2.6-1 for specific projects that have been currently identified for implementation in the FY 2007 to FY 2009 period for Harvest RM&E.

Performance Measures: No biological or environmental performance measures or targets for the FCRPS have been identified for Harvest.

Action 13: Fund Selected Harvest Investigations

The Action Agencies will fund selected harvest investigations linked to FCRPS interests:

- Evaluate the feasibility of obtaining PIT-tag recoveries in Zone 6 to determine whether recoveries can help refine estimates of in-river harvest rates, upstream survival rates, and straying rates. For FY 2007, focus on a pilot to test the feasibility of PIT-tag recoveries in Zone 6 harvest (spring, summer, and fall Chinook salmon and summer steelhead). (Initiate in FY 2007 to 2009 Projects)
- Evaluate methods to develop or expand use of selective fishing methods and gear. (Initiate in FY 2007 to 2009 Projects)
- Evaluate post-release mortality rates for selected fisheries. (Initiate in FY 2007 to 2009 Projects)
- Support coded-wire tagging and coded-wire tag recovery operations that inform survival, straying, and harvest rates of hatchery fish by stock, rearing facility, release treatment, and location. (Initiate in FY 2007 to 2009 Projects)
- Investigate the feasibility of genetic stock identification monitoring techniques. (Initiate in FY 2007 to 2009 Projects)

B.2.6.6 RM&E Strategy 6—Hatchery RM&E

RM&E Strategy 6: Hatchery RM&E

Funding Source(s): BPA – direct funding

Rationale: Hatcheries provide central mitigation for FCRPS effects. Safety-net and conservation hatcheries and hatchery reforms funded by the Action Agencies should be evaluated within the framework of ESA recovery goals.

What's New: Additional actions and hatchery reforms benefiting ESA-listed fish.

Management Questions: The following are the primary management questions with respect to hatchery actions. Hatchery RM&E Actions are focused on providing information needed to answer these questions to support ongoing and adaptive management decisions.

- Are hatchery improvement programs and actions achieving the expected biological performance targets?
- What is the proportion and origin of hatchery fish within naturally spawning salmon and steelhead populations?
- Can hatchery reforms reduce the deleterious effects of artificial production on listed populations, thereby contributing to a reduction in extinction risk for affected natural populations?
- Can properly designed intervention programs using artificial production make a net positive contribution to recovery of listed populations?
- What is the reproductive success of hatchery fish spawning in the wild relative to the reproductive success of wild fish?

See Table 5, Attachment B.2.6-1 for specific projects that have been currently identified for implementation in the FY 2007 to FY 2009 period for Hatchery RM&E. Additional, more detailed information supporting the identification of Hatchery RM&E Actions is provided in Attachment B.2.6-5.

Performance Measures: The primary performance measures for hatcheries involve implementation tracking and the qualitative ranking of the expected benefits of actions. The objectives of these actions include:

- Safety-net programs reduce extinction risk for target populations in Snake River Sockeye Salmon, Snake River Spring/Summer Chinook Salmon, Mid-Columbia River Steelhead, Lower Columbia River Steelhead, and Columbia River Chum Salmon ESUs.
- Conservation hatchery programs increase abundance of target populations in Snake River Spring/Summer Chinook Salmon, Snake River Fall Chinook Salmon, and Upper Columbia Steelhead ESUs, thereby reducing the time to recovery.
- High-priority hatchery reform actions (i.e., those needed to address hatchery programs) that are considered major limiting factors by NMFS, result in improved abundance, productivity, diversity, and/or spatial structure of target populations.
- Future implementation of additional hatchery reforms identified through Columbia River Hatchery Scientific Review Group's hatchery review process, combined with use of best management practices (BMPs) at FCRPS hatchery facilities, improve abundance, productivity, diversity, and/or spatial structure of target populations, depending on the nature of the reform.

Hatchery action effectiveness research will be used to help confirm and update our expectations of these benefits as new information becomes available.

In addition to these qualitatively rated benefits and performance targets identified above, a more quantitative assessment approach has been included for the benefits associated with improved hatchery management practices. This assessment associates changes in management practices to a change from historical to current reproductive success of hatchery fish spawning in the wild. This change in reproductive success of hatchery fish and the number of hatchery spawning fish over time has been used to estimate a survival improvement for supplemented populations. Research on the current reproductive success of hatchery fish spawning in the wild will be used to help confirm these estimated benefits and update modeled population effects where needed.

Programmatic performance standards will be developed for BMPs that are being set for various hatcheries based on ongoing regional program reviews.

Action 14: Monitor Hatchery Effectiveness

The Action Agencies will continue to fund selected monitoring and evaluation of the effectiveness of Hatchery Actions. The evaluation of hatchery projects will be coordinated with the Tributary Habitat monitoring and evaluation program. These actions include:

- Determine the effect that safety-net and conservation hatchery programs have on the viability and recovery of the targeted populations of salmon and steelhead. (Initiate in FY 2007 to 2009 Projects)
- Determine the effect that implemented hatchery reform actions have on the recovery of targeted salmon and steelhead populations. (Initiate in FY 2007 to 2009 Projects)

Action 15: Investigate Hatchery Critical Uncertainties

The Action Agencies will continue to fund selected research directed at resolving artificial propagation critical uncertainties:

- Estimate the relative reproductive success of hatchery-origin salmon and steelhead compared to reproductive success of their natural-origin counterparts. (Initiate in FY 2007 to 2009 Projects)
- Determine if hatchery reforms reduce the deleterious effects of artificial production on listed populations, thereby contributing to a reduction of extinction risk for the affected natural populations. (Initiate in FY 2007 to 2009 Projects)
- Determine if properly designed intervention programs using artificial production make a net positive contribution to recovery of listed populations. (Initiate in FY 2007 to 2009 Projects)

The Action Agencies will place a priority on hatchery critical uncertainties research in areas where answers to hatchery management questions are most critical to the success of the Hatchery Action. Answers to hatchery critical uncertainties are most critical for Upper Columbia River Steelhead, Snake River Spring/Summer Chinook Salmon, Snake River B-Run Steelhead, and Snake River Fall Chinook Salmon.

B.2.6.7 RM&E Strategy 7—Predation Management RM&E

RM&E Strategy 7: Predation Management RM&E

Funding Source(s): BPA – direct funding; Corps Operation and Maintenance and Columbia River Fish Mitigation Program funding.

Rationale: Evaluating predation management actions is a key aspect of the FCRPS actions.

What's New: Additional actions including RM&E leading to development of a land management plan for avian predators.

Management Questions: The following are the primary management questions with respect to predation. Predation RM&E Actions described in this plan are focused on providing information needed to answer these questions to support ongoing and adaptive management decisions.

- Are predation management programs and actions achieving the expected biological performance targets?
- What are the impacts and consumption rates of major piscivorous, avian, and marine mammal predators on juvenile salmonids within the Columbia River Basin?
- What are the distributions, population sizes, and productivity for the major predators within the Columbia River Basin?
- Is there compensation occurring in reaction to predation reduction measures?
- What is the effect of alternative management alternatives/actions used to reduce the impact of predation? What are the most effective management alternatives/actions?

See Table 6, Attachment B.2.6-1 for specific projects that have been currently identified for implementation in the FY 2007 to 2009 period Predation Management RM&E.

Performance Measures: Estimates of juvenile fish survival improvements associated with changes in both piscivorous and avian predation have been identified for the periods FY 2007 to 2009 and for FY 2010 to 2017 for long-term performance targets for predation management. Performance standards have also been set for annual tracking of project implementation projected for the periods FY 2007 to 2009 and for FY 2010 to 2017. Research and monitoring on predator – prey relationships, predator exploitation rates, and resulting change in annual juvenile fish survival rates will be used to evaluate progress and achievement of expected survival improvements from predation actions.

The following actions address avian, fish, and marine mammal predation in turn.

Action 16: Monitor and Evaluate the Caspian Tern Population in the Columbia River Estuary

The Action Agencies will monitor the tern population in the estuary and its impacts on outmigrating juvenile salmonids, as well as the effectiveness of the Caspian tern management plan. Specific actions include:

- Estimate annual Caspian tern predation rates on juvenile salmonids and the estimated change in juvenile salmonids survival rates. (Initiate in FY 2007 to 2009 Projects)
- Determine the size, habitat use, nesting success, and factors limiting the nesting success of the Caspian tern colony on East Sand Island. (Initiate in FY 2007 to 2009 Projects)

- Determine diet composition of Caspian terns nesting on East Sand Island. (Initiate in FY 2007 to 2009 Projects)
- Detect the formation of tern colonies at other dredged-material disposal sites in the estuary. (Initiate in FY 2007 to 2009 Projects)
- Determine the accuracy of tern predation rates on salmonids based on smolt PIT-tag recoveries on colony. (Initiate in FY 2007 to 2009 Projects)
- Continue ongoing research to detect PIT-tags deposited on avian bird colonies in the estuary. (Initiate in FY 2007 to 2009 Projects)

Action 17: Monitor and Evaluate the Double-Crested Cormorant Population in the Columbia River Estuary

The Action Agencies will monitor the cormorant population in the estuary and its impacts on outmigrating juvenile salmonids in an effort to determine if management is warranted and to determine potential management techniques to decrease predation rates. Specific actions include:

- Estimate annual double-crested cormorant predation rates on juvenile salmonids and the estimated change in juvenile salmonids survival rates. (Initiate in FY 2007 to 2009 Projects)
- Determine the colony size, habitat use, nesting success and factors limiting nesting success of double-crested cormorants nesting on East Sand Island. (Initiate in FY 2007 to 2009 Projects)
- Determine diet composition of cormorants nesting on East Sand Island. (Initiate in FY 2007 to 2009 Projects)
- Determine the accuracy of cormorant predation rates on salmonids based on smolt PIT-tag recoveries on colony. (Initiate in FY 2007 to 2009 Projects)
- Determine the geographic boundaries of the Pacific Coast subspecies of double-crested cormorant so that the size of the population and management unit that includes the East Sand Island cormorant colony can be ascertained. (Initiate in FY 2007 to 2009 Projects)
- Determine the potential to use social attraction and habitat improvements to attract double-crested cormorants to alternative nesting locations. (Initiate in FY 2007 to 2009 Projects)
- Continue ongoing research to detect PIT-tags deposited on avian bird colonies in the estuary. (Initiate in FY 2007 to 2009 Projects)

Action 18: Monitor and Evaluate Inland Avian Predators

The Action Agencies will monitor avian predator populations in the Mid-Columbia River and evaluate their impacts on outmigrating juvenile salmonids in an effort to determine if management of the colonies is warranted and to determine potential management techniques to decrease predation rates. Specific actions include:

- Determine colony locations, size, and distribution, and habitat use and nesting success of avian predators on Corps-managed lands in the lower Snake and middle Columbia rivers towards developing a land management plan. (Initiate in FY 2007 to 2009 Projects)
- Determine diet composition and consumption of juvenile salmonids by inland avian predators (including terns nesting on Crescent Island and by cormorants nesting on Foundation Island). (Initiate in FY 2007 to 2009 Projects)
- Determine the effects of operational strategies on avian predation rates on juvenile salmon. (Initiate in FY 2007 to 2009 Projects)

Action 19: Monitoring Related to Marine Mammal Predation

The Action Agencies will monitor the marine mammal population at Bonneville Dam and its impacts on returning adults, as well as the effectiveness of the management actions to reduce predation rates. Specific actions include:

- Estimate overall sea lion abundance immediately below Bonneville Dam. (Initiate in FY 2007 to 2009 Projects)
- Monitor the spatial and temporal distribution of sea lion predation attempts and estimate predation rates. (Initiate in FY 2007 to 2009 Projects)
- Monitor the effectiveness of deterrent actions (e.g., exclusion gates, acoustics, and harassment) and their timing of application on spring runs of anadromous fish passing Bonneville Dam. (Initiate in FY 2007 to 2009 Projects)

Action 20: Monitoring Related to Piscivorous (Fish) Predation

The Action Agencies will:

- Continue to update and estimate the cumulative benefits of sustained removals of northern pikeminnow since 1990. (Initiate in FY 2007 to 2009 projects)
- Continue to evaluate if inter and intra compensation is occurring. (Initiate in FY 2007 to 2009 projects)
- Evaluate the benefit of additional removals and resultant increase in exploitation rate's effect on reduction in predator mortality since the 2004 program incentive increase. (Initiate in FY 2007 to 2009 projects)
- Develop a study plan to review, evaluate, and develop strategies to reduce non-indigenous piscivorous predation. (Initiate in FY 2007 to 2009 projects)

B.2.6.8 RM&E Strategy 8—Coordination and Data Management RM&E

RM&E Strategy 8: Coordination and Data Management RM&E

Funding Source(s): BPA – direct funding; Corps appropriations; Reclamation appropriations

Rationale: Because FCRPS RM&E is part of the overall RM&E for recovery of salmon in the Columbia River Basin, coordination and data management are tools to make this RM&E more effective.

See Table 7, Attachment B.2.6-1 for specific projects that have been currently identified for implementation in the FY 2007 to 2009 period for RM&E Coordination and Data Management.

Action 21: Coordination

The Action Agencies will coordinate RM&E activities with other Federal, State and Tribal agencies, including:

- Organizing and supporting the Corps AFEP.
- Supporting and participating in the Council's Columbia River Basin Fish and Wildlife Program project planning and review efforts.
- Supporting the standardization and coordination of tagging and monitoring efforts through participation and leadership in regional coordination forums such as PNAMP.

- Working with regional monitoring agencies to develop, cooperatively fund, and implement standard metrics, business practices, and information collection and reporting tools needed to cooperatively track and report on the status of regional fish improvement and fish monitoring projects.
- Coordinating the further development and implementation of Hydrosystem, Tributary Habitat, Estuary/Ocean, Harvest, Hatchery, and Predation RM&E through leadership and participation in ongoing collaboration and review processes and workgroups.
- Coordinating implementation with other appropriate regional collaboration processes. This includes coordination related to statutory provisions for the Federal government (BPA/Council), voluntary coordination among Federal agencies (Federal Caucus), and coordination with regional processes for Federal/non-Federal engagement [Technical Management Team (TMT), System Configuration Team (SCT), PNAMP, Northwest Environmental Data-Network, and others).

Action 22: Data Management

The Action Agencies will ensure that the information obtained under the auspices of the FCRPS RM&E Program is archived in appropriate data management systems. Actions include:

- Continue to work with regional Federal, State and Tribal agencies to establish a coordinated and standardized information system network to support the RM&E program and related performance assessments. The coordination of this development will occur primarily through leadership, participation, and joint funding support in regional coordination forums such as the Northwest Environmental Data (NED) workgroup and PNAMP and the ongoing RM&E pilot studies in the Wenatchee River, John Day River, Upper Salmon River, and Columbia River Estuary. (Initiate in FY 2007 to 2009 Projects)
- Contribute funding for data system components that support the information management needs of individual Hydrosystem, Tributary Habitat, Estuary/Ocean, Harvest, Hatchery, and Predation RM&E. (Initiate in FY 2007 to 2009 Projects)
- Participate in regional coordination and collaboration efforts, such as PNAMP and NED, to develop and implement a regional management strategy for water, fish and habitat data. (Initiate in FY 2007 to 2009 Projects)

B.2.6.9 RM&E Strategy 9—Project Implementation and Compliance Monitoring RM&E

RM&E Strategy 9: Project Implementation and Compliance Monitoring RM&E

Funding Source(s): BPA – direct funding; Corps appropriations; Reclamation appropriations

Rationale: Regular tracking of implementation commitments is essential to accountability.

The Action Agencies have identified specific commitments or actions for each of our hydrosystem, estuary/ocean, tributary habitat, hatchery, and predation management strategies, providing clear programmatic level measures for evaluating progress, subject to adaptive management. Implementation details will be updated in 3-year cycles. Projects will be monitored for implementation of planned deliverables and compliance to performance expectations.

Action 23: Implementation and Compliance Monitoring

The Action Agencies will:

- Annually monitor the successful implementation of projects through standard procedures and requirements of contract oversight and management, and review of project deliverables and final reports.
- Maintain project and action level details for planning and reporting purposes. This approach will provide the most up-to-date information about the status of actions and projects being implemented.

REFERENCES

Estuary/Ocean RM&E Subgroup. 2004. Plan for Research, Monitoring, and Evaluation of Salmon in the Columbia River Estuary.

Sovereign Collaboration Group. 2006. Research, Monitoring and Evaluation—Conceptual Framework Outline.

Attachment B.2.6-1
Research, Monitoring, and Evaluation Project Tables

TABLE OF CONTENTS

LIST OF ACRONYMS

BMPs	best management practices
BPA	Bonneville Power Administration
CBFWA	Columbia Basin Fish and Wildlife Authority
COMPASS	Comprehensive Fish Passage Model
Corps	U.S. Army Corps of Engineers
Council	Northwest Power and Conservation Council
CPUE	catch-per-unit effort
D-value	differential delayed survival of transported fish
ESA	Endangered Species Act
FCRPS	Federal Columbia River Power System
FPC	Fish Passage Center
FY	fiscal year
ISAB	Independent Scientific Advisory Board
Lambda	annual population growth rate
LCREP	Lower Columbia River Estuary Program
M&E	monitoring and evaluation
MOU	memorandum of understanding
NED	Northwest Environmental Data Network
NPMP	Northern Pikeminnow Management Program
PIT	passive integrated transponder (tag)
PNAMP	Pacific Northwest Aquatic Monitoring Partnership
PSMFC	Pacific States Marine Fish Commission
Reclamation	U.S. Bureau of Reclamation
RM&E	research, monitoring, and evaluation
RSW	removable spillway weir
SAR	smolt-to-adult return
SCT	System Configuration Team
SMP	Smolt Monitoring Program
TDG	total dissolved gas
TMT	Technical Management Team
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

1. RESEARCH, MONITORING, AND EVALUATION PROJECT TABLES

The Action Agencies have identified the following funded projects that have been identified for implementation during the FY 2007 to FY 2009 period to meet the Actions for Research, Monitoring and Evaluation (RM&E) for Hydrosystem (Table 1), Habitat (Table 2), Estuary/Ocean (Table 3), Harvest (Table 4), Hatchery (Table 5), Predation (Table 6), RM&E Coordination and Data Projects (Table 7), and Fish Population Status Monitoring (Table 8).

Table 1. Hydrosystem RM&E Projects Occurring during the FY 2007 to 2009 Period, Status Monitoring (S), Action Effectiveness (A), and Uncertainties (U)

Project/Action & Agency (Hydrosystem RM&E)	Objective/Deliverable	S	A	U
System-Wide Studies				
RM&E of Emerging Issues and Measures to Recover the Snake River Fall Chinook Salmon ESU (BPA 1991-029-00)	Monitor and evaluate post-release attributes and survival of natural and hatchery juvenile Fall Chinook Salmon in the Snake River and Hanford Reach of the Columbia River. Results from this study will inform decisions related to FCRPS effectiveness, to maximize growth, and survival of wild fall Chinook salmon, reduce interactions of wild and hatchery fish, and to increase understanding of the summer spill program.	X	X	X
Snake River Fall Chinook Salmon Life History Investigations (BPA 2002-032-00)	Investigate the consequences of ocean- and reservoir-type life histories on passage timing, travel rate, and survival, of Snake River Fall Chinook Salmon. Mechanisms and prevalence of these life histories are explored. The research goal is to provide fishery managers with an increased understanding of how reservoir water temperature, reservoir water velocity, and migration timing affect juvenile Fall Chinook Salmon behavior, survival, and life history.	X	X	X
Analyze the Persistence and Spatial Dynamics of Snake River Chinook Salmon (BPA 1999-020-00)	Results will advance current understanding of the relationship between landscape characteristics and the distribution, pattern, and persistence of Chinook Salmon. This information is key to development of conservation and restoration strategies. Closeout of previous research is ongoing.	X		
Snake River Spring Transport Studies (Corps) Determine Seasonal Benefits of Transported Fish from the Snake River 2007-2012	Monitor barging benefits by estimating Snake River Spring Chinook and Steelhead SARs from the 2004-2006 barge indexed groups.	X	X	X
	Provide weekly SARs for transported and in-river migrating Chinook and Steelhead for 2007 – 2009 from LGR. Results will be used to determine best annual strategy for transport operations. Identify and evaluate factors that contribute to differences in weekly SARs.	X	X	X
	Provide D-values estimates for appropriate transport release groups.	X	X	X
	Evaluate transportation of juveniles from the Lower Monumental facility.	X	X	X

Table 1. Hydrosystem RM&E Projects Occurring during the FY 2007 to 2009 Period, Status Monitoring (S), Action Effectiveness (A), and Uncertainties (U)

Project/Action & Agency (Hydrosystem RM&E)	Objective/Deliverable	S	A	U
System-Wide Studies				
Mid-Columbia River Transport Studies (Corps)	Estimate SARs for Columbia River Chinook and steelhead for all passage routes (transport, bypass, and non-detected) at McNary Dam. Research from this study is expected to provide operational information on the success of bypassing and spilling spring migrating fish and whether re-initiating spring transport at McNary Dam would be appropriate. Final returns of Columbia River Chinook Salmon will be in 2007, and 2008 for steelhead. The final report is due in 2009.	X	X	X
Snake River Fall Chinook Salmon Transport Studies (Corps)	New information suggests that a significant percentage of Snake River Fall Chinook Salmon adults overwintered within the hydrosystem or estuary and outmigrated as yearlings. This raises questions about the significance of summer operations to the Fall Chinook Salmon population. As a result, a more comprehensive plan will be developed to address the operational needs of Snake River Fall Chinook Salmon. Future research would help to determine whether transport or in-river passage in the summer is the best management strategy for juvenile Snake River Fall Chinook Salmon (2008 to 2011).		X	
	Finalize comprehensive Fall Chinook Salmon plan for transport vs. in-river survival (2007).	X	X	X
	Implement comprehensive Fall Chinook Salmon transport vs. in-river study (2008 to 2011).	X	X	X
	Estimate SARs for fall Chinook Salmon to be used in determine the seasonal transportation decisions. Results from this study along with the BPA-funded Snake River Fall Chinook Salmon studies will decrease the uncertainty in how the reservoir life history affects estimates of SARs of Snake River Fall Chinook Salmon, and to increase the understanding of when to spill water and transport fish in the Snake River to increase juvenile Fall Chinook Salmon survival.	X	X	X
Fish Ladder Temperature Evaluation (Corps)	Define water temperature problems in the fish ladder that may affect adult salmon and steelhead passage. Water temperature gradients occasionally occur in the Lower Granite fish ladder and may impair passage. Monitoring of water temperature and adult fish passage at Lower Granite fish ladder as been completed. Analysis of the data is planned for 2008 and will be used to determine the need for a prototype ladder temperature control structure.		X	X

Table 1. Hydrosystem RM&E Projects Occurring during the FY 2007 to 2009 Period, Status Monitoring (S), Action Effectiveness (A), and Uncertainties (U)

Project/Action & Agency (Hydrosystem RM&E)	Objective/Deliverable	S	A	U
System-Wide Studies				
PIT-Tag Data Recovery (Corps & BPA funding) – The PIT-tag trawler detection system operation in the estuary (BPA Project 1993-029-00, cost shared with Corps when appropriate). *The juvenile and adult PIT-tag detection systems operation for passage data at the mainstem dams (BPA Project 1990-080-00).* *PIT-tag detection on the inland and estuarine islands to estimate avian predation (Corps funded).*	Estimate survival for releases of yearling spring/summer Chinook salmon and steelhead (hatchery and wild) through the Snake and lower Columbia rivers.	X	X	X
	Estimate survival from McNary Dam tailrace to John Day Dam tailrace for subyearling fall Chinook salmon during the summer migration.	X	X	X
	Estimate survival and travel time for subyearling fall Chinook salmon from Pittsburg Landing and Billy Creek on the free-flowing Snake River through the lower Snake River.	X	X	X
	Extend system survival estimates to Bonneville Dam tailrace using PIT-tag pair trawl detections.	X	X	X
	Collection and storage of juvenile and adult passage data at all PIT-tag detection sites for other future analyses.	X	X	X
	Estimate avian predation rates for juvenile fish with various migration histories (e.g., transport).	X	X	X
Evaluate the Impacts of Avian Predation on Salmonid Smolts from the Columbia and Snake Rives (Corps)	Determine stock specific predation rates relative to the proportion of in-river juvenile salmonids passing the Crescent Island Caspian tern and Foundation Island cormorant colonies under changes in system operations. Study will provide information for management actions (2007 to 2009).	X	X	X
	Estimate stock specific Crescent Island tern and Foundation Island cormorant predation rates on migrating salmonids.	X	X	X
	Determine magnitude of overwintering cormorants at Snake River projects and diet composition.	X	X	X
	Determine biotic and abiotic factors influencing steelhead vulnerability to avian predators (pilot study in 2007).	X	X	X
Development of System-wide Predator Control for Northern Pikeminnows (BPA 1990-07-700)	The Northern Pikeminnow Management Program (NPMP) is designed to remove predator-sized northern pikeminnows from the mainstem Columbia River. This program employs a sport reward fishery for northern pikeminnow with a goal of a 10 to 20% exploitation rate for predatory size fish in order to reduce salmonid predation by up to 50%. This program attempts to evaluate the effectiveness of pikeminnow removals for population analysis and determination of the effect of the NPMP on increase in salmonid survival.		X	

Table 1. Hydrosystem RM&E Projects Occurring during the FY 2007 to 2009 Period, Status Monitoring (S), Action Effectiveness (A), and Uncertainties (U)

Project/Action & Agency (Hydrosystem RM&E)	Objective/Deliverable	S	A	U
System-Wide Studies				
Adult Passage Studies (Corps)	Complete final summary reports of 1996 to 2004 radio tag data (finalized in 2006), including escapement, straying, fallback, and passage and spawning success evaluations using PIT-tagged fish only. Develop methodology to measure adult performance standards using PIT-tag data. Investigate development of PIT-tag detection in index tributaries to measure straying. Continue PIT tag monitoring (BPA and Corps) to provide the annual adult fish system survival performance data.		X	
Installation of Adult PIT-tag Detection Systems (BPA 2001-003-00) . This project is coordinated with the Corps' Adult PIT-tag improvements.	Procure PIT-tag interrogation system electronic components and labor for assembly and installation in adult fish ladders.		X	
	Install additional adult PIT-tag detection systems at The Dalles Dam (North and East ladders).		X	
	Modify adult PIT-tag detection systems at John Day dam (north and south ladders).		X	
Adult Temperature Evaluation (Corps)	Evaluate the effect of water temperature on adult salmon migration behavior (rate of passage, delays, wandering/straying, and survival through the hydrosystem), and impacts the physiological processes that make spawning successful (e.g., viability and energy expenditure). Analysis and reporting are ongoing.		X	
Adult Fish Transition Pool and Weir Modifications (Corps)	Lower Granite transition pool was significantly modified and a telemetry passage evaluation conducted in 2006, to determine if the modifications to reduce adult salmon turn around near the transition pool in the adult fishway were effective. Pending final analysis, future modification will be developed and implemented as warranted.		X	
Recondition Wild Steelhead Kelts (BPA Project 2000-017-00)	Evaluation of potential kelt steelhead management scenarios including direct release, transport and release, short-term reconditioning and transport; and, long-term reconditioning and release. Evaluate effects of long-term kelt reconditioning on the gamete and progeny viability. Perform experiments to evaluate homing fidelity in first time spawners, reconditioned spawners, and (if feasible) natural repeat spawners from the same spawning populations.	X	X	
Kelt Evaluations (Corps)	Studies on steelhead kelts have been conducted for several years. The focus of the studies were to enumerate downstream kelt passage and run timing through the lower Columbia River projects, and to determine passage routes, distribution, and survival. Recent evaluations have concentrated on determining the return rates of kelts with PIT-tags for both in-river and transported groups. Pending the results of the final summary report from PIT-tagged fish, an action plan will be developed to evaluate additional measures or studies as needed.	X	X	

Table 1. Hydrosystem RM&E Projects Occurring during the FY 2007 to 2009 Period, Status Monitoring (S), Action Effectiveness (A), and Uncertainties (U)

Project/Action & Agency (Hydrosystem RM&E)	Objective/Deliverable	S	A	U
System-Wide Studies				
Overwintering steelhead evaluations (Corps)	Radio-telemetry studies of adult steelhead have shown that substantial numbers of summer steelhead overwinter within the FCRPS. Many of these fish fall back at FCRPS dams and as a result, have reduced escapement. Evaluate the effectiveness of operating The Dalles Dam ice and trash sluiceway during winter months in reducing overwintering steelhead fallback through turbines. If warranted, and where feasible, evaluate operation of surface flow outlets at other FCRPS dams as a means of reducing adult steelhead fallback through turbines during winter months.	X	X	
Turbine Survival Program (TSP) (Corps)	TSP is focused on measures to improve salmonid survival through turbines, which include: a) the development of a long term Biological Index Testing (BIT) plan, and b) support in completing model and survival studies for the U.S. Department of Energy, and c) the development of a process for turbine improvements related to turbine rehabilitation.		X	
	Develop plan for a long-term BIT strategy. Continue investigations on the biological assessment of physical model data and bioresponse of fish passing through turbines. Develop detailed John Day BIT strategy. Initiate studies to assess pressure acclimation impacts on fish in the context of past, present, and future TSP studies. Continued participation in regional and national forums as they pertain to fish passage.		X	
	Further assess the impacts of pressure cycles associated with turbine passage on fish. Continue development of Long-term BIT Plan. Correlate the effect of fish diversion devices on fish distribution at the turbine runner. Perform internal turbine prototype imaging and pressure history to better define the physical environment and fish passage route. Implement BIT strategy to additional families of turbines.		X	
	Develop and test a process for designing and evaluating turbines designed for safer fish passage. Apply TSP turbine rehabilitation decision framework to existing rehabilitation plan.		X	
Evaluate Delayed (Extra) Mortality Associated with Passage of Yearling Chinook Salmon Smolts through Snake River Dams (BPA 2003-041-00)	Continue studies to assess downstream migration through Snake River dams relative to changes in post-Bonneville mortality.			X
Delayed Mortality of Juvenile Salmonids (Corps)	Estimate value of D when conducting comparative transport studies. Identify and evaluate causes of differential delayed mortality of transported juvenile fish (D-value), Ongoing studies are evaluating the effects of alternate barge release strategies, incidences of latent mortality associated with type and severity of infectious disease to develop transport operations to optimize returns.	X	X	X

Table 1. Hydrosystem RM&E Projects Occurring during the FY 2007 to 2009 Period, Status Monitoring (S), Action Effectiveness (A), and Uncertainties (U)

Project/Action & Agency (Hydrosystem RM&E)	Objective/Deliverable	S	A	U
System-Wide Studies				
Pit Tagging Spring/Summer Chinook Salmon (CSS Study) (BPA 1996-020-00)	Monitor adult returns of juvenile salmon to determine factors that effect SARs for different stocks. Adult and juvenile PIT-tag recovery data are analyzed to compare survival estimates for transported fish and in-river migrants of known origin; wild and hatchery fish; and fish handled and not handled at dams.	X		
CBFWA Collaborative Systemwide Monitoring and Evaluation Program (BPA 2003-036-00)	Metadata inventories of Columbia subbasin fish data, expand their strength and weaknesses analyses of this existing data, and broaden their collaborative design of improved monitoring and evaluation (M&E) methods for the Columbia River Basin. This project assists with collaborative work plan development, inventories existing data to help answer relevant questions, organizes subsets of data into accessible formats, evaluates the ability to answer questions using existing data, provide collaborative monitoring design, assists with multi-agency implementation of monitoring programs, and also helps to evaluate new monitoring programs.	X		X
Canada-U.S. Shelf Salmon Survival Study (BPA 2003-009-00)	The primary objective of this research is to determine how the ocean environment and climate affect the production of Columbia River salmon by sampling juvenile salmon and oceanographic data in an area of critical importance to Columbia River salmon.			X
	Assess the effects of climate-induced variability on ocean productivity and coastal ecosystems.			X
	Develop reliable models to forecast the marine survival of Columbia River salmon.			X
	Document the distribution and of marine invasive species and range expansion of warm water species and their impacts on marine ecosystems.			X
	Determine the effects of ocean conditions on the marine survival of Columbia River salmon.			X
	Describe the geographic distribution and migration of Columbia River salmon in coastal environments.			X
Acoustic Tracking for Survival (BPA 2003-114-00)	Track smolts in the ocean to resolve how to better manage the FCRPS. A large-scale array is being constructed that will allow establishing ocean movements and survival of Columbia River salmon directly for the first time. This proposal describes the application of this technology to several key resource management issues.		X	X

Table 1. Hydrosystem RM&E Projects Occurring during the FY 2007 to 2009 Period, Status Monitoring (S), Action Effectiveness (A), and Uncertainties (U)

Project/Action & Agency (Hydrosystem RM&E)	Objective/Deliverable	S	A	U
System-Wide Studies				
New Marking and Monitoring Techniques (BPA 1983-319-00)	Develop new and improved PIT-tag technology, including tag, transceiver, and antenna. Continue development of small-stream PIT-tag detection with capability of remote location. Continue development of a high-flow and high-Q PIT-tag detection system for the use in spillways or surface passage devices (e.g. removable spillway weirs [RSWs], sluiceways). Complete development of a next generation PIT-tag detection transceiver with numerous additional capabilities.	X	X	X
	Complete development of a small-stream PIT-tag detection system with capability of deployment in remote locations. Continue development of various PIT-tag detection systems as needed.	X		
	Continue development of various PIT-tag detection systems as needed.	X		
System and project survival studies – Development of new juvenile tags. Corps and BPA)	Evaluate new fish marking techniques that would allow for the detection of juveniles through the outmigration and as returning adults. This system would allow for juvenile interrogation through all passage routes.		X	
	Initiate evaluation of existing technologies and regional development of long-term goals.		X	
	Initiate tag development based on results from 2005 program.		X	
Below Bonneville Survival Studies – (Corps)	Assess juvenile salmon and steelhead behavior and survival from Bonneville Dam to the mouth of the Columbia River, including, effects of different FCRPS migration histories on post-FCRPS survival, identification of areas of losses, and evaluation of post-Bonneville behavior of both transported and in-river migrating fall Chinook salmon.	X		X
Smolt Monitoring by federal and Non-federal Agencies (BPA 1987-127-00)	Collect daily passage data through the mainstem, Snake, Columbia and mid-Columbia rivers to facilitate fish passage management decisions.	X		

Table 1. Hydrosystem RM&E Projects Occurring during the FY 2007 to 2009 Period, Status Monitoring (S), Action Effectiveness (A), and Uncertainties (U)

Project/Action & Agency (Hydrosystem RM&E)	Objective/Deliverable	S	A	U
System-Wide Studies				
	Conduct annual Smolt Monitoring Program (SMP) at seven mainstem Snake and Columbia River dams, Lewiston Snake River trap, Lower Grande Ronde trap, and White Bird trap on the Salmon River. (Note: Imnaha River trap is another SMP site operated by the Nez Perce Tribe under BPA funded project 1997-015-01). Perform PIT-tagging of juvenile fish at five hatcheries and upload data files to Pacific States Marine Fish Commission (PSMFC) database (U.S. Fish and Wildlife Service [USFWS] tagging support component). Transmit daily juvenile fish passage, sampling, marking, and other biological and hydrological data to online databases at Fish Passage Center (FPC) and PSMFC for distribution region-wide. Participating agencies and organizations prepare and submit annual reports to PSMFC summarizing SMP activities and data collected at each monitoring site for use in compiling FPC annual report.	X		
Statistical Support for Salmonid Survival Studies (BPA 1989-107-00)	Develop better measurement tools and study designs to estimate juvenile and adult salmonid survival. Develop statistical methods to determine survival rates and survival relationships. Provide statistical guidance to Columbia River Basin investigators.	X	X	X
	Develop and refine statistical methods, quantitative tools, and performance measures for the research, monitoring, and evaluation of salmonid life history through the hydrosystem.	X	X	X
	Provide statistical support to NMFS to conduct smolt survival and transport studies, providing software engineering support for data analyses, statistical model development for field investigations, and peer review and co-authorship of technical and scientific papers.	X	X	X
PIT-Tagging Wild Chinook Salmon (BPA 1991-028-00)	Collect time-series information to examine migration characteristics of wild ESA-listed Snake River Spring/Summer Chinook Salmon stocks. PIT-tag wild Chinook salmon parr annually; and subsequently monitor as parr/smolts at stream traps and river dams.	X		X
	Determine migration timing and survival differences between and within years for individual and combined populations of wild Snake River Spring/Summer Chinook Salmon juveniles at instream PIT-tag monitors and Lower Granite Dam.	X		X
	Determine parr-to-smolt growth rates for these wild PIT-tagged fish populations, annually, by utilizing the separation-by-code system at Little Goose Dam juvenile fish bypass system.	X		X

Table 1. Hydrosystem RM&E Projects Occurring during the FY 2007 to 2009 Period, Status Monitoring (S), Action Effectiveness (A), and Uncertainties (U)

Project/Action & Agency (Hydrosystem RM&E)	Objective/Deliverable	S	A	U
System-Wide Studies				
	Determine relationships between water quality and environmental/climatic factors where wild parr reside and subsequent movements/survival of parr/smolts through downstream instream PIT-tag monitors and at Lower Granite Dam.	X		X
Imnaha Smolt Survival and SAR Quantification (BPA 1997-015-01)	Quantify juvenile emigrant abundance, determine smolt survival from the Imnaha River to Lower Granite and McNary dams, quantify SARs of wild/natural Chinook salmon at Lower Granite Dam and back to the Imnaha River. Closeout of previous research is ongoing.	X		
M&E Statistical Support For Life-Cycle Studies (BPA 1991-051-00)	Develop statistical methods for monitoring and evaluating salmonid recovery plans. Provide added-value analyses and statistical support on regional fisheries issues. Provide smolt migration timing predictions on the internet.	X	X	X
	Provide in-season statistical support. Provide real-time run-timing predictions.	X	X	X
	Provide an annual review of run-timing predictions. Provide statistical analysis of historical tagging data. Provide post-season outmigration estimation.	X	X	X
	Provide analysis of SARs.	X	X	X
	Provide sample size software.	X	X	X
	Provide statistical support for region. Provide statistical consultation.	X	X	X
	Provide continued statistical evaluation of performance standards to improve decision analysis.	X	X	X
Monitoring and Evaluation of Yearling Snake River Fall Chinook Salmon Outplanted Upstream of Lower Granite Dam (BPA 1998-010-04) –Yearling Fall Chinook Salmon from Pittsburg Landing, Big Canyon, and Captain John acclimation facilities (BPA Project 1998-010-05) to maximize success of the Fall Chinook Salmon supplementation program above Lower Granite Dam.	Monitor, evaluate, and compare survival and performance:	X		
	Pre-release and release conditions of yearling hatchery Fall Chinook Salmon released at the Pittsburg Landing, Big Canyon Creek, and Captain John Rapids acclimation facilities with on-station releases at Lyons Ferry Hatchery;	X		
	Post-release behavior, migration timing, and survival of yearling Fall Chinook Salmon released at Pittsburg Landing, Big Canyon Creek, Captain John Rapids, and Lyons Ferry Hatchery;	X		
	Contribution and distribution of adult returns and SARs of yearling Fall Chinook Salmon released from Pittsburg Landing, Captain John Rapids, Big Canyon Creek, and Lyons Ferry Hatchery.	X		
Evaluate Factors Limiting Columbia River Gorge Chum Salmon Populations (BPA 2000-012-00)	Evaluate factors limiting Chum Salmon production in Hardy Creek, Hamilton Springs, and Columbia River side-channel. Closeout of previous research is ongoing.	X		

Table 1. Hydrosystem RM&E Projects Occurring during the FY 2007 to 2009 Period, Status Monitoring (S), Action Effectiveness (A), and Uncertainties (U)

Project/Action & Agency (Hydrosystem RM&E)	Objective/Deliverable	S	A	U
System-Wide Studies				
Evaluate Spawning Of Fall Chinook And Chum Salmon Just Below The Four Lowermost Columbia River Mainstem Dams (BPA 1999-003-01)	Monitor, protect, and enhance the spawning populations of Fall Chinook Salmon and Chum Salmon below Bonneville Dam. Search for evidence of Fall Chinook Salmon spawning below The Dalles, John Day, and McNary dams.	X		
	Continue to conduct spawning ground surveys for fall Chinook salmon and chum salmon in the mainstem Columbia and chum salmon in its tributaries from The Dalles Dam downstream to monitor known spawning areas and identify new locations.			
	Determine on-set, peak, and end of spawning fall Chinook salmon and chum salmon in the mainstem Columbia below Bonneville Dam.			
	Continue to refine population estimate methods for fall Chinook salmon and chum salmon spawning in the mainstem Columbia below Bonneville Dam and chum in its tributaries from The Dalles Dam downstream. Continue to refine the total Columbia River chum salmon return estimates.			
Bonneville Dam				
Project Survival Studies (Corps)	Initiate biological evaluations once all passage modifications are complete including MGRs, PH1 Sluiceway and PH2 FGE.		X	
	Evaluate juvenile fish project and passage route distribution and survival.		X	
	Additional evaluation of spillway passage survival may be necessary as well as model studies to establish powerhouse unit operation priorities.		X	
Bonneville PH2 FGE Improvements (Corps)	Evaluate the effect of improvements to the screen bypass system at the Bonneville PH2 following installation of the modifications of the screen bypass system. If warranted, evaluate Bonneville PH2 FGE with improvements.		X	
Evaluate the Effectiveness of the First Powerhouse Sluiceway (Corps)	Determine the best survival routes and determine if additional measures for juvenile survival improvements are needed at the PH1. Data analysis is ongoing.		X	
Post-Construction Evaluation of Sluiceway Improvements	Evaluate sluiceway passage efficiency, forebay behavior, and survival.		X	
Complete Installation of PH1 MGRs and Conduct a Post-Construction Evaluation	Estimate total survival of fish passing through turbines at PH1.		X	
Evaluate the Effects of TDG on Emerging Chum Salmon Fry below Bonneville Dam	Conduct lab and field studies of TDG and effects on chum salmon fry.		X	

Table 1. Hydrosystem RM&E Projects Occurring during the FY 2007 to 2009 Period, Status Monitoring (S), Action Effectiveness (A), and Uncertainties (U)

Project/Action & Agency (Hydrosystem RM&E)	Objective/Deliverable	S	A	U
System-Wide Studies				
The Dalles Dam				
Spillway Survival Improvements (Corps)	Evaluate dam and route-specific survival, tailrace egress, passage distribution, effects on TDG, and erosion monitoring to determine whether additional spillway improvements are warranted.		X	
	Design and construct additional improvements.		X	
	Spillway improvements post construction testing: Evaluate project, dam, and route specific survival and tailrace egress behavior.		X	
Sluiceway Evaluations (Corps)	Evaluate juvenile salmonid response to hydrodynamic conditions upstream of and at the sluiceway entrances. Evaluate post-construction sluiceway entrance improvements if installed.		X	
Evaluate Adult Delay and Fallback (Corps)	Evaluate adult delay and fallback with new spill patterns developed with respect to the installation of the spillway training wall.		X	
Evaluate the Behavior of Fish in the Forebay (Corps)	Evaluate the behavior of fish in the forebay of The Dalles Dam to determine the feasibility of a physical guidance device for the forebay and assist in design of a device to improve fish passage efficiency.		X	
John Day Dam				
John Day Biological Index Testing (Corps)	Survival data from 2002 to 2003 suggest that turbine survival at John Day is much lower than at other FCRPS projects. Design a test strategy to evaluate best turbine operating geometry for fish.		X	
	Conduct direct survival and injury portion of the test strategy.		X	
	Conduct total survival portion of the strategy.			
	Evaluate and report on metrics, including direct effects of turbine passage on fish injury and survival, total survival for fish passing all routes (route-specific and dam), and tailrace egress times and routes.		X	
Survival/Efficiency Study	Survival studies conducted between 1999 and 2000 indicate high spillway survival, low powerhouse survival, and a clear relationship between tailrace egress and fish survival. Alternatives to reduce powerhouse passage and improve tailrace egress will be investigated, starting in 2008. Evaluate forebay behavior, fish passage distribution through the dam, tailrace egress, and project, dam and route-specific survival.		X	

Table 1. Hydrosystem RM&E Projects Occurring during the FY 2007 to 2009 Period, Status Monitoring (S), Action Effectiveness (A), and Uncertainties (U)

Project/Action & Agency (Hydrosystem RM&E)	Objective/Deliverable	S	A	U
System-Wide Studies				
McNary Dam				
Survival/Efficiency Study (Corps)	Provide biological performance data in support of the actions in Configuration and Operation Plan for McNary Dam. Future decisions being considered will include turbine improvements and operations, debris management, and outfall relocation.		X	
	Project passage studies conducted from 2002 to 2005 have provided a baseline data set for operations under the 2004 BiOp operations. Results have been used in the development and implementation of surface passage concepts. As improvements are made to McNary, project and route specific survival will be estimated. Future decisions regarding spill, operations, and project upgrades are expected to continue 2006 to 2012.		X	
	In support of surface bypass development, estimate survival and approach behavior studies with TSWs in two spillbays. Examine two spill patterns at 40% project spill during the spring, and both 40% and 60% spill during summer.		X	
Ice Harbor Dam				
Survival/Efficiency Study (Corps)	2007 will be the third year of evaluation of the RSW at Ice Harbor Dam. Following analysis of results, a decision will be made on whether further testing is needed to decide on a standard operation. If the one of the two tested scenarios is selected, further testing may not be needed. However, if new scenarios (e.g., spill patterns, spill percentages) are desired, further testing may be required.		X	
	Provide biological performance data in support of the actions in Configuration and Operation Plan for Ice Harbor. Future decisions being considered at Ice Harbor will include turbine improvements and operations, fish screen improvements, spillway chute or deflector modifications.		X	
Lower Monumental Dam				
Survival/Efficiency Study (Corps)	Provide biological performance data in support of the actions in Configuration and Operation Plan for Lower Monumental. Future decisions at Lower Monumental include RWS and spill optimization, relocation of the bypass outfall, turbine operations.		X	
	Evaluate project distribution and survival through all passage routes including the RSW (2008).		X	
	Evaluate the effects of late season operations on Snake River Fall Chinook Salmon holding (2006 to 2009).		X	

Table 1. Hydrosystem RM&E Projects Occurring during the FY 2007 to 2009 Period, Status Monitoring (S), Action Effectiveness (A), and Uncertainties (U)

Project/Action & Agency (Hydrosystem RM&E)	Objective/Deliverable	S	A	U
System-Wide Studies				
Little Goose Dam				
Survival/Efficiency Study (Corps)	Provide biological performance data in support of the actions in Configuration and Operation Plan for Little Goose. Future decisions include RSW and spill optimization, relocation of the bypass outfall, primary bypass improvements, and turbine operations.		X	
	Project and route specific survival estimates have been provided as the baseline data set for future project improvement comparisons (2006 to 2007).		X	
	Estimate fish distribution, approach behavior, and survival for evaluation of the RSW and associated deflectors, including forebay delay, tailrace egress, and direct injury evaluations (2009 to 2011).			
Lower Granite Dam				
Survival/Efficiency Study (Corps)	Provide biological performance data in support of the actions in Configuration and Operation Plan for Lower Granite. Future decisions include juvenile fish facility improvements and turbine operations.		X	

Table 2. Tributary Habitat RM&E Projects occurring during the FY 2007 to 2009 Period, Status Monitoring (S), Action Effectiveness Research (A), and Uncertainties Research (U)

Project/Action & Agency (Tributary RM&E)	Objective/Deliverable	S	A	U
PNAMP Funding (BPA project no. 2004-002-00)	Coordinate PNAMP workgroups and products.	X	X	
PNAMP Fish Population Monitoring Tagging Protocols - (BPA project no. 2007-216-00)	RM&E Design and Protocols for fish population monitoring. Programmatic and Standardized Work Products for the Pacific Northwest and the Columbia River Basin.	X		
Develop and Implement an Integrated Status and Effectiveness Monitoring Program for Salmonids and their Habitat in Three Pilot Subbasins (BPA 2003-017-00)	Develop, as subbasin scale pilot programs, status and trend monitoring efforts for anadromous salmonids and their habitat in the pilot subbasins.	X		X
Salmon River Habitat Enhancement M&E (BPA 1994-050-00)	Maintain habitat improvements and evaluate benefits; monitor salmonid populations and habitat parameters; coordinate land and water stewardship activities; coordinate planning, implementation, monitoring, and evaluation of new improvements and protections.	X		
Salmonid Productivity, Escapement, Trend, and Habitat Monitoring in the John Day (BPA 1998-016-00)	Monitor natural escapement and productivity of John Day River Basin Spring Chinook salmon and Summer Steelhead. Estimate SAR, egg-to-smolt survival, smolt abundance, and adult and parr distribution for Chinook Salmon and SAR and spawner escapement for Steelhead.	X		
Okanogan Basin Monitoring and Evaluation Project (BPA 2003-022-00)	Monitor and evaluate important biological, water quality, and physical habitat indicators for anadromous fish throughout the Okanogan River subbasin to establish a long-term status and trend data set and determine responses from habitat restoration effort.	X		
Indexing Carrying Capacity of Salmonids on the Basis of Stream Temperature - John Day Basin (Reclamation RM&E183.JDB.03.100.02)	Monitor, analyze, and evaluate effects of push-up dam removal.		X	X
Support the Development of Reclamation Tool, Protocol Manager (RME181.JDB.03.100.06)	Continue to support the development and use of Protocol Manager, a database tool.	X	X	
Reclamation Data Dictionary Development for Pilot Studies (RME183.CBP.04.100.02)	Data Dictionary work in the pilot projects in support of protocol development.	X	X	
Reclamation GIS Support (RME181.JDB.03.100.04 RME181.JDB.04.100.01)	Continued GIS support for development of key data layers.	X	X	
Reclamation PNAMP Funding	Continued coordination support for PNAMP.	X	X	
Lower Methow Tributaries Effectiveness Monitoring Study (Reclamation RM&E183.MET.03.100.05a)	Study the geomorphological, hydrologic, and biological responses to irrigation diversion dam redesign and removal in several tributaries in the Methow River Basin.		X	X

Table 2. Tributary Habitat RM&E Projects occurring during the FY 2007 to 2009 Period, Status Monitoring (S), Action Effectiveness Research (A), and Uncertainties Research (U)

Project/Action & Agency (Tributary RM&E)	**Objective/Deliverable**	**S**	**A**	**U**
Reclamation Interagency Agreement with USGS/PNAMP -Fish Protocol Review and Planning	Hire lead scientist to evaluate and recommend tests required to improve and standardize field protocols for fish sampling.	X	X	X
Reclamation Interagency Agreement with NMFS - remote sensing techniques	NMFS applying remote sensing techniques to identify landscape controls on stream temperatures in the John Day Basin.	X		
Anadromous Fish Habitat and Passage (BPA 2000-001-00)	Habitat rehabilitation efforts to decrease sediment loads and improve passage for anadromous steelhead and salmon, with monitoring and evaluation efforts to assess effectiveness of ongoing activities.	X	X	
Yakima/Klickitat Fisheries Project-M&E (BPA 1995-063-25)	Monitoring and evaluation of natural production, harvest, ecological and genetic impacts for Spring Chinook Salmon, Fall Chinook Salmon, and Coho salmon fisheries enhancement projects in the Yakima River Basin.	X		
Trout Creek O&M (BPA 1994-042-00)	Conducting monitoring and evaluation of riparian enclosures, instream habitat improvements, smolt outmigrants population estimates, adult upstream composition, and population estimate.	X	X	
Life Studies of Spring Chinook Salmon (BPA 1992-026-04)	Assess critical habitat, abundance, migration patterns, survival, and alternate life history strategies exhibited by Spring Chinook Salmon and Summer Steelhead juveniles from distinct populations in the Grande Ronde River and Imnaha River subbasins.	X		
Idaho Natural Production Monitoring and Evaluation (BPA 1991-073-00)	Identify limiting factors and recommends methods to improve adult-to-smolt and smolt-to-adult survival of Chinook salmon and steelhead. Provides long-term monitoring data to determine the effectiveness of recovery actions and population status.	X	X	

Table 3. Estuary RM&E Projects occurring during the FY 2007 to 2009 Period, Status Monitoring (S), Action Effectiveness Research (A), and Uncertainties Research (U)

Project/Action & Agency (Estuary RM&E)	Objective/Deliverable	S	A	U
Survival and Growth of Juvenile Salmonids in the Columbia River Plume (BPA 1998-014-00) 1998-2009	Continue to physically characterize and model the Columbia River plume in the nearshore ocean environment, provide estimates of growth of juvenile Chinook and coho salmon inside and outside the plume, and document the impact of changing ocean productivity on survival and growth rates of juvenile salmonids.	X		X
Grays River Watersheds Restoration and Effectiveness Monitoring (BPA 2003-013-00)[a]	Restore and monitor habitat-forming processes important to enhance chum salmon as well as other declining populations in the Grays River following recommendations developed during the BPA-sponsored Grays River Watershed Assessment.		X	
Lower Columbia River/Estuary Ecosystem Monitoring (BPA 2003-007-00)	Habitat monitoring program to develop protocols, procedures, and indicators for measuring habitat condition for both long-term habitat monitoring and restoration project monitoring and evaluation requirements; and a toxic contaminants in sensitive habitat areas, contaminant trends over time, and possible impacts on sensitive species.	X		X
Canada-USA Shelf Salmon Survival Study (BPA 2003-009-00)	Provide a single coast-wide set of data that will allow U.S. and Canadian scientists to begin identifying broad regions of good or poor salmon growth in the ocean, and to begin defining the reasons why growth differs between regions and to establish which specific stocks of salmon remain resident in the areas of poorest growth, and therefore to develop some understanding of why marine survival may differ between different stocks of salmon in the ocean.			X
Historic Habitat Food Web Link (BPA 2003-010-00) 2003-2009	Evaluate the role of river flow on habitat opportunities and food web structures for juvenile salmon by comparing historic and current conditions using model simulations and empirically derived food-web linkages. Continue to provide support to both the conceptual and numeric estuary models that will contribute to understanding the physical processes that control or contribute to potential limiting factors for juvenile salmonids.		X	X
Ocean Survival of Juvenile Salmonids in the Columbia River Plume (BPA 2003-114-00) 1998-2003	Develop an ability to allow the assessment of early marine survival and ocean movements for Columbia River salmon stocks. Develop a skeleton acoustic array to demonstrate an approach to tracking movements of individual fish through the river and along the West Coast of North America.			X
Ecology of Juvenile Salmon in Tidal Freshwater in the Vicinity of the Sandy River Delta (BPA 2005-001-00)	Determine presence through time of yearling subyearling Chinook salmon at the Sandy River delta in the tidal freshwater reach of the Columbia River, assess the feasibility of acoustic telemetry in shallow water, and integrate these results with data from other selected estuary monitoring studies.	X	X	X
Sampling PIT-Tagged Juvenile Salmonids Migrating in the Estuary (Corps BPS-W-00-11)	Detect PIT- tagged juvenile salmon in the estuary to allow survival to be partitioned between river and ocean environments. Assess migration timing to the estuary for yearling Chinook salmon and steelhead from tagging operations on the Snake and Columbia rivers.	X		X

Table 3. Estuary RM&E Projects occurring during the FY 2007 to 2009 Period, Status Monitoring (S), Action Effectiveness Research (A), and Uncertainties Research (U)

Project/Action & Agency (Estuary RM&E)	Objective/Deliverable	S	A	U
A Study to Estimate Salmonid Survival through the Columbia River Estuary using Acoustic Tags (Corps EST-P-02-01) 2001-2010	Develop an acoustic tag and arrays to estimate survival, residence behavior, and ocean entry timing of salmonids. Assess the life histories and FCRPS passage histories and survival and conduct survival studies, to obtain baseline data on yearling and subyearling Chinook salmon travel time and survival from Bonneville Dam to the Columbia River mouth.	X	X	X
Estuarine Habitat and Juvenile Salmon – Current and Historic Linkages in the Lower Columbia River and Estuary (Corps EST-P-02-02) 2001-2007	Gain information to further our understanding of how juvenile salmonids use the estuarine environment and what factors effect their overall survival and fitness. This information will be critical to assist in present and future estuary restoration activities. As restoration efforts begin in the estuary and lower river, hypotheses will be formalized and specific studies may continue.	X		X
Evaluation of the Relationship among Time of Ocean Entry, Physical, and Biological Characteristics of the Estuary and Plume (Corps EST-P-02-03) 2002-2008	Assess estuary and near ocean entry timing, and associated physical and biological characteristics, and survival to adult. This project worked to tag and release salmon for four years with the study continuing through the adult recovery of the last group released. The study is currently in the recovery and analysis phase.			X
Evaluating the Cumulative Ecosystem response to Restoration Projects in the Columbia River Estuary (Corps EST-P-02-04) 2003-2009	Perform research to develop a framework and methodology to measure and evaluate the cumulative effects of habitat restoration actions within the lower Columbia River and estuary. Additionally, the project will develop standard protocols for key monitoring attributes of estuary ecosystem structures, processes, and functions to be implemented at both restoration and reference sites. These protocols have (in draft format) been coordinated throughout the region through the Lower Columbia River Estuary Program (LCREP) and CREST audiences. The Action Agencies intend to use this multi-year research effort to establish scientific capability to assess whether habitat restoration is having a measurable, cumulative effect on the lower river and estuary, and ultimately contributing to the recovery of ESA-listed salmonids in the Columbia River Basin.		X	X

[a] CREST et al. is listed as a habitat project in BPA's Decision Letter on the FY07-09 Columbia River Basin Fish and Wildlife Program.

Table 4. Harvest RM&E Projects occurring during the FY 2007 to 2009 Period, Status Monitoring (S), Action Effectiveness Research (A), and Uncertainties Research (U)

Project/Action & Agency (Harvest RM&E)	Objective/Deliverable	S	A	U
Technical Advisory Committee (TAC) of *U.S. v. Oregon*, *PIT-tag recoveries in commercial and sport fisheries,* (BPA TBD).	Evaluate the feasibility of obtaining PIT-tag recoveries in Zone 6 to determine whether recoveries can help refine estimates of in-river harvest rates, upstream survival rates, and straying rates.	X		X
Confederated Colville Tribes, *Evaluation of Live-Capture, Selective Fishing Gear* (BPA 2007-249-00)	Identify and test live capture selective harvest methods. Identify the CPUE of the target species, Chinook salmon, for each gear and location combination. Evaluate the comparative survival of Chinook salmon captured in these gears and held. Evaluate the immediate survival of target and bycatch captured in these gears.		X	X
Pacific States Marine Fisheries Commission, Washington Dept. of Fish and Wildlife, *Coded Wire Tag Recoveries* (BPA 1982-013-02, BPA 1982-013-01)	Support coded-wire tagging and coded-wire tag recovery operations that inform survival, straying, and harvest rates of hatchery fish by stock, rearing facility, release treatment, and location (BPA projects 198201302 and 198201301).	X	X	

Table 5. Hatchery RM&E Projects occurring during the FY 2007 to 2009 Period, Status Monitoring (S), Action Effectiveness Research (A), and Uncertainties Research (U)

Project/Action & Agency (Hatchery RM&E)	Objective/Deliverable	S	A	U
Methow River Steelhead relative reproductive success study (New - BPA TBD)	Initiate a study of reproductive success of hatchery-origin steelhead relative to natural-origin steelhead in the Methow River to verify metrics used for gap analysis.		X	X
Investigate Snake River Sockeye Salmon smolt mortality between the Stanley Basin and Lower Granite Dam (New - BPA TBD)	Initiate a radiotracking study of radiotagged Sockeye Salmon smolts between the release sites in the Stanley Basin of Idaho and Lower Granite Dam. The overall objective is to identify the location(s) and potentially the source(s) of the relatively high smolt losses that have been observed during downstream migration in the Salmon and Snake rivers.		X	X
Umatilla Hatchery M&E [Mid-Columbia River Steelhead component] (BPA 1990-005-00)	Continue monitoring and evaluation related to Mid-Columbia River Steelhead safety-net program.		X	X
Umatilla Basin Natural Production M&E [Mid-Columbia River Steelhead component] – CTUIR (BPA 1990-005-01)	Continue monitoring and evaluation related to Mid-Columbia River Steelhead safety-net program.		X	X
Hood River Production Program M&E [Lower Columbia River Steelhead component] – ODFW (BPA 1988-053-04)	Continue monitoring and evaluation related to Lower Columbia River Steelhead safety-net program.		X	X
Hood River Production Program M&E [Lower Columbia River Steelhead component] – CTWSRO (BPA 1988-053-03)	Continue monitoring and evaluation related to Lower Columbia River Steelhead safety-net program.		X	X
Grande Ronde Supplementation Lostine River O&M/M&E (BPA 1998-007-02)	Continue monitoring and evaluation related to Grande Ronde Chinook (Snake River Spring/Summer Chinook) Salmon safety-net program.		X	X
Grande Ronde Supplementation O&M/M&E (BPA 1998-007-03)	Continue monitoring and evaluation related to Grande Ronde Chinook (Snake River Spring/Summer Chinook) Salmon safety-net program.		X	X
Captive Broodstock Artificial Propagation (BPA 1998-010-06)	Continue monitoring and evaluation related to Grande Ronde Chinook (Snake River Spring/Summer Chinook) Salmon safety-net program.		X	X
Nez Perce Tribal Hatchery M&E [Snake River Fall Chinook Salmon component] (BPA 1983-350-03)	Continue monitoring and evaluation related to Snake River Fall Chinook Salmon supplementation in the Clearwater River Basin.		X	X
Evaluation of Reproduction of Steelhead (BPA 2003-050-00)	Continue to evaluate the individual reproductive success of naturally spawning hatchery steelhead relative to that of native wild steelhead using genetic tools and methods.			X
Reproduction of Steelhead in Hood River (BPA 2003-054-00)	Continue estimating the reproductive fitness of traditional and supplementation hatchery stocks relative to that of wild fish. New data to include summer run supplementation stock vs. wild, and effects of mixing first generation fish back into hatchery.			X

Table 5. Hatchery RM&E Projects occurring during the FY 2007 to 2009 Period, Status Monitoring (S), Action Effectiveness Research (A), and Uncertainties Research (U)

Project/Action & Agency (Hatchery RM&E)	Objective/Deliverable	S	A	U
Evaluate Reproductive Success of Wild and Hatchery Origin Snake River Fall Chinook Salmon Spawners Upstream of Lower Granite Dam (BPA 2003-060-00)	Continue and complete the project. Use genetic analysis of wild and hatchery-origin Snake River Fall Chinook Salmon to estimate relative reproductive success. These data will assist assessment of hatchery Chinook Salmon effects on productivity and recovery.			X
Evaluate the Relative Reproductive Success of Reconditioned Kelt Steelhead (BPA 2003-062-00)	Continue to directly measure the reproductive success of natural-origin, hatchery origin, and reconditioned kelt steelhead in natural streams. The study will yield quantitative data replicated geographically and temporally.			X
Idaho Supplementation Studies (BPA 1989-098-00)	Continue the evaluation of supplementation as a recovery/restoration strategy for Spring/Summer Chinook Salmon in Idaho. The project is a multi-agency effort, covering 30 streams throughout the Salmon and Clearwater subbasins.		X	X
Genetic Monitoring of Snake River Chinook Salmon and Steelhead (BPA 1989-096-00)	This genetic monitoring program is designed to evaluate the effects of hatchery-reared fish on natural and wild populations of Spring/Summer Chinook Salmon and Steelhead in the Snake River Basin. This study has two major research components, gene frequency monitoring over time and space and a direct examination of reproductive success through pedigree reconstruction. Project includes research on relative reproductive success of hatchery-origin Steelhead in Little Sheep Creek and hatchery-origin Spring/Summer Chinook Salmon in the Lostine River and Catherine Creek (where the hatchery-origin fish are adult offspring of captive broodstock program parents).		X	X
Snake River Sockeye Salmon Habitat and Limnological Monitoring (BPA 1991-071-00)	Monitor and enhance (if necessary) rearing conditions for juvenile Sockeye Salmon in Stanley Basin, Idaho, nursery lakes. Investigate competition, growth rates, and survival for progeny released from the Snake River Sockeye Salmon Captive Broodstock Program.		X	X
Research to Advance Hatchery Reform, Including Captive Broodstocks (BPA 1993-056-00)	This project will provide guidance on management of Columbia River Basin hatcheries, including captive broodstocks. Research will focus on developing methods to improve broodstock management and fish quality and reduce negative ecological interactions.			X
YKFP – Klickitat Subbasin Monitoring and Evaluation (BPA 1995-063-35)	The project will continue to test whether new artificial production techniques, coupled with strategic habitat actions, can be used to increase harvest and natural production of Yakima Basin Spring Chinook Salmon, Fall Chinook Salmon, Coho Salmon, and Steelhead while maintaining the long-term genetic fitness of the population being supplemented and keeping adverse genetic and ecological interactions with non-target species or stocks within acceptable limits. The project is designed to provide knowledge about supplementation so that it may be used to mitigate effects on anadromous fisheries throughout the Columbia River Basin.			X

Table 5. Hatchery RM&E Projects occurring during the FY 2007 to 2009 Period, Status Monitoring (S), Action Effectiveness Research (A), and Uncertainties Research (U)

Project/Action & Agency (Hatchery RM&E)	Objective/Deliverable	S	A	U
Develop Progeny Marker for Salmonids to Evaluate Supplementation (BPA 2002-030-00 – a project in the Agreement on 2007 FCRPS Fish Operations)	The project will assess the relative reproductive success of Umatilla Hatchery Summer Steelhead using a pedigree analysis and a laboratory-tested strontium progeny marker injection and will compare the power and accuracy of the two techniques.		X	X
Growth Modulation in Salmon Supplementation (BPA 2002-031-00)	This project assesses and develops methods to control high rates of early male maturation in salmon supplementation programs. Reductions in early male maturation will increase smolt-to-adult survival and reduce genetic and ecological impacts.			X
Monitoring the Reproductive Success of Naturally Spawning Hatchery and Natural Spring Chinook Salmon in the Wenatchee Watershed (BPA 2003-039-00)	Continue quantitative evaluation of the relative reproductive success and survival of naturally spawning hatchery and natural origin Spring Chinook Salmon in the Wenatchee River watershed above Tumwater Dam.			X

Table 6. Predator RM&E Projects occurring during the FY 2007 to 2009 Period, Status Monitoring (S), Action Effectiveness Research (A), and Uncertainties Research (U)

Project/Action & Agency (Predator RM&E)	2007-2009 Deliverable/Objective	S	A	U
Northern Pikeminnow Management Program (BPA 1990-077-00)	Continue and improve ongoing monitoring and evaluation program component of Northern Pikeminnow Program. Evaluate effectiveness of any other non-indigenous predator management program if tested and implemented.	X	X	
Avian Predation on Juvenile Salmonids in the Lower Columbia River (BPA 1997-024-00)	Continue the RM&E program to determine the effects of tern redistribution on colony size, annual reproductive success, and annual consumption levels of juvenile salmonids by Caspian terns remaining on East Sand Island. Continue and expand research on double-crested cormorants to determine population status, distribution, productivity, diet composition, and management issues.	X	X	X
Mid Columbia Avian Predation Monitoring (Corps) – Continuation of monitoring of avian predators on Corps-managed lands in the mid Columbia River towards supporting a management program aimed at improving juvenile salmonid survival.	Continuation of monitoring of avian activity on Corps- managed lands. Key elements will include monitoring Crescent and Foundation islands towards understanding the numbers of salmonids taken by avian predators.	X	X	
Pinniped predation on adult Chinook salmon (Corps)	Continue monitoring to estimate predation rates by pinnipeds on adult salmon immediately below Bonneville Dam. This effort will also identify individual animals, assess the effectiveness of acoustic deterrent methods, assess hazing in the fishways and assess the potential impacts of sea lion excluder devices (SLEDs) on salmon and pinnipeds at Bonneville Dam.	X	X	

Table 7. RM&E Coordination and Data Management Projects Occurring during the FY 2007 to 2009 Period

Project/Action & Agency (Coordination and Data)	**2007-2009 Deliverable/Objective**
Develop and Implement an Integrated Status and Effectiveness Monitoring Program (BPA 2003-017-00)	Coordinate monitoring approaches and protocols with other regional entities across all pilot study areas. Develop standardized monitoring protocol tool, spatial (GIS) database, and tabular database (with GIS links). Coordinate across all pilot study areas.
PNAMP Funding (BPA project no. 2004-002-00)	Coordinate PNAMP workgroups and products
PNAMP Fish Population Monitoring Tagging Protocols - (BPA project no. 2007-216-00)	RM&E Design and Protocols for fish population monitoring. Programmatic and Standardized Work Products for the Pacific Northwest and the Columbia Basin.
Streamnet (CIS/NED) (BPA project no. 198810804)	Regional coordinated information system for archiving fish and habitat data.
Technical Management Team Support (BPA 1996-019-00)	Hydrosystem survival and fish passage information.

Table 8. Fish Population Status Monitoring Project occurring during the FY 2007 to FY 2009 Period

Project/Action & Agency (Fish Population Status)	**2007-2009 Deliverable/Objective**
Nez Perce Tribal Hatchery RM&E (BPA 1983-350-03)	Fish Population Data
Umatilla Fish Passage Operations (BPA 1988-022-00)	Fish Population Data
Hood River Production M&E-ODFW (BPA 1988-053-04)	Fish Population Data
Hood River Production M&E-Warm Springs (BPA 1988-053-03)	Fish Population Data
Salmon Studies ID Rivers (BPA 1989-098-00)	Fish Population Data
Umatilla Basin Natural Production M&E (BPA 1990-005-01)	Fish Population Data
Life Studies of Spring Chinook Salmon (BPA 1992-026-04)	Fish Population Data
Idaho Steelhead M&E Studies (BPA 1990-055-00)	Fish Population Data
Trout Creek O&M (BPA 1994-042-00)	Fish Population Data
Yakima/Klickitat Fisheries Project- M&E (BPA 1995-063-25)	Fish Population Data
Johnson Creek Artificial Propagation (BPA 1996-043-00)	Fish Population Data
Listed Stock Adult Escapement (BPA 1997-030-00)	Fish Population Data
Grande Ronde Spring Chinook Salmon-ODFW (BPA 1998-007-04)	Fish Population Data
M&E Yearling Snake River Fall Chinook Salmon (BPA 1998-010-03)	Fish Population Data
M&E Snake River Fall Chinook Salmon Spawning (BPA 1998-010-04)	Fish Population Data
Captive Broodstock Artificial Propagation (BPA 1998-010-06)	Fish Population Data
Salmonid productivity, escapement, trend, and habitat monitoring in the John Day (BPA 1998-016-00)	Fish Population Data
Anadromous Fish Habitat &Passage (BPA 2000-001-00)	Fish Population Data
Tucannon River Spring Chinook Salmon Captive Broodstock Program (BPA 2000-019-00)	Fish Population Data
Walla Walla Subbasin Collaborative Salmonid M&E Project (BPA 2000-039-00)	Fish Population Data
Assess Salmonids Asotin Creek Watershed (BPA 2002-053-00)	Fish Population Data
Integrated Status and Effectiveness Monitoring Program (BPA 2003-017-00)	Fish Population Data
Okanogan Basin M&E Project (BPA 2003-022-00)	Fish Population Data
Monitor Reproduction in the Wenatchee Watershed (BPA 2003-039-00)	Fish Population Data
Evaluate Reproductive Success Snake River Fall Chinook Salmon (BPA 2003-060-00)	Fish Population Data
Listed Stock Chinook Salmon Gamete Preservation (BPA 1997-038-00)	Fish Population Data
Grande Ronde Captive Brood O&M – ODFW (BPA 1998-010-01)	Fish Population Data
Nez Perce Harvest Monitoring (BPA 2002-06-000)	Fish Population Data
Imnaha River Monitoring Project (BPA 1997-015-01)	Fish Population Data
Note: While BPA currently provides regional support for these fish population status data, all of these projects are under review for monitoring efficiencies and prioritization of RM&E efforts and there scope of work and/or funding levels are subject to change in FY 2008 and FY 2009.	

Attachment B.2.6-2
Hydropower Research, Monitoring, and Evaluation Action

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ANNEXES

LIST OF ACRONYMS

AER	action effectiveness research
AFEP	Anadromous Fish Evaluation Program
BA	Biological Assessment
BiOp	Biological Opinion
BIT	biological index testing
BMP	best management practice
BPA	Bonneville Power Administration
CBFWA	Columbia Basin Fish and Wildlife Authority
COMPASS	Comprehensive Fish Passage Model
COP	Configuration and Operations Plan
Corps	U.S. Army Corps of Engineers
Council	Northwest Power and Conservation Council
CPUE	catch-per-unit effort
CRFM	Columbia River Fish Mitigation
CRITFC	Columbia River Inter-Tribal Fish Commission
CROHM	Columbia River Operational Hydronet System
DPS	Distinct Population Segment
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FCRPS	Federal Columbia River Power System
FPC	Fish Passage Center
FPE	Fish Passage Efficiency
FY	fiscal year
ISAB	Independent Scientific Advisory Board
IT	Implementation Team
LCREP	Lower Columbia River Estuary Program
M&E	monitoring and evaluation
MOU	memorandum of understanding
MPG	Major Population Group
NED	Northwest Environmental Data Network
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPMP	Northern Pikeminnow Management Program
PH1	Powerhouse 1
PH2	Powerhouse 2
PIT	passive integrated transponder (tag)

PNAMP	Pacific Northwest Aquatic Monitoring Partnership
PSMFC	Pacific States Marine Fish Commission
PWG	Policy Work Group
Reclamation	U.S. Bureau of Reclamation
RM&E	research, monitoring, and evaluation
RSW	removable spillway weir
SAR	smolt-to-adult return
SCT	System Configuration Team
SMP	Smolt Monitoring Program
SPE	Spill Passage Efficiency
SWRG	Studies Review Work Group
TAC	Technical Advisory Committee
TDG	total dissolved gas
TMT	Technical Management Team
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

1. INTRODUCTION

This attachment provides some additional details regarding hydropower research, monitoring, and evaluation (RM&E) Actions that will be implemented to answer key management questions. These questions involve the achievement of hydropower fish passage performance standards/targets, identification and understanding of hydro-related limiting factors, and the effectiveness of hydropower actions.

Research and monitoring for the Hydropower Action will include procedures for tracking implementation of the action and management of data. Coordination with regional agencies and Tribes will be an integral part of the RM&E process.

RM&E has been a key component of past and ongoing evaluations of actions to improve survival for Endangered Species Act (ESA)-listed salmon and steelhead in the Columbia River Basin. The Action Agencies are committed to a continuation of this process for the forthcoming Biological Opinion (BiOp). As an example, Table 1, Attachment B.2.6-1 summarizes specific projects that have been currently identified for implementation in fiscal year (FY) 07 to FY 09 period to meet the Actions for Hydropower RM&E.

This attachment to Appendix B, Section 2.6 describes the RM&E approach for the hydropower proposed action. It involves the following sections:

- Management Questions
- Performance Measures, Standards, and Targets
- Hydropower Status Monitoring (both Biological and Environmental Monitoring)
- Action Effectiveness Evaluations
- Critical Uncertainty Research
- Implementation and Compliance Monitoring
- Coordination
- Data Management

2. MANAGEMENT QUESTIONS

The following are the primary management questions with respect to Federal Columbia River Power System (FCRPS) hydrosystem passage actions. Hydropower RM&E Actions described in this section are focused on providing information needed to answer these questions to support ongoing and adaptive management decisions.

- Are salmon and steelhead meeting juvenile and adult hydrosystem passage performance standards and targets?
- Is each project in the hydropower system safely and efficiently passing adult and juvenile migrants?
- What are the most effective configurations and operations for achieving desired performance targets in the FCRPS?
- What is the post-Bonneville mortality effect of changes in fish arrival timing and transportation to below Bonneville?

- Under what conditions does in-river passage provide greater smolt-to-adult return rates than transport?

These management questions can be addressed using one or more of the following types of RM&E:

- Status Monitoring – Statistically designed monitoring of fish and/or wildlife population and/or environmental conditions (i.e., watershed conditions) to assess the current status or change (trend) over time. This is sometimes referred to as an observational study.
- Action Effectiveness Research – research to determine the effects of an action or suite of actions on fish survival, productivity and/or habitat conditions. This is a manipulative experiment that statistically assesses the effect of a treatment (action) condition relative to a control or reference condition
- Uncertainties Research – research to resolve scientific uncertainties regarding the relationships between fish or wildlife health, population performance (abundance, survival, productivity, distribution, diversity), habitat conditions, life history and/or genetic conditions (e.g., the existence and causes of delayed mortality or hatchery spawner reproductive success relative to wild populations). This is a manipulative experiment where variables are manipulated to infer or demonstrate cause-and-effect relationships using statistically designed hypothesis testing.
- Project Implementation and Compliance Monitoring – monitoring the execution and outcomes of projects to determine whether projects are implemented as planned.

3. PERFORMANCE MEASURES, STANDARDS AND TARGETS

The Action Agencies have identified measures that will be monitored to assess performance standards (benchmarks) and performance targets (longer-term goals) and to inform adaptive management actions. We will be monitoring two aspects of performance:

- Programmatic Performance
- Biological and Environmental Performance

Programmatic performance will be tracked through project implementation and compliance monitoring. Biological and environmental performance measures are tracked and evaluated through status monitoring, action effectiveness research, and critical uncertainty research in combination with existing and developing quantitative models.

Performance standards will be monitored to insure accountability and adherence to proposed actions. Performance targets will be evaluated over longer time periods as new information and learning is applied through analytical models. Targets allow us to check for progress toward expected life stage survival improvements and trends in evolutionarily significant unit (ESU) or population performance. Performance targets inform longer-term adaptive management decisions and prioritization of options across populations with different relative needs.

The biological and environmental performance measures for hydropower are:

- juvenile and adult system level survival,
- juvenile dam passage survival,
- proportion of juveniles transported,

- fish and spillway passage efficiency,
- forebay behavior,
- tailrace egress, and
- total dissolved gas levels at fish passage projects.

Performance standards have been set for average juvenile dam survival for run-of-river spring and summer migrants and adult hydrosystem survival. The expected increase in total juvenile system survival associated with the Hydropower Actions has been set as a long-term performance target for each ESU.

3.1 ADULT SURVIVAL

For adult fish, we have largely achieved or exceeded the performance standard identified in the 2000 BiOp (personal communication, Ruff to Brian Brown, June 29, 2004). The proposed operation is expected to maintain or improve adult passage survival. The Action Agencies will annually assess adult survival through the hydrosystem to evaluate this performance standard to ensure that adult passage survival remains high. This assessment will be based on ESU-specific reach survival estimates applied as a rolling 5-year average. Annual estimates will be determined using the following methodology.

Estimates of adult system survival will be based on PIT-tagged fish known to have migrated in-river past Bonneville Dam as juveniles and are detected at Bonneville (adult survivors detected again at McNary or Lower Granite dams) as returning adults. This method has several advantages over previous methods (i.e., radio-telemetry or dam counts): 1) it relies upon full detection of PIT-tagged adults and so does not require additional handling or surgery which could affect adult migration behavior; 2) it produces survival estimates for individual ESUs / DPSs using known origin fish as surrogates; 3) the calculations are simple and straightforward (only estimates of harvest and straying rates between Bonneville and the upstream detection site are needed); and 4) the PIT-tag database is commonly available – ensuring transparency and reproducible results. Specifically, the methodology for estimating adult system survival includes the following steps:

1. Determine the number of PIT-tagged adult salmon and steelhead detected at Bonneville Dam that represents the ESU / DPS in question. This is accomplished by selecting adult detections from the PITAGIS database that meet the following requirements: 1) are of known origin, i.e., are from the ESA-listed stock or a valid surrogate stock 2) migrated in-river as juveniles, 3) returned as adults (2+ years old for Chinook salmon). For example, to represent Upper Columbia River spring Chinook salmon, select all appropriate age 2+ spring Chinook salmon tagged upstream of Rock Island Dam detected at Bonneville Dam to represent Upper Columbia River spring Chinook salmon.
2. Determine the number of PIT-tagged adult salmon and steelhead (of those identified in step 1) that were re-detected at McNary or Lower Granite dam (or at locations upstream of these dams).
3. Calculate an unadjusted survival rate: $\mathbf{S = N_U / N_B}$ where S = survival rate, N_U = number of fish re-detected at or above the upstream targeted dam (McNary or Lower Granite), and N_B = number of fish initially detected at Bonneville Dam.
4. Calculate an adjusted survival rate: $\mathbf{S = (N_U - Nharv - Nstray) / N_B}$ where Nharv = estimated harvest based on Joint Staff/TAC reported harvest rates corrected for reascension rates at Bonneville (TAC harvest rate/Bonneville count correction factor) and Nstray = estimated straying (turning off and remaining in spawning areas before reaching the targeted upstream dam) based on historical (or future) radio-telemetry studies or other sources of information (PIT-tag detections in tributaries, hatchery facilities, etc.).

We are pursuing improvements in harvest estimating techniques to reduce the uncertainty associated with these estimates. Consistent with our adaptive management approach, we will adjust our actions as warranted to ensure implementation of an effective and efficient program for adult migrants. We will continue to report on adult hydrosystem survival in our annual and cumulative progress reports.

The performance standard for Snake River Chinook ESUs (including Spring/Summer and Fall), will be based on PIT-detections at Bonneville and Lower Granite dams. Past estimates have yielded an upstream survival estimate of 90 percent for Snake River Spring Chinook, 94 percent for Snake River Summer Chinook and 92 percent for Snake River Fall Chinook. The Action Agencies propose to use these estimates as the standard. For the Upper Columbia River Chinook Salmon ESU, the standard will be measured from Bonneville Dam to McNary Dam and survival is estimated as 92 percent.

Interior Steelhead ESUs are presently encountering significant harvest above McNary Dam which is not accounted for in any ESA documentation. Therefore, it is not possible at this time to estimate conversion. While harvest estimates from TAC could be used to complete the analysis, the uncertainty associated with the estimates has not yet been determined. While estimates of steelhead conversion will be reported, no standards are being proposed at this time. If adequate information becomes available on reliable harvest rates for Upper Columbia River steelhead and Snake River steelhead, a performance standard may be warranted in the future.

For Snake River sockeye where insufficient data exist, no standard is proposed, however if information can be gathered with sufficient rigor in the future, a performance standard or report may be warranted.

For Mid-Columbia and lower Columbia ESUs, (Mid-Columbia River Steelhead, Lower Columbia River Steelhead, Lower Columbia River Coho Salmon, Lower Columbia River Chinook Salmon, Columbia River Chum Salmon, Willamette ESUs), no standards are proposed, however, migratory success will be reported. In that similar stocks must migrate through the lower river at the same time, a surrogate using upriver stocks would be expected to provide a high level of protection for lower river stocks as well. The calculation of per project survival would be reported for these stocks using surrogates of upriver Chinook salmon or steelhead stocks as appropriate.

The Willamette and chum salmon ESUs in the lower river only incidentally encounter the mainstem FCRPS projects and therefore passage success is not likely to be a key driver in population viability. No performance standard is proposed.

To determine upstream passage survival, the Action Agencies will monitor PIT-tagged adult fish from known sources, including from BPA, Corps and other RM&E programs, using PIT-detection at FCRPS fish ladders. Because the intent of this performance is to measure the success of the adult passage system, transported fish, which can have a lower upstream success rate than in-river migrants, will not be used for the calculation. In addition, because jacks are not subject to the same pressures as full spawning age adults, and often have higher upstream success rate, jack detections will not be used in the calculation.[1] A five-year rolling average survival will be made, based on PIT-tag detections with adjustments for estimated harvest and stray rates.

[1] The Action Agencies were advised by NMFS and other PWG parties, most notable Washington to exclude jacks from the adult survival performance metrics because these smaller male fish have little effect on the productivity of populations and harvest and stray rate estimates used to calculate fish losses due to the hydro system are not generally applicable to jacks.

Straying estimates will be based on historic Corps-funded radio tag studies (University of Idaho Technical Report 2005-5) or upon the best information available in the future from other sources (e.g., tributary PIT-tag detectors, etc.). Harvest estimates for each year will be based on US-v-Oregon's Technical Advisory Committee (TAC) information. The adult survival standard will take into account fallback and delay effects in so much as they affect PIT-detection survival estimates.

While several FCRPS fish ladders will be monitored and reported, (Bonneville, McNary, Lower Granite and Ice Harbor), the assessment by ESU would be the longest migration points between the FCRPS projects that a known source fish would take. For example, this would be assessed from Bonneville Dam to the most upstream federal dam in the fish's migration path (i.e. to Lower Granite Dam) for most Snake River ESUs and to McNary Dam for Upper Columbia ESUs. Future installation of adult PIT-detection at FCRPS projects is being considered should a finer level of detail be required.

For ESUs with populations that may encounter only a portion of the FCRPS dams, the metric would be survival from Bonneville to McNary dams, for populations originating above McNary, the 4th root of Bonneville to McNary survival, raised to the number of dams passed. The reach and associated rationale are summarized by ESU in Table 1.

Table 1. Adult Performance Standards by ESU

ESU	Adult Standard	Reach	Rationale
Snake River Spring Chinook Salmon	90%	Bonn. to Lower Granite	Longest migratory route
Snake River Summer Chinook Salmon	94%	Bonn. to Lower Granite	Longest migratory route
Upper Columbia Spring Chinook Salmon	92%	Bonn. to McNary	Longest migratory route
Snake River Fall Chinook Salmon	92%	Bonn. to Lower Granite	Longest migratory route
Willamette River Chinook	None	None	Low Encounter Rate
Lower Columbia River Chinook Salmon	None	None	Surrogate of upriver ESU
Snake River Steelhead	NA	Bonn. to Lower Granite	Unaccounted harvest leads to uncertainty in calculations
Upper Columbia River Steelhead	NA	Bonn. to McNary	Unaccounted harvest leads to uncertainty in calculations
Mid-Columbia River Steelhead	NA	Variable	Unaccounted harvest leads to uncertainty in calculations
Lower Columbia River Steelhead	None	None	Upriver Steelhead ESU surrogate
Willamette River Steelhead	None	None	Low Encounter Rate
Snake River Sockeye Salmon	None	None	Uncertainty in data
Lower Columbia River Coho Salmon	None	None	Upriver Chinook Salmon ESU surrogate
Columbia River Chum Salmon	None	None	Low Encounter Rate

3.2 JUVENILE SYSTEM SURVIVAL

In the biological analyses, the Action Agencies have assessed the expected juvenile system survival to the Bonneville tailrace under current conditions (2006 hydro configuration and the operation plan that were identified in the 2004 Biological Opinion) and under the prospective conditions of our proposed hydrosystem actions through 2017. The Action Agencies propose to use the relative improvement in direct system survival from the 2004 base level conditions to the 2017 proposed action conditions, as our system survival performance targets. Progress toward these targets will be checked and reported on in the 2012 and 2015 comprehensive reports, and used to inform adaptive management decisions.

In developing our overall analysis of the effects of the proposed hydro action on listed anadromous fish, the Action Agencies used the Comprehensive Fish Passage Model (COMPASS) that incorporate the best available science on current and future fish passage conditions. (See Appendix B of the Comprehensive Analysis on Analysis of Effects of Hydro Actions.) These estimates use a 70-year hydrologic record to capture the full range of expected water conditions and the average over time. We will report updated assessments of juvenile survival improvements relative to this target in 2012 and 2015, as follows:

2012. For yearling Chinook salmon and steelhead, the Action Agencies' comprehensive evaluation will estimate the average 2011 system survival (with actual operation plans and system configurations that have been implemented to date) relative to the 2004 base level survival conditions. These estimates will be based on the most recent fish passage research applied within the COMPASS passage model, calibrated and validated by recent years' empirical survival data. The model estimates will use the full 70-year hydrologic record for both the current 2011 and base 2004 survival estimates (the same procedure used in estimating the hydro survival benefits in the biological analyses). We will compare this 2004 to 2011 modeled survival improvement to the 2004 to 2017 performance target to evaluate our progress.

2015. The Action Agencies' 2015 comprehensive evaluation and progress report will use the same approach as in 2012. The estimates will be updated with additional research results, empirical survival data, and any new operations or configurations current in 2014. We will compare this 2004 to 2014 modeled survival improvement to the 2004 to 2017 performance target to evaluate our progress.

Ongoing smolt monitoring at the dams and through river reaches will be the primary sources of data to inform the COMPASS modeling estimates. It is not practical to attempt field measurements of juvenile fish survival for each stock migrating each year. We may use surrogates as indicators for some ESUs. For example, estimated survival of a composite of Snake River stocks in the lower Columbia River could serve as a surrogate to represent the survival of mid- and lower Columbia River stock survival through the same reach (such as McNary Dam to Bonneville Dam). However, we are increasing the smolt monitoring efforts for Upper Columbia River Chinook Salmon and Steelhead, and potentially for Snake River Sockeye Salmon, in order to have more specific information for these ESUs in the future. In addition, further research and monitoring of Snake River Fall Chinook may allow Compass modeling of this ESU in the future.

3.3 JUVENILE DAM PASSAGE SURVIVAL

The Action Agencies propose specific performance standards of 96 percent average relative dam survival for spring migrating fish and 93 percent average relative dam survival for summer migrating fish, with averaging/tradeoffs allowed between dams. Any survival averaging or tradeoffs between dams may occur amongst the Snake River dams or amongst the lower Columbia River dams, but not between Snake and Columbia River dams.

The dam passage performance standards are based on the anticipated effects of Phase I Hydro Actions (described in the Proposed RPA table). These estimates are based on best professional judgment. The survival rate changes were used as inputs to the COMPASS model which allowed for the assessment of dam by dam survival. The survival rates can be found in Appendix B of the Comprehensive Analysis. The fall Chinook survival performance standards are based on estimates of current survival at the projects and estimated improvements associated with future actions.

This standard would be assessed based on the average passage survival at each dam incorporating the effects of the passage route and the immediate tailrace without the reservoir effects. It would be estimated to a precision level of +/- 3 percent at the 95 percent confidence interval precision using route-specific relative survival estimating techniques, such as radio or acoustic telemetry. Survival studies will use standard methodologies developed by the Regional Forum's Studies Review Workgroup (SRWG). As mentioned above, these survival studies will focus on survival from the face of the dam to a standard reference point in the immediate tailrace of the project as determined by the SRWG. Studies will attempt to determine estimates of absolute survival but it is understood that all paired or single release survival estimates will be relative to the operation or control group. This standard will not be assessed during a drought year or conditions that result in operations other than planned under the Proposed RPA. This target is based on the best available modeled estimates using those types of measuring techniques. These standards apply to Snake River and Upper Columbia River ESUs. There is not sufficient data specific to the separate stocks to support the development of separate standards for Snake River and Upper Columbia River stocks, nor other specific ESUs. This target is averaged such that if one dam is estimated to provide 93 percent survival, it can be offset by another dam providing 97 percent survival so long as both dams generally pass the same ESUs. For instance low survival at Little Goose may be offset by high survival at Lower Granite since the same ESUs tend to pass both dams. However, low survival at The Dalles may not be offset by high survival at Ice Harbor since The Dalles passes ESUs from the mid- and lower-Columbia that do not pass through Ice Harbor.

Since it is not feasible to evaluate dam survival for all ESUs at all eight mainstem dams each year, the field studies to assess progress toward meeting this dam survival standard will be completed according to the following guidelines. A technical team of regional representatives will meet to discuss whether any of the dams are already meeting the dam survival. If any of them are, there would be no immediate requirement for a field study to estimate current performance relative to the dam survival standard. For those dams not currently believed to be meeting the standard, a field study of dam survival would be performed after survival improvements have been implemented. If dam survival estimates exceed the standard in two separate years, the target would be met for that dam.

The Action Agencies have significant influence over direct dam survival. The standard does not include reservoir survival because there is too much variability beyond the Action Agencies' control. Reservoir survival will still be reflected in the direct system survival standard. Additionally, there is too much uncertainty surrounding potential delayed and latent effects to incorporate them in a survival standard.

One mechanism for adaptive management to improve performance, when necessary, will be the Configuration and Operation Plans (COPs) that the Corps prepares to evaluate and develop hydrosystem project improvements. The Corps has prepared COPs that lead to improvements including surface passage [e.g., removable spillway weirs (RSWs)] and other dam passage improvements at Corps projects. A COP is being/has been developed for each dam that will recommend the ultimate configuration and operation for that project. Each COP will be/is developed in close coordination with the Region at the technical level. The COP considers alternatives and performance standards, and several other components as described in the Draft Snake and Columbia River Surface Passage Strategy prepared by the Corps in July 2005. Following installation of dam passage improvements, an evaluation will be conducted to determine the success of the action in meeting the performance standard. If the standard is not met, the Corps will update the COP coordinated through the Regional Forum to determine additional potential actions.

4. HYDROPOWER STATUS MONITORING

4.1 BIOLOGICAL MONITORING

4.1.1 Monitor and Evaluate Fish Performance in the FCRPS

The Action Agencies will monitor biological responses and/or environmental attributes, and report these estimates on an annual basis. These proposed actions include:

- Monitor and evaluate juvenile salmonid dam survival rates for a subset of FCRPS projects.
- Monitor and evaluate juvenile salmonid system survival through the FCRPS, including estimates of differential post-Bonneville survival of transported fish relative to in-river fish (D-value) as needed.
- Monitor and evaluate adult salmonid system survival upstream through the FCRPS.
- Provide additional PIT-tag marking of Upper Columbia populations to provide ESU-specific estimates of juvenile and adult survival through the Federal mainstem dams.
- Assess the feasibility of PIT-tag marking of Snake River Sockeye Salmon for specific survival tracking of this ESU through the FCRPS.
- Develop an action plan for conducting hydropower status monitoring (analytical approaches, tagging needs, methods and protocols) in ongoing collaboration with the State and Federal fishery agencies and Tribes. This will be done in coordination with status monitoring needs and strategies being developed for estuary/ocean, habitat, hatcheries, and harvest.

4.1.2 Issues Regarding Performance Indices and Related Matters

4.1.2.1 Adult Survival Indices

In recent years, both radio-tagged and PIT-tagged adults have been used to estimate adult passage survival from Bonneville Dam to their exit point from the FCRPS. Future monitoring efforts will rely on using returning fish that were PIT-tagged as juveniles. Part of the challenge accompanying this approach, is to account for tributary turnoff, straying, fallback and in-river harvest removals en route from Bonneville Dam to the uppermost dam particular to the ESU in question.

An Action Plan for Status Monitoring that describes methods and procedures for accomplishing this is proposed to be developed in ongoing collaboration with the State and Federal fishery agencies and Tribes in coordination with status monitoring needs for estuary/ocean, habitat, hatcheries, and harvest. Although PIT-tagged jack salmon will not be included in the annual calculations of system survival, the data will be reported.

4.1.2.2 Sampling Units

Selecting appropriate biological sampling units determines the demographic resolution for indexing performance. These can be defined at the species level, the ESU component, or populations thereof. Ideally, information specific to individual populations is desirable, because some populations may respond differently to a similar hydrosystem experience. Unfortunately, attaining this ideal situation has proved to be impractical for a variety of reasons.

The term environmental sampling unit refers to the geographic bounds over which fish performance is measured. With respect to the FCRPS for juveniles, this extends from the point where an index ESU or population (biological sampling unit) enters the system to some short distance downstream from Bonneville Dam. For adults, it is the same, but in reverse. Following are brief descriptions of the sampling units that will be considered.

Spring Migrants

Currently, a complex of juvenile wild and hatchery stocks are PIT-tagged each year and form a composite index group to monitor passage related survival of juvenile Snake River Spring/Summer Chinook Salmon and Steelhead through the FCRPS. This composite group forms the basis for existing in-river and total system survival estimates. This is not expected to change in the future, but it is not clear exactly what the tagging scheme will be in the future. Furthermore, there is a need to continue tributary tagging at current levels, or greater.

In the Upper Columbia River, opportunities to PIT-tag wild fish are more limited and long-term tagging of hatchery stocks in suitable numbers has not occurred. Thus, too few fish have been available to obtain useful estimates through the FCRPS on a regular basis. As a consequence, managers have relied on performance estimates obtained for Snake River fish migrating through the lower Columbia River to represent upper and mid-Columbia River ESUs. To better assess the survival of upper Columbia River ESUs, the Action Agencies will be implementing additional tagging of these fish based on a collaborative review of the tagging needed assess performance standards.

Snake River Fall Chinook Salmon

Presently, no acceptable method exists to adequately monitor survival of juvenile Fall Chinook Salmon through the FCRPS. This poses a severe limitation for monitoring and evaluating the performance of this ESU as they migrate through the FCRPS. This issue is receiving attention and will continue to be addressed within ongoing RM&E collaboration processes and the COMPASS modeling forum.

Adult Salmonids

Annual system survival monitoring of adults will rely on returning adults previously PIT-tagged as juveniles while in their natal habitat (tributary or hatchery). If the stock complement of fish being tagged differs much from historical efforts, differences in harvest or stray rates may emerge. Tagging plans and final assessments will need to be sensitive to this point.

Dam Survival

To monitor dam survival of juveniles, run-of-river fish will form the sampling unit. These fish will be obtained onsite or near the dam of interest. It may include a blend of hatchery and wild fish passing each location. Specific experimental designs and analytical frameworks will be described in an Action Plan that is proposed to be developed in ongoing collaboration with the State and Federal fishery agencies and Tribes in coordination with status monitoring needs for estuary/ocean, habitat, hatcheries, and harvest.

4.1.2.3 PIT-Tagging Requirements

To obtain useful estimates of life stage survival at the population or wild ESU level, adequate numbers of naturally produced fish need to be PIT-tagged. The experience in the Snake River over the last decade has shown that collecting and tagging enough naturally produced fish to represent the Spring/Summer Chinook Salmon and Steelhead ESUs, has not been possible. As a consequence, fishery managers have relied on hatchery fish to augment the sample sizes to represent the performance of those ESUs as they migrate through the FCRPS. The National Marine Fisheries Service (NMFS, also called National Oceanic and Atmospheric Administration [NOAA] Fisheries) investigators have determined that hatchery fish are an adequate surrogate for indexing the performance of the wild ESUs that migrate during the spring.

Importantly, NMFS has relied on other studies to produce tagged fish that can opportunistically be used for this monitoring (e.g., the Comparative Survival Study and wild stock tagging in tributaries). Some of those tagged fish serve several purposes as evidenced here. Regionally, there is a need to coordinate such tagging across the All-Hs. As noted previously, the Oregon Department of Fish and Wildlife and Columbia River Inter-Tribal Fish Commission (CRITFC) input to the Remand Collaboration Process has identified a number of candidate stocks, with proposed sample sizes, that could be PIT-tagged. This provides an excellent starting point, and the Action Agencies will work with the fishery agencies to refine the needed PIT-tagging effort and coordinate these hydropower tagging needs with other non-hydropower tagging and monitoring.

4.1.3 Projects Contributing to Status Monitoring

Table 1 in Attachment B.2.6-1 identifies those projects funded by the Corps and BPA that contribute to status monitoring efforts called for in this plan.

4.1.4 Monitoring Juvenile Migration and Fish Condition

4.1.4.1 Northwest Power and Conservation Council / Bonneville Power Administration Fish & Wildlife Program

Bonneville Power Administration (BPA)-funded RM&E activities are coordinated under the auspices of the Northwest Power and Conservation Council's (Council's) Columbia River Basin Fish and Wildlife Program (Fish and Wildlife Program). This program was developed by the Council in accordance with Public Law 96-501, the Pacific Northwest Electric Power Planning and Conservation Act.

As part of the Fish and Wildlife Program, smolt monitoring tracks various performance indices (e.g., travel time), and fish condition at dams in the FCRPS, as well as projects and trap sites upstream from the FCRPS. PIT-tagging efforts associated with the current smolt monitoring program have provided some of the index fish used by NMFS and others in estimating smolt system survival. Some of those tagged fish have come from the Comparative Survival Study. A similar tagging effort will provide the PIT-tag numbers necessary for adequate passage survival status monitoring. The intent is to use this pool of tags to monitor both population level survival [(as indicated by the smolt-to-adult return ratio (SAR)] and juvenile system survival. The Action Agencies agree with this approach and will collaborate with those parties and other fishery agencies to finalize stock coverage and sample sizes.

4.1.4.2 Corps Requirements

The Corps requires a program for sampling and monitoring juvenile fish for three primary purposes. The first is to determine if a juvenile fish facility is operating appropriately. Secondly, there is a need to acquire basic information as part of the juvenile fish transportation program. Those estimates include hourly and daily species composition, as well as the number and size frequency of fish collected. Third, there is a need to sample and collect fish for assorted action effectiveness research projects.

Facility Operation

When operating the juvenile fish facilities, there is the potential for fish injury to occur when screens become plugged, orifices become blocked by tree branches, or tumbleweeds get caught on the trashracks or other structures. Because of this, some level of fish condition sampling is required to determine if the facility is operating as designed. When transporting is not being conducted (e.g., at Ice Harbor Dam), sampling for this purpose occurs 2 days a week. This facility operates in primary bypass mode continuously during the spring and has the highest survival of any screened bypass system on the river. With the incorporation of a delayed start of the juvenile fish transportation program at Snake River projects in 2004, the Corps Fish Passage Plan was revised to reflect periodic sampling at Lower Monumental and Little Goose prior to the initiation of transport. Everyday sampling for the BPA-funded smolt monitoring is expected to continue at Lower Granite Dam, but is more than what the Corps needs for managing the facilities. Sampling is also required at McNary, John Day, and Bonneville dams.

Transport Program

When transporting, the Corps must estimate hourly and daily fish collection for managing the juvenile fish transportation program. This sampling is typically a very small proportion of the daily collection and is essential for determining the appropriate loading of raceways, barges, and trucks. Therefore, whenever transporting at a project, daily sampling will be conducted to facilitate the transportation process.

Research Program

When performing action effectiveness research (e.g., RSW effectiveness), sampling at the hydropower facility is required to obtain fish for study. As a result, to capture fish of a specific species or run type, sampling of additional fish is often required, and monitoring of the type of fish collected is required. This research is performed at a variety of projects across a variety of timeframes and can only be planned on a year-to-year basis.

4.1.5 Monitoring Adult Migration & Fish Condition

4.1.5.1 Corps Program

Monitoring adult passage counts is a cornerstone monitoring activity that must be performed on an annual basis. Adult fish counting is typically performed 16 hours per day, during daylight hours, by either video or visual counting methods, at all of the Corps projects that pass fish. Adult fish counting will continue at a minimum on the schedule presented in Table 2.

Table 2. Minimum Adult Fish Counting Schedule

Dam	Duration of Operation	Duration of Counting	Hours of Count
Bonneville	January 1 - December 31	January 1 - December 31	04:00 - 20:00
The Dalles	February 20 – December 7	February 20 – December 7	04:00 - 20:00
John Day	February 20 – December 7	February 20 – December 7	04:00 - 20:00
McNary	March 1 – December 31	March 1 – December 31	04:00 - 20:00
Ice Harbor	March 1 – December 31	March 1 – March 31	06:00 - 16:00
		April 1 - October 31	04:00 - 20:00
L. Monumental	March 1 – December 31	April 1 - October 31	04:00 - 20:00
Little Goose	March 1 – December 31	April 1 - October 31	04:00 - 20:00
Lower Granite	March 1 – December 31	March 1 – March 31	06:00 - 16:00
		April 1 - June 14	04:00 - 20:00
		June 15 - August 31	24 hours
		August 31 - October 31	04:00 - 20:00
		November 1 - December 15	06:00 - 16:00

4.2 ENVIRONMENTAL CONDITIONS-MONITORING

4.2.1 Monitor and Evaluate Migration Characteristics and River Condition

The Action Agencies will monitor and evaluate key biological and physical attributes of anadromous fish species migrating through the FCRPS on an annual basis. These proposed actions include:

- Monitor and estimate the abundance of smolts passing index dams.
- Monitor and describe the migration timing of smolts at index dams, identify potential problems, and evaluate implemented solutions.

- Monitor and document the condition (e.g., descaling, injury, gas bubble trauma) of smolts at index dams, identify potential problems, and evaluate implemented solutions.
- Monitor and enumerate adult salmonids passing through fishways in the FCRPS, identify potential problems, and evaluate implemented solutions.
- Monitor and describe the migration timing of adults at dams in the FCRPS, identify potential problems, and evaluate implemented solutions.
- Monitor and evaluate the total dissolved gas (TDG), temperature, turbidity, and flow at projects in the FCRPS relative to performance objectives.

4.2.1.1 Corps Program - TDG Standards & Monitoring (including associated parameters)

The general policies of the Corps related to water quality are summarized in the Corps' *Digest of Water Resources Policies and Authorities, Engineering Pamphlet 1165-2-1*, dated February 1996 (Corps 1996). The Corps policy is to comply with water quality standards to the extent practicable regarding nationwide operation of water resources projects.

In past BiOps, the NMFS water quality strategy was for the Corps to take the actions necessary to implement the spill program at the dams called for in the BiOp, including obtaining TDG variances from appropriate State water quality agencies. These variances would adjust the TDG criteria when "voluntary" spill is required to assist juvenile salmonids transport past Corps projects. Since 1996, the States have provided waivers and rule modifications, and voluntary spill for fish passage has been managed as needed so that TDG levels in the tailraces of projects do not exceed 120 percent, and do not exceed 115 percent in the forebays of any lower Snake River or lower Columbia River dam or at the Camas/Washougal station, as measured by the 12 highest hourly measurements in any calendar day.

Monitoring

The TDG monitoring program will consist of a range of activities designed to provide management information about dissolved gas and spill conditions. These activities will include time-series measurements, data analysis, synthesis and interpretation, and calibration of numerical models. Four broad categories of targets are involved:

- Data acquisition, to provide decision-makers with synthesized and relevant information to control dissolved gas supersaturation on a real-time basis,
- Real-time monitoring, to ascertain how project releases affect water quality relative to ESA BiOp and existing State and Tribal dissolved gas standards;
- Trend monitoring, to identify long-term changes in basin-wide dissolved gas saturation levels resulting from water management decisions; and
- Model refinement, to enhance predictive capability of existing models used to evaluate management targets.

The Corps considers TDG monitoring a high priority activity with considerable potential for adversely affecting reservoir conditions and ongoing regional efforts to protect aquatic biota. It will make all reasonable efforts toward achieving at least a data quality and reliability level comparable to that provided in previous years.

Furthermore, the Corps believes it is important to maintain a two-way communication between those conducting the monitoring and the users of monitoring information. These interactions give decision-makers and managers an understanding of the limitations of monitoring and, at the same time, provide the technical staff with an understanding of what questions should be answered. Therefore, comments and recommendations received from users were, and continue to be, very useful in establishing monitoring program priorities and defining areas requiring special attention.

Actual data collection and transmission will begin in early March at the monitoring stations below Bonneville Dam in conjunction with the Spring Creek Hatchery release. Otherwise, the data collection and transmission will begin no later than 1 April for the entire monitoring network. The exact starting date will be coordinated with the Corps' Reservoir Control Center, project biologists, and cooperating agencies, based on runoff, spill, and fish migration conditions.

The following data will be collected approximately every hour:

- Water Temperature (^oC)
- Barometric Pressure [millimeters (mm) of mercury (Hg)]
- Total Dissolved Gas Pressure (mm of Hg)
- Gauge depth (feet)

Data will be collected at least hourly and transmitted at least every four hours. If feasible, the previous 12 hours of data will also be sent to improve the capability of retrieving any data that may have been lost during the preceding transmission. After decoding, all data will be stored in the Corps' Columbia River Operational Hydromet Management System (CROHMS) database.

Given their direct relevance to fish mortality, the first three parameters (i.e., temperature, barometric pressure, and TDG) will be collected on a first priority basis.

Daily reports summarizing TDG and related information will be posted on the Technical Management Team's (TMT) home page. Information provided on the homepage will include some or all of the following data:

- Station Identifier
- Date and Time of the Probe Readings
- Water Temperature, °C
- Barometric Pressure, mm of Hg
- TDG Pressure, mm of Hg
- Calculated TDG Saturation Percent (percent)
- Project Hourly Spill, in thousand cubic feet per second (kcfs)
- Project Total Hourly Outflow (Total River Flow), in kcfs
- Probe Depth, in feet
- Calculated Compensation Depth, in feet

The Corps Reservoir Control Center staff will perform reconciliation of data received to CROHMS, based on input from the field before the data are permanently stored in the Corps' Water Quality Data Base. Additional data posting in the TMT home page will continue.

Data will be collected at the locations detailed in the *Corps of Engineers Plan of Action for Dissolved Gas Monitoring in 2007*, an appendix to the Water Management Plan.

5. HYDROSYSTEM ACTION EFFECTIVENESS EVALUATIONS

5.1 MONITOR AND EVALUATE THE EFFECTS OF CONFIGURATION AND OPERATION ACTIONS

The Action Agencies will monitor and evaluate the effects of the assorted operations and configurations implemented at projects in the FCRPS. These project evaluations will be conducted following modifications to configurations or operations. For project-specific information on configuration or operational changes, see B.2.1, Hydropower Action.

- Monitor and evaluate the effects of existing spillways, modifications, and operations on smolt survival.
- Monitor and evaluate the effectiveness of traditional juvenile bypass systems and modifications to such, on smolt survival and condition.
- Monitor and evaluate the effectiveness of surface bypass structures and modifications on smolt survival and condition.
- Monitor and evaluate the effectiveness of turbine operations and modifications on smolt survival and condition.
- Monitor and evaluate overall dam passage with respect to modifications at projects.
- Monitor and evaluate the effectiveness of the juvenile fish transportation program and modifications to operations.
- Monitor and evaluate the effects of environmental conditions affecting juvenile fish survival.
- Monitor and evaluate the effectiveness of reducing predation towards improving juvenile fish survival.
- Investigate, evaluate and deploy alternative technologies and methodologies for fish passage and RM&E Actions.
- Determine if actions directed at benefiting juveniles have an unintended effect on migrating adults (e.g., certain spill operations).
- Install and maintain adult PIT-tag detectors in fish ladders at key dams in the FCRPS.
- Install and maintain PIT-tag detectors for use in natal streams and tributaries as appropriate to support more comprehensive and integrated All-H monitoring designs and assessments of stray rates.
- Monitor and evaluate the effects of fish ladder operations and configurations on adult passage rates.

The objective of hydrosystem action effectiveness evaluations is to assess the effects of hydrosystem actions on fish survival and fish condition in a quantitatively rigorous approach. The information developed will be critical for assessing the expected benefits of hydrosystem actions and their relative priority for implementation.

This research requires well-designed experiments, typically with specified treatments, controls and adequate replication. Under this strategy, the Action Agencies expect to implement the Hydropower Action in coordination with other regional Federal, State, and Tribal agencies to achieve effectiveness research that quantifies the effect of hydrosystem fish passage improvement actions on the survival of juvenile and adult anadromous fish.

With respect to the biological sampling units, it is often difficult to separate out the effects of a hydropower action on specific populations, particularly for studies staged at individual dams. Many of the research and monitoring efforts in the hydrosystem will focus on the ESU, as often represented by the population-at-large a mix of hatchery and wild fish (e.g. action effectiveness, impact assessment, system survival). However, where possible, action effectiveness research (AER) projects will attempt to examine fish performance at the major population group (MPG) scale (e.g., juvenile PIT-tag detection, adult PIT-tag detection).

Both the Corps and BPA fund AER projects. All of these studies are designed and conducted under the auspices of the Corps' Anadromous Fish Evaluation Program (AFEP). Details regarding each study can be found on the AFEP and Council websites.

There are two general categories of AER projects, those that assess biological effects of configurations and operations and those that monitor changes in physical or environmental conditions associated with such actions.

5.2 JUVENILE EFFECTS

The following AER projects are those that are associated with construction changes or changes that may be warranted, within the period of the BiOp, for improving juvenile survival through the hydropower system. These reflect actions and evaluations funded by the Corps, primarily under the AFEP. Biological parameters measured for these evaluations typically include passage survival, injury, delay in forebays and tailraces, spill passage efficiency, fish passage efficiency, migrational behavior, and travel times.

5.2.1 Evaluate the Effectiveness of Existing Spillways and Improvements (AFEP)

As a general rule, spillways at most Corps projects provide the highest rates of survival for juvenile salmonids passing these dams. Where exceptions to this rule exist, modifications and evaluations are needed. Studies anticipated at Corps projects over the course of this BiOp include biological evaluations of existing and modified structures including flow deflectors, training walls, guidance devices, and other structure. They also include studies on passage effects, including survival and tailrace egress. Examples include:

Bonneville Dam	Estimate the direct and total effects of per bay discharge and flow deflector submergence on juvenile salmon and steelhead survival and injury.
The Dalles Dam	Estimate the dam and route specific survival rates, fish passage distribution, forebay behavior, tailrace egress, and the direct effects of spillway improvements including an extended spillwall.
McNary Dam	Evaluate the potential to improve the survival of juvenile fish passing the spillway by optimizing egress.
Ice Harbor Dam	Evaluate the spillway for fish passage injuries and evaluate any warranted improvements.

Lower Monumental Evaluate the potential to improve the survival of juvenile fish passing the spillway by identifying limiting factors and evaluate any warranted improvements.

Lower Granite Evaluate the potential to improve the survival of juvenile fish passing the spillway by identifying limiting factors and evaluate any warranted improvements.

5.2.2 Evaluate the Effectiveness of Traditional Juvenile Bypass Systems and Improvements (AFEP)

Traditional juvenile bypass systems typically consist of turbine intake screens, bypass channels, and conduits to transportation systems and/or back to the river. While these systems typically provide reasonably high survival around hydropower projects, exceptions to this rule exist, modifications and evaluations may be needed. Evaluations of bypass systems will likely include assessment of replacement of older facilities, improved bypass outfall locations, and improvements to existing screening systems. Specific examples include:

Bonneville Dam Evaluate Powerhouse 2 (PH2) fish guidance efficiency improvements to verify post-construction performance.

McNary Dam Evaluate the potential to improve the survival of juvenile fish passing through the bypass system by optimizing tailrace egress and evaluate any warranted improvements.

Ice Harbor Dam Evaluate any warranted modifications to turbine intake screens.

Lower Monumental Evaluate an alternative outfall location towards improving juvenile survival.

Little Goose Dam Evaluate an alternative outfall location towards improving juvenile survival.

Lower Granite Dam Evaluate any improvements to, or rehabilitation of, the juvenile fish facility.

5.2.3 Evaluate the Effectiveness of Surface Bypass Structures and Improvements (AFEP)

Surface bypass structures (e.g., sluiceways and RSW) provide juvenile fish with a means to pass around hydropower projects through what are believed to be safe and effective passage routes. Surface collection structures are meant to take advantage of juvenile salmonids surface orientation (top 10 to 20 feet of water) on their downstream migration as opposed to traditional bypass systems and spillways (which typically provide a passage route 50 feet or more from the water's surface).

Project evaluations will estimate project and route specific survival rates, fish passage distribution [e.g., fish passage efficiency (FPE) and spill passage efficiency (SPE)], forebay behavior, and tailrace egress for juvenile fish. Specific examples of action effectiveness research on surface bypass routes include:

Bonneville Dam Evaluate prototype and post-construction performance of Powerhouse 1 (PH1) sluiceway improvements by estimating fish passage efficiency, sluiceway passage efficiency, and sluiceway passage survival.

Estimate fish passage and sluiceway passage efficiency at Powerhouse 2 (PH2) with and without a guidance device (i.e., a trash shear boom) in the forebay.

The Dalles Dam Evaluate the effectiveness of sluiceway entrance improvements on juvenile salmonid passage efficiency.

John Day Dam Support prototype and post construction evaluations of surface flow bypass and tailrace egress improvements.

McNary Dam Evaluate surface passage alternatives as a means to improve the passage survival of juvenile fish.

Ice Harbor Dam Evaluate the RSW for fish passage behavior and injuries and evaluate any warranted improvements.

As warranted, evaluate any follow on actions in the surface bypass plan for juvenile passage improvements.

Lower Monumental Evaluate an RSW for fish passage behavior and injuries and evaluate any warranted improvements (2008 and 2009).

As warranted, evaluate any follow on actions in the surface bypass plan for juvenile passage improvements.

Little Goose Dam Evaluate RSW and associated structures for fish passage behavior and injuries and evaluate any warranted improvements (through 2010).

As warranted, evaluate any follow-on actions in the surface bypass plan for juvenile passage improvements.

Lower Granite Dam As warranted, evaluate any follow-on actions in the surface bypass plan for juvenile passage improvements.

5.2.4 Evaluate the Effectiveness of Turbine Operations and Improvements (AFEP)

Overall, the survival of fish passing through FCRPS turbines appears to be relatively low. However, while the survival of fish through some turbines has been estimated as low as 72 percent, other turbine survival has been estimated as high as 96 percent. The higher observed survival rates demonstrate a potential to significantly improve the survival of fish passing through other similar type turbines. By developing and implementing operational and design improvements, it is not unreasonable to expect that survival rates for fish passing through FCRPS turbines could greatly improve. Furthermore, juvenile salmonids continue to pass through turbines despite considerable efforts to prevent or reduce it.

Continuing evaluations towards understanding and improving turbine survival include:

Systemwide Continue to investigate the effects of turbine pressure cycling on juvenile salmonid survival, and implement improvements if warranted.

	Conduct biological index testing (BIT) at FCRPS powerhouses as warranted as a means of improving turbine operations for fish passage, egress and ultimately, dam passage survival.
Bonneville Dam	Estimate fish survival at PH1 following minimum gap runner replacement work.
Ice Harbor Dam	Conduct studies for support or replacement of Unit 2 existing turbines designed with fish improvement.

5.2.5 Evaluate the Effectiveness of the Juvenile Fish Transportation Program and Improvements to Operations (AFEP)

Until the new BiOp is completed, the Action Agencies will continue the current fish barging program for improved survival of Snake River and Columbia River salmon and steelhead with some modifications. The barging strategy will be adjusted as needed, based on new scientific information. Evaluations of transportation typically include ratios of SAR of transported and in-river migrants, estimates of differential delayed mortality ("D" –value) of transported fish, and other monitoring and evaluating measures.

5.2.5.1 Spring Migrants

An evaluation of weekly SAR rates will be conducted to evaluate and refine the appropriate operation for transportation during the spring season. More precise transportation data in the April time frame for wild yearling Chinook salmon and steelhead is expected to provide clarity regarding the effects of transportation to the portion of the run where data are typically less certain. More precise data in the May time frame should allow for correlation of physical and environmental factors to guide the Action Agencies as to the appropriate triggers of how to operate for transportation on an annual basis towards maximizing adult returns.

Upon complete installation of surface bypass collectors and modified bypass outfalls on the Snake River dams, the Action Agencies propose to conduct an intensive transportation study to evaluate seasonal SARs of bypass and transported wild steelhead and yearling Chinook salmon. The information gained from this research is expected to inform the Action Agencies as to whether constructional and operational changes in the hydrosystem allow for alternative operations for maximizing adult returns.

The Action Agencies propose to perform a bypass and transportation evaluation at Lower Monumental Dam to determine if wild Chinook salmon and steelhead return at higher rates depending on management strategy. This research is expected to inform the Action Agencies on whether transportation or bypass is the preferred management strategy for collected fish at Lower Monumental Dam.

The Action Agencies will continue to fund data collection and reporting for the transportation evaluation at McNary Dam. This research is expected to inform the Action Agencies on whether in-river migration, transportation or bypass is the preferred management strategy for Upper Columbia River Chinook Salmon and Steelhead. Other information gathered could yield a better understanding of whether seasonal or species specific transportation is a reasonable management strategy.

The Action Agencies will continue data collection and reporting for the transportation evaluations for Lower Snake River ESUs. This research is expected to inform the Action Agencies on whether in-river migration or transportation is the preferred management strategy for Snake River Spring/Summer Chinook Salmon and Steelhead. Other information gathered could yield a better understanding of whether seasonal or species specific transportation provides greater adult returns.

The Action Agencies propose to investigate the feasibility of conducting a Snake River Sockeye Salmon transportation study and implement a study if warranted.

The Action Agencies propose to monitor for and identify the potential mechanisms for differential delayed mortality of transported Chinook salmon and steelhead. If any mechanisms are identified, evaluations of operational or constructional alternatives to reduced delayed mortality would be conducted.

The Action Agencies propose to examine the transportation operation to determine if adult returns can be increased by releasing fish from barges at an alternative release site. Releasing fish closer to the estuary under the appropriate environmental conditions may have the potential to reduce predation on smolts, thereby increasing adult returns.

The Action Agencies propose to monitor the homing of adult fish that were transported as juveniles using PIT-tagged fish and adult PIT-tag detectors.

5.2.5.2 Summer Migrants

The Action Agencies propose to conduct a long-term operations evaluation towards determining the appropriate management strategy towards optimizing adult returns for Snake River Fall Chinook Salmon. These intensive RM&E efforts for subyearling Fall Chinook Salmon would occur at least through 2009 and will require specific operations during the study. Major components of this analysis are expected to include evaluating early life history and migration behavior, the performance of hatchery fish as surrogates for wild fish, and investigating the benefits of late season transportation. This may also include tagging production fish as comparisons when both the wild and surrogate groups are tagged. Continuation of RM&E regarding the life history of Fall Chinook Salmon will be important to this effort.

A comprehensive study plan (transportation/in-river migration) for Snake River Fall Chinook Salmon will be developed that addresses the relevant issues associated with the study design, such as the source and numbers of fish to be marked, the analytical methods to be used, the operations to be implemented, and the plan for independent scientific review. This study plan will be developed by October 2007, reflective of the comments received to date in the collaborative process.

5.2.6 Evaluate Environmental Conditions towards Improving Juvenile Fish Survival (AFEP)

Environmental conditions associated with fish passage operations can cause unintended consequences to rearing and migrating fish. Efforts towards reducing mortality or harm due to these include:

Bonneville Dam Investigate the effects of gas super-saturation on emergent chum salmon fry downstream from Bonneville Dam as warranted. There will be continuing evaluations TDG monitoring of chum redds in 2008.

McNary Dam Evaluate alternatives for limiting water temperature extremes in the juvenile bypass system.

5.2.7 Evaluate the Effectiveness of Reducing Predation towards Improving Juvenile Fish Survival (AFEP & BPA)

Predation is an important factor that could be limiting recovery of Columbia Basin salmonids. To improve conditions for listed stocks, the Action Agencies are proposing to:

Avian Predation Determine the effectiveness of Caspian tern management measures implemented to reduce the level of avian predation on salmonid stocks in the Columbia River estuary. Also assess the impact that Caspian terns are having on similar juvenile salmonid populations at alternative locations and determine if the impact is of sufficient concern to consider modification of the proposal to redistribute Caspian terns to those locations. Monitor inland Caspian tern colonies and evaluate the impact of system operations and other factors on avian predation on the juvenile salmon outmigration. Provide information to support a comprehensive management plan for inland avian predation.

Determine the population level of double-crested cormorants and other avian predators in the lower Snake and Columbia rivers, and estuary and the level of their predation on salmonid stocks in the Columbia River. Assess the methods available to manage predator habitat and/or population levels to reduce their level of predation on salmonid stocks. Establish the baseline information required prior to develop a National Environmental Policy Act environmental impact statement (NEPA EIS) concerning management of this species.

Fish Predation The Northern Pikeminnow Management Program is implemented to reduce the level of fish predation on salmonid stocks in the Columbia River System. It also provides for monitoring harvest rates and effects on the pikeminnow population. (See the separate section of the Action on Predation Management RM&E for additional information [Appendix B, Section B.2.6.7].)

5.2.8 Investigate, Evaluate and Deploy Alternative Technologies for Fish Passage and RM&E Actions

To improve the evaluation process and designs of future fish passage facilities, a level of baseline research is often required. The Action Agencies propose to:

- Evaluate the effects of different entrance designs on the behavior of juvenile fish (e.g., The Dalles sluiceway, Bonneville Corner Collector, Ice Harbor RSW, Lower Granite RSW) towards designing consistent and effective surface bypass alternatives.
- Continue to develop the capability to estimate system (Lower Granite Dam to the Columbia River mouth) survival for juvenile salmon and steelhead.
- Continue to develop technologies that will enable lifecycle survival estimates that can be related back to FCRPS migration histories.
- Continue developing potential improvements to juvenile PIT-tag detection systems and alternative technologies associated with high discharge fish passageways (e.g., Bonneville Corner Collector, spillways and turbines) and tributaries.

5.3 ADULT PASSAGE EFFECTS

While adult survival through the hydrosystem is consistently high, some areas exist for improving delay.

Bonneville Dam Document the spatial and temporal distribution of sea lion predation attempts, estimate predation rates, and estimate overall sea lion abundance in order to assess the effects of a combination of deterrent actions (e.g., exclusion gates, acoustics, and/or harassment) and their timing of application on spring runs of anadromous fish passing Bonneville Dam (AFEP).

Evaluate effectiveness of running PH2 corner collector for steelhead kelt downstream passage during winter months, first by investigating fallback records through the juvenile bypass system and, if warranted, by evaluations with PH2 corner collector operating in March (AFEP).

John Day Dam

Where warranted, assess the effects of juvenile fish passage improvements on adult salmon and steelhead passage times and fallback rates (AFEP).

Evaluate the effects of adult ladder improvements on adult fish passage times and ladder use (AFEP).

Where warranted, assess the effects of juvenile fish passage improvements on adult salmon and steelhead passage times and fallback rates (AFEP).

Systemwide

Evaluate the potential for using surface flow bypass routes to reduce adult steelhead fallback through turbines. Results from radio-telemetry studies indicate that during winter, steelhead from most metapopulations moved up- and downstream past dams, temporarily used non-natal tributaries, hold for widely varying lengths of time, and were in mixed-stock assemblages at locations throughout the monitored area. Later arriving fish, mainly B-run Snake River steelhead, were more likely to overwinter in the hydrosystem than earlier migrants. Results also suggest that steelhead that fall back through a FCRPS dam have reduced survival compared to steelhead that do not fall back: overall, 21 percent of the successful overwintering fish fell back at least once after 1 January while nearly three times as many (60 percent) of the unsuccessful fish that met the researchers' overwintering criteria fell back. Fallback behavior at dams occurred throughout the winter study period, with larger numbers of fish falling back at all dams in November and again in March-April when upstream migration resumed. Results also suggest winter mortality in the FCRPS may be disproportionately high for Snake River B-run steelhead populations.

Studies of adult downstream passage in the presence of a surface route show significant reductions in delay associated with forebay residence times. Adult steelhead survival through sluiceways and other surface bypass routes is hypothesized to be higher than through turbines. Turbine passage, the primary route during winter periods, may be a causative mechanism for many unsuccessful steelhead overwintering migrants. An evaluation of The Dalles Dam sluiceway during November – December 15, and March – April to evaluate overwintering steelhead use of these routes relative to turbine passage will be conducted in 2008-2009.

Further develop the adult PIT-tag system to interrogate adult passage in natal streams and tributaries. This will allow for further enumeration of pre-spawning mortality, straying rates, and reduced spawning success of adult upstream migrating fish, which may be due to or exacerbated by passage through the FCRPS hydropower projects. If measures are identified which will reduce the pre-spawning mortality rate or straying, the Action Agencies will implement these measures, as warranted (AFEP/BPA).

Evaluate the effects of changes in fish ladder temperatures to determine if modifications are needed to decrease temperature differences within the fishway (AFEP).

Report on water temperature effects on adult salmonids between McNary Dam and the confluence of the Clearwater River (AFEP).

Adult telemetry evaluation to help identify factors that contribute to successful spawning or unaccounted loss continued in 2004. Data analysis is scheduled through 2005 and the final report will be available in 2006. PIT-tag evaluations are planned for future years. Spawning success evaluations are planned into 2008.

5.4 CRITICAL UNCERTAINTY RESEARCH

5.4.1 Investigate Critical Uncertainties

The Action Agencies will fund research directed at resolving critical uncertainties that are pivotal in lifecycle model analyses. These proposed actions include:

- Investigate and quantify delayed differential effects (D-value) associated with the transportation of smolts in the FCRPS as needed.
- Investigate the post-Bonneville mortality effect of changes in fish arrival timing and transportation to below Bonneville.
- Conduct a workshop every other year with members of the Independent Scientific Advisory Board (ISAB) to review current research and monitoring approaches on post Bonneville mortality for transported and non-transported fish.
- Investigate, describe and quantify key characteristics of the early life history of Snake River Fall Chinook in the mainstem Snake, Columbia and Clearwater rivers.
- Investigate effects of adult passage experience in the FCRPS on pre-spawning mortality.

The Action Agencies, NMFS, and State and Tribal fishery agencies have identified several topics of critical uncertainty that are deemed to require resolution through targeted research. Many of these are reflected in the management questions appearing near the beginning of this plan. These are broad issues that span the system and are not locally focused like the AER actions.

There are four topic categories of critical uncertainty research, as the bullets indicate. These categories are considered to be critical because either passage model or lifecycle model analyses are very sensitive to these parameters, or our ability to accurately quantify these parameters is deficient. Thus, there is a critical need for targeted research on these topics.

- **Delayed Differential Effects Associated With Transportation (D-value) -**What is the magnitude of delayed effects associated with transporting smolts? Can in-river passage provide greater adult return rates than transporting smolts, and under what passage conditions? Determine if subyearling Snake River Fall Chinook Salmon benefit from being transported when spill is provided. Determine mechanisms of differential delayed mortality of transported fish (D-value). This may include evaluations of ocean entry timing, physiological assessments, and transportation of stocks separately. This action is being considered in the critical uncertainties section because of the implications of the varied life history of Snake River Fall Chinook Salmon.

- **Post-Bonneville Survival Effects Associated With In-River Passage Through The FCRPS (L-value) -** Do smolts migrating through the FCRPS incur effects that are manifested as mortality later in the lifecycle, and what is the magnitude of such effects? What are the causes of such effects, and to what extent can they be rectified by altering operations? Projects that attempt to estimate post-Bonneville survival of smolts having migrated through the FCRPS may contribute to resolving this issue.
- **Early Life History of Snake River Fall Chinook Salmon -** The complex life history patterns exhibited by this ESU have thwarted attempts to estimate system survival and hydrosystem impacts in general. An ongoing research effort by USFWS continues to reveal new information that will clarify important processes affecting this ESU.
- **Effects of Passage on Pre-spawning Mortality -** Some agencies have raised concerns that adults migrating through the FCRPS may be encountering conditions that exacerbate pre-spawning mortality, which would be expressed in the tributaries. Thus far, limited radiotelemetry investigations have been conducted. PIT-tag evaluations are planned for future years. Spawning success evaluations are planned into 2008.

5.4.2 Delayed Effects Associated with Transport (D-value) and In-River Passage (L-value)

These two research topics address issues regarding the existence, magnitude and mechanisms affecting delayed effects associated with smolt passage through or around the FCRPS. Uncertainty regarding the existence and magnitude of delayed or latent mortality has been a critical uncertainty in past FCRPS BiOps and was a significant topic of discussion within the BiOp Remand Collaboration Process.

The uncertainty associated with these issues is so acute that no less than eight regional hypotheses now characterize our interpretation of limited and confounding information on these matters. These hypotheses were posed through Collaboration Process Workgroups and were submitted by the Policy Working Group to the ISAB for review. Briefly, the hypotheses are:

1. Latent mortality associated with in-river migration (L-value) is a function of water travel time (surrogate for migration speed) for wild yearling Snake River Chinook Salmon.
2. Latent mortality associated with in-river migration is a function of arrival timing at Bonneville Dam for wild yearling Snake River Chinook Salmon.
3. The four Snake River dams cause latent mortality of in-river migrants averaging 59-64 percent for wild yearling Snake River Chinook Salmon.
4. Latent mortality of in-river migrants is low, confounded and unquantifiable for wild yearling Snake River Chinook Salmon.
5. Delayed effects associated with transporting smolts (D-value) as reflected in historical estimates is driven by climate processes largely manifested in the marine environment.
6. Delayed effects associated with transporting smolts can be estimated from existing data by accounting for sampling error, for wild yearling Snake River Chinook Salmon and Steelhead.
7. Delayed effects associated with transporting smolts are a function of arrival date in the estuary.
8. Delayed effects associated with transporting smolts vary throughout the season for wild yearling Snake River Chinook Salmon.

The ISAB Latent Mortality Report (April 6, 2007) review of these hypotheses concluded that:

- The hydrosystem causes some fish to experience latent mortality, but strongly advises against continuing to try to measure absolute latent mortality. Latent mortality relative to a no dam reference is not measurable due to numerous confounding factors.
- Research should focus on estimating total post-Bonneville mortality for in-river migrants and transported fish, which is the critical management issue for recovery of listed salmonids. Efforts would be better expended on quantifying these total effects, which can be measured directly.
- More effort should be put into monitoring and estimation of processes that can be measured directly and used to inform modeling estimates and relationships for post-Bonneville mortality.

Several research projects currently attempt to resolve the strengths and weaknesses of these hypotheses. Research projects that either are providing, or will provide, data and analyses to address these delayed mortality hypotheses are identified in Table 1 of Attachment B.2.6-1. Some of these projects have been in place for several years, and the studies address a broad range of issues. However, the collective information obtained to date has not yet been synthesized.

The Action Agencies propose that a workshop be held within 12 months of BiOp completion (and every other year thereafter) to collate and synthesize the new information and review the need and direction of current research in light of the ISAB review. The purpose of the workshop will be to determine if the collective research can resolve the hypotheses posed above, what modifications to the research may be warranted, and what additional research may be needed. This can help inform decisions regarding the fate of existing studies, and/or the need for new refocused research efforts. The workshop should include not only results from the research projects listed here, but relevant analyses from other investigators (e.g., the NMFS analyses depicting the linkage between latent mortality and the timing of smolt arrival in the estuary).

We expect that results from the workshop will also assist in more clearly identifying PIT-tagging and hydropower acoustic needs for wild and hatchery stocks that could be used in future latent mortality and transport evaluations. Of particular interest are population (MPG) coverage, sample size requirements, and supporting rationale based on a sound analytical framework.

5.4.3 Snake River Fall Chinook Salmon Investigations

At least two studies focus directly on early life history and transport effects on Snake River Fall Chinook Salmon. These studies are critical for formulating effective management strategies for this ESU. Unfortunately the transport evaluation has been postponed for 2007, and will be implemented in 2008. Without this information, it will be impossible to determine whether transport or in-river passage with spill, or some combination will maximize survival. No model analyses can resolve this matter with existing data.

5.4.4 Pre-Spawning Mortality

Studies to assess the effects of FCRPS migration on adult salmon reproductive success have been ongoing since 2000. A radio-telemetry evaluation was recently completed, and results are forthcoming. In addition to radio-telemetry, South Fork Salmon River juvenile spring Chinook salmon were PIT-tagged in 2003, 2004, and 2005, to be able to evaluate potential effects of different FCRPS migration histories on the survival and reproductive fitness of known source adults returning from these tagged groups.

6. IMPLEMENTATION AND COMPLIANCE MONITORING

The Action Agencies will prepare implementation plans to document our specific strategies, priorities, actions, measurable targets, and timetables. In these plans, the Action Agencies will identify ESU-specific actions. BPA will maintain a BiOp database to provide project and action level detail for planning and reporting purposes. This approach will be efficient and provide the most up-to-date information about the status of actions and projects being implemented.

Implementation plans will identify responsibilities specific to the Action Agencies and will serve to coordinate agency efforts with other appropriate regional processes. Those efforts will typically include coordination due to a statutory obligation for the Federal government (BPA/Council), voluntary coordination among Federal agencies (Federal Caucus), and coordination committed to under this FCRPS Biological Assessment (BA) and subsequent BiOp. Some of the Federal/non-Federal agencies and forums currently included in coordination activities include; TMT, System Configuration Team, Northwest Environmental Data-Network, and Pacific Northwest Aquatic Monitoring Partnership.

6.1 PROGRESS REPORTING

The BPA will use the project-level detail contained in the BiOp database to track results and assess our progress in meeting programmatic level performance standards. We will track overall population performance through annual reports of adult abundance and trends in adult abundance for ESA-listed ESUs. The results of the progress reports will inform adjustments in future year plans through adaptive management.

The Action Agencies will prepare annual progress reports based on our implementation plans. Hydropower Action specifies anticipates dates for implementation of certain actions that are important steps toward achieving performance standards. The Action Agencies consider those dates to be benchmarks for implementation and will report on the status of achievement of these benchmarks in the annual progress report

The Action Agencies will prepare a comprehensive programmatic evaluation of progress after 2012 and 2015. These check-in reports will also serve as the annual progress report for the year in which they are presented. Comprehensive evaluation reports will summarize cumulative accomplishments over the relevant time period, review survival and fish return status, propose corrective actions where we are off track, and address key variables, new research, and monitoring and evaluation results.

7. COORDINATION

The Corps RM&E activities are coordinated in the following manner with the agencies indicated.

7.1 ANADROMOUS FISH EVALUATION PROGRAM COORDINATION

Coordination with regional fish agencies and tribes has always been a key component of the Corps' fish passage program, including the AFEP. The Corps conducts technical coordination through three interagency work groups including the Fish Facility Design Review Workgroup, Studies Review Workgroup, and the Fish Passage Operations and Maintenance Workgroup. Primary work group participants include fish passage specialists with the Idaho, Oregon, and Washington fish and wildlife/game departments, the CRITFC, NMFS, USFWS, BPA, and the Council. Meetings are open to any interested participants and the work group mailing lists include a wide array of entities and persons interested in Columbia basin fish restoration.

7.1.1 Studies Review Work Group

RM&E studies are developed and reviewed by the Studies Review Work Group (SRWG). The Corps works with SRWG participants to develop study targets. The group then reviews draft proposals and reports within the technical areas of the AFEP. These include: surface bypass, transportation, conventional bypass systems, in-river passage (spill, gas, and reach survival), adult fish migration, and turbine passage. The coordination schedule for AFEP studies features SRWG meetings and review between February and January to accomplish study development tasks (Table 3).

7.1.2 Fish Facility Design Review Work Group

The Fish Facilities Design Review Work Group provides input to engineering and design of fish facility modifications and new passage technologies. Participants review new or modified facilities from concept through engineering, design, and construction phases. Review emphasis is on application of biological criteria and impacts of structures and their operation on fish behavior, condition, and survival.

Table 3. Typical Annual SRWG Program Schedule

SRWG sub-group meetings	February-April
Send out research summaries to SRWG	May
Research summary review meeting	Early June
Final comments research summaries	Late June
Requests for pre-proposals	Late June
Preliminary proposals due	July
Distribute pre-proposals to region	August
SRWG preliminary proposal review	Late August
Final comments due	September
Revise proposals	October
Final proposals out for review	October
Annual research review	November
Final proposal review	Late November
Briefing on funded proposals	January

7.1.3 Fish Passage Operations and Maintenance Work Group

The Fish Passage Operations and Maintenance (FPOM) Technical Committee provides input on ongoing project operations issues. This includes any fish passage problems that may arise at the projects during the passage season. The group comments on the adult fish counting program, outage schedules for turbines and fishways, and special operations required to conduct AFEP studies or other needs. The FPOM also reviews the Corps' annual Fish Passage Plan. This document describes fish facility and project operating criteria that will be in effect in a particular year to provide acceptable passage conditions.

The SRWG and FPOM meetings are chaired jointly by the Corps Portland and Walla Walla Districts. Meetings held by the Fish Facilities Design Review Work Group are hosted separately by the two Districts due to the group's workload. Recommendations and decisions are documented in meeting minutes. Action items are implemented by District staffs or by other participants, as appropriate.

7.1.4 Relation to Regional Forum Groups

The Regional Forum process has been developed since 1995 by NMFS and other regional entities to implement ESA provisions for protection and recovery of listed salmon species. Members of the Regional Forum include:

- State and Tribal sovereigns with management authority over fish and wildlife resources and water quality in the Columbia River Basin, including Alaska;
- Federal agencies with regulatory or action authority in the Columbia River, including NMFS, USFWS, BPA, Corps, the U.S. Environmental Protection Agency (EPA), and Reclamation;
- Northwest Power and Conservation Council; and
- Idaho Power Company and the Mid-Columbia Public Utility Districts

The Regional Forum consists of several workgroups. One of these groups, the SCT, prioritizes and recommends to the Corps elements of the Columbia River Fish Mitigation (CRFM) Plan for implementation. Those CRFM items that require biological studies become priority areas of investigation for AFEP. These priorities are used by the technical coordination groups to recommend AFEP study objectives. Most disagreements or issues concerning varying points of view and interpretations of technical information are resolved in the work groups. Any unresolved issues are brought to Regional Forum groups for further discussion and resolution. Updates of SRWG and Fish Facilities Design Review Work Group activities are provided to SCT.

The SCT addresses issues that are not resolved in the technical coordination groups. Issues or disputes not resolved by SCT are forwarded to the Implementation Team (IT) for resolution. If the IT is unable to agree on a course of action, the matter may be referred to the Executive Committee for a recommendation. Regardless of how far the disputes are elevated, the Corps' Northwestern Division Commander is responsible to make the final decision based on recommendations that emerge from the Regional Forum process.

7.2 COUNCIL COLUMBIA RIVER BASIN FISH AND WILDLIFE PROGRAM

BPA-funded RM&E activities are coordinated under the auspices of the Council's Columbia River Basin Fish and Wildlife Program.

8. DATA MANAGEMENT

Data sets that are required to execute the monitoring program called for in this plan are housed in database systems at several agencies. Source sites are listed here:

Adult Passage

- Adult counts at dams by species (Corps, Northwestern Division)
- PIT-tagged fish detected at dams (Pacific States Marine Fisheries Commission

Juvenile Passage

- PIT-tag release and detection data (Pacific States Marine Fisheries Commission)
- Smolt counts and indices: dams, transportation, passage (Corps and Fish Passage Center)

Environmental Data and River Conditions

- River Environment: flow, spill (Corps, Northwestern Division)
- Water Quality: temperature, TDG, turbidity (Corps, Northwestern Division)

In addition to these source sites, there are other data management sites that compile and synthesize the source information and calculate a variety of passage estimates that characterize fish passage performance (e.g., adult conversion rates, smolt travel time, and transport percentages). Those sites currently include database systems at the Fish Passage Center, Battelle Pacific Northwest Laboratories, Streamnet, and the University of Washington.

Most estimates calculated as part of status monitoring are archived in one or more of these locations. However, some critical data sets are currently held officially by NMFS. These include historical estimates of smolt system survival (in-river and combined with transport), and the latest dam configuration passage and survival estimates. Both are pivotal, because they are fundamental components for calibrating and configuring passage models used by the region. We propose that these estimates be archived on one or more of the regional database systems, to permit easy examination of that information.

Annex 1 - Definition of Performance Metrics

PASSAGE METRICS

- **Spillway Passage Efficiency (SPE):** The number of fish passing a dam through the spillway divided by the total number of fish passing the dam through all available routes.

- **Fish Passage Efficiency (FPE):** The number of fish passing a dam through any non-turbine route divided by the total number of fish passing the dam through all available routes.

- **Fish Guidance Efficiency (FGE):** The number of fish that enter a turbine intake and are subsequently guided by screens into a bypass system divided by the total number of fish passing into the turbine intake.

- **Sluiceway Passage Efficiency (SLPE):** The number of fish passing the powerhouse through an ice and trash sluiceway divided by the total number of fish passing the powerhouse.

- **Surface Bypass Efficiency (SBE):** The number of fish passing through a surface flow route (RSW, TSW, etc) divided by all fish passing through the dam area where the surface route is located. (e.g. spillway for the Ice Harbor RSW and Bonneville second powerhouse for the corner collector)

- **RSW Efficiency (RPE):** The number of fish passing through a removable spillway weir (or other surface flow route?) divided by the total number of fish passing the dam through all available routes.

- **Spill Effectiveness (SE):** The ratio of the proportion of fish passing through the spillway to the proportion of water being spilled.

- **RSW Effectiveness (RE)**: The ratio of the proportion of fish passing through a surface flow route to the proportion of water passing through the same route.

- **Route Effectiveness**: The ratio of the proportion of fish passing through a given route (i.e. spill, RSW, sluiceway etc...) to the proportion of water passing through the same route.

TIMING METRICS

- **Forebay Residence Time:** The elapsed time from first detection on arrays established at the upstream limit of the boat restricted zone (BRZ) to the time of passage at the dam.

- **Tailrace Residence/Egress Time:** The elapsed time from passage at a given route to last detection on a line established at the tailrace BRZ line.
  - Bypass fish (JBS, Sluiceway, or Surface Bypass routes): the start time for this calculation should be the time closest to exit from the outfall pipe.
  - Turbine fish: start time for this calculation should be the last detection on the turbine intake screen if draft tube detection not in place.
  - Spillway fish: start time for this calculation should be the last detection on underwater spillbay antennas.

- **Spillway Passage Time:** Last detection on an underwater antenna or underwater detection array at the spillway.

- **Turbine Passage Time:** First detection time on an underwater antenna or detection array within the turbine intake a fish chooses for passage (if detection array outside and upstream of intake, should use last detection time.

- **Bypass Passage Time:** First detection time on an underwater antenna or detection array within the turbine intake that a fish chosses for passage (if detection array outside and upstream of an intake, should use last detection time).

SURVIVAL PARAMETERS

- **System Survival (COMPASS):** The probability of a fish surviving from Lower Granite Dam to Bonneville tailrace (Snake River ESUs), from the confluence of the Snake and Columbia rivers to the Bonneville tailrace (upper Columbia River ESUs), or from point of entry into the Columbia to below Bonneville Dam (mid-Columbia River stocks) for both in-river and transported fish, where appropriate.

- **Project Survival:** The probability of survival from the head of the reservoir of a given dam (e.g. tailrace of upstream dam or end of "free flowing section"), through the forebay, dam, and immediate tailrace to the downstream tailrace BRZ) of the dam in question.

- **Dam Survival:** As defined in the Proposed RPA, means from, at, or within the route of passage to the release point of the control fish in the tailrace. (*This definition differs somewhat from what was reported in Peven et al. 2005 where "Dam Survival" was designated as the survival of the fish going through the combined passage routes of the dam, as defined by the forebay through the tailrace. However, the Action Agencies definition aligns more closely with NOAA's definition of "Concrete Survival"*

- **Passage-Route Survival:** The probability of survival for fish passing through an individual route to the release location of a tailrace reference group (downstream tailrace BRZ).

- **Concrete Survival:** The combined probability of passage-route survival for available routes of passage weighted by the probability of passage through each that route i.e. (S_{Spill} x P_{Spill}) + (S_{Bypass} x P_{Bypass}) + ($S_{Turbine}$ x $P_{Turbine}$)
  - S = Probability of Survival
  - P = Probability of Passage

- **Forebay Survival:** The probability of survival from first detection on the forebay entrance line to passage at the project. (*using current methods this is not possible to estimate directly because a mortality event can occur simultaneously or after detection, therefore, this parameter must be "inferred" as Dam Survival – Concrete Survival, each as defined above*)

- **BRZ to BRZ Survival:** The combined probability of first detection on forebay entrance line (near upstream BRZ) to controlled release site near downstream BRZ.

Attachment B.2.6-3
Tributary Habitat Research, Monitoring, and Evaluation Action

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ACRONYMS

AEF	action effectiveness research
BACI	before-after, control-impact
BiOp	Biological Opinion
EMAP	Environmental Monitoring and Assessment Program
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FCRPS	Federal Columbia River Power System
FY	fiscal year
GIS	geographic information system
IMW	Intensely Monitored Watershed
ISEMP	Integrated Status and Effectiveness Monitoring Project
MOU	Memorandum of Understanding
NED	Northwest Environmental Data
PNAMP	Pacific Northwest Aquatic Monitoring Program
RM&E	research, monitoring, and evaluation

1. INTRODUCTION

This attachment to the Research, Monitoring, and Evaluation (RM&E) Action provides additional details regarding monitoring and evaluation that will be implemented to answer key management questions regarding the achievement of tributary habitat performance standards/targets, identification and understanding of habitat-related limiting factors, and the effectiveness of Habitat Actions. Performance metrics, monitoring approaches, and proposed actions needed to answer these management questions are identified, along with the associated proposed actions needed for tracking implementation of tributary habitat projects, coordination of these research and monitoring actions with regional agencies, and management of tributary habitat data.

RM&E has been a key component of past and ongoing evaluations of actions to improve survival for Endangered Species Act (ESA)-listed salmon and steelhead in the Columbia River Basin. The Action Agencies are committed to a continuation of this process for the forthcoming Biological Opinion (BiOp). This attachment describes the approach to the proposed action for tributary habitat RM&E. It involves the following sections:

- Management Questions
- Performance Measures
- Monitoring Precepts
- Action Monitoring Approaches
- Problems with Ideal Monitoring Approaches
- Monitoring Approach
- Importance of Habitat Models
- Confounding Hatchery or Harvest Effects
- Tributary Habitat RM&E Actions
- Project Implementation and Compliance Monitoring
- RM&E Coordination and Data Management

2. MANAGEMENT QUESTIONS

The following are the primary management questions with respect to Tributary Habitat Actions. The RM&E actions described in this section are focused on providing information needed to answer these questions to support ongoing and adaptive management decisions relative to the RM&E Action for the Federal Columbia River Power System (FCRPS).

1. Are Tributary Habitat Actions achieving the expected performance standards and targets?
2. What are the relationships between Tributary Habitat Actions and fish survival or productivity increases?
3. What actions are most effective?
4. What are the limiting factors or threats preventing the achievement of desired habitat or fish performance objectives?

Answers to these questions will require a combination of status monitoring, action effectiveness research, critical uncertainty research, and project implementation, and compliance monitoring.

3. PERFORMANCE MEASURES

The Action Agencies have identified performance measures that will be monitored and evaluated relative to performance *standards* (benchmarks) and performance *targets* (longer-term goals) to assess progress and inform adaptive management actions. There are two general categories of performance measures with associated monitoring requirements:

- Programmatic (i.e., project tracking)
- Biological and Environmental (i.e., survival, habitat conditions)

The programmatic performance measures are tracked through project implementation and compliance monitoring. The Biological and Environmental performance measures are tracked and evaluated through status monitoring, action effectiveness research (AEF) and critical uncertainty research in combination with existing and developing quantitative models.

Performance *standards* are monitored frequently to insure accountability and adherence to proposed actions. They have potential contingencies or other time critical corrective actions that may be associated with them. Performance *targets* are evaluated over longer time periods as new information and learning is applied through analytical models to check for progress toward expected life stage survival improvements and trends in population performance. Performance targets inform longer term adaptive management decisions and prioritization of options across populations with different relative needs.

Survival and productivity benefits for Tributary Habitat Actions that are expected to be implemented from 2007 to 2017 have been estimated for individual populations and used within the Biological Assessment. These estimated benefits provide performance targets for 2017 for individual populations and their habitats, and identify benefits estimated after 2017 for some types of habitat projects that can accrue benefits over decades (e.g., riparian enhancement projects). (See Appendix C of the Comprehensive Analysis for more information on the method of estimating benefits of Habitat Actions.)

Performance standards have been set for annual tracking of project implementation (linked to expected changes in limiting factors and their habitat) projected for the periods fiscal year (FY) 2007 to 2009 and for FY 2010-2017, which were used to estimate the long-term benefits. RM&E will be used to confirm and improve our understanding of the relationships between different habitat actions, the environment, and the habitat performance measures. As this information is developed and relationships and models are updated, the Action Agencies will re-confirm the modeling estimates of expected improvements associated with actions. Specific tributary habitat performance standards, contingencies, and performance targets, and their relation to the broader proposed action are identified in more detail in Section B.2.7.

The Action Agencies are using a modeling approach to estimate the benefits of actions at both individual projects and collective project levels. The models are based on the relationships between habitat and the performance measures. Appendix C of the Comprehensive Analysis provides information on models and analytical tools that were used to estimate benefits and performance measures for the Biological Assessment and proposed action. As we collect new information about the effects of our actions, we will use the monitoring data to improve our models of the habitat and fish relationships and improve the model performance, both in our ability to predict at multiple scales and with higher certainty. Thus, the monitoring and modeling strategy will adapt as new information is obtained.

4. MONITORING PRECEPTS

Past monitoring activities have taught us much about monitoring Tributary Habitat Actions. Some of the most important lessons learned include:

- Research and monitoring should support a decision framework (evaluation) that is adaptive. The adaptive management strategy should start with a set of management questions and performance measures.
- Since all tributary habitat projects cannot be monitored due to time and cost constraints, an analytical process and models are needed to support the decision framework. Models used should provide the most accurate predictions and be the most transparent to the users and decision makers. The model outputs are the data metrics associated with the performance measures. The data inputs to the models then help define the field data collection.
- Status and trend monitoring of fish populations (juvenile and adult) and habitat conditions are useful to establish baseline conditions and to develop a reference for large-scale, long-term patterns that may confound population-scale analyses of habitat restoration effects.
- Population-level responses to Tributary Habitat Actions can only be detected at the appropriate spatial and temporal scales. Measurements of the effects of restoration actions may occur at multiple spatial and temporal scales, but the monitoring program should be designed ultimately to evaluate responses at the population scale, or at least the scale of major life-history components, and over multiple years or generations.
- Individual habitat actions generally do not directly impact population processes. Their direct effects are to modify physical or biological habitat condition. Therefore, responses of individual habitat actions are most easily detected at the scale of the action (i.e., reach or habitat unit scale).
- For populations that may be affected by hatchery programs or modifications to those programs, the evaluation and monitoring approach must take these effects into account and appropriately integrate them into the study design.

Given these precepts, one should be able to develop valid approaches to monitoring the effects of Tributary Habitat Actions can be developed.

5. PROBLEMS WITH IDEAL MONITORING APPROACHES

In general, the basic before-after, control-impact (BACI) design provides a foundation for monitoring the effects of Tributary Habitat Actions on population productivity and distribution. The validity of the basic BACI design can be extended by including sampling at multiple Control and Impact locations on multiple occasions during the Before and After period (MBACI). Better yet, the certainty of inferences may be further improved by establishing several pairs of Control and Impact locations that are sampled on multiple occasions during the Before and After period [MBACI(P)]. The intent of these designs is to reduce the likelihood of alternative explanations for differences seen in treatment and control locations. These designs, if implemented correctly, include the four essential ingredients of an ideal design: randomization, replication, controls, and independence.

The “ideal” design is rarely, if ever, feasible at the population scale because of losses of control and/or treatment areas, spatial arrangements of populations, lack of randomization, lack of independence, the nature of variables measured, and institutional and economic arrangements. BACI-type designs require institutional control over the time and place of implementation of treatments and the selection and preservation of control areas. This is rarely feasible at the scale of populations. In reality, controlling social, economic, and political arrangements at the scale of populations is very difficult and the lack of experimental control often results in treatments being implemented at different times and intensities, and control areas being treated (loss of independence). Maintaining control populations for comparison with treated populations for long periods of time is very difficult institutionally.

In addition, some performance measures, such as fish abundance, biomass, and productivity are quite variable in space and time. Variability in fish metrics may result from different seeding levels (recruitment) and density-dependent factors that can be independent of habitat conditions. Large variability in fish metrics makes it difficult to assess effects of Tributary Habitat Actions on population productivity.

Given the problems associated with implementing BACI-type designs at the scale of populations, alternative approaches are needed. Although these alternatives do not provide the level of certainty of inference that attends MBACI or MBACI(P) designs, the alternatives may demonstrate causation at the population scale if implemented correctly.

6. MONITORING APPROACH

The Action Agencies plan to undertake the following four primary approaches to assess habitat treatment effects on population productivity and distribution:

- ***Intensively Monitored Watershed (Single Habitat Type)***—This Intensely Monitored Watershed (IMW) approach involves the implementation of a single habitat action type in a population-scale area. The treated area is matched with a control population-scale area. Effects of a specific action type are assessed through monitoring population productivity in a treatment-control or intervention-analysis context.
- ***Status/Trend Monitoring***—Status/trend monitoring of population productivity and habitat condition is a long-term effort (decades) that assesses effects of habitat actions through correlation of productivity change to habitat condition and action reporting. Status/trend monitoring provides higher certainty of inference if before-after data are collected at the population scale and physical and biological effects are measured at the reach or habitat scale.
- ***Project-based Monitoring***—Project-based monitoring includes measuring physical and biological effects of individual habitat actions at a reach or habitat scale. Because this type of monitoring does not directly measure the effects of habitat actions on the population, status/trend monitoring should be used to assess possible changes at the scale of the population. Effects of individual actions are assessed through extrapolation of action influence and modeled connection of habitat condition to population processes.
- ***Watershed-scale Monitoring***—This approach is similar to IMWs, but is implemented at a sub-population scale (a watershed scale smaller than the geographic area of the population). As with IMWs, this approach may include multiple habitat action types or single action types. Because watershed-scale monitoring does not directly measure the effects of habitat actions on the population, status/trend monitoring should be used to assess possible changes at the scale of the population.
- ***Intensively Monitored Watersheds (Multiple Habitat Types)***—This IMW approach involves the implementation of multiple habitat action types in a population-scale area. The treated area is matched with a control population-scale area. Cumulative effects of the actions are assessed through monitoring population productivity in a treatment-control or intervention-analysis context. This approach cannot by itself separate the effects of individual habitat action types on population productivity.

- Both IMW approaches provide inferences at the population scale; however, only the IMW (single habitat action type) can assess the effects of specific habitat types on population productivity. The lack of spatial replication and randomization limits the certainty of inferences of IMWs. In addition, they require long-term institutional control, which means that relatively few of these can be implemented successfully.

These monitoring approaches lie along a gradient of inferential certainty from relatively weak to relatively strong (Table 1). IMWs provide more inferential certainty than do the other approaches, because IMWs are design-based at the population scale. That is, inferences from IMWs are based on the design rather than model assumptions. However, the lack of randomization and replication of IMWs may not allow their results to be easily generalized to other populations. Inference is made by virtue of a study design, a modeling process, or both. The approach may be mechanistic or merely associative, and it varies by spatial and temporal scale.

The status/trend, project-based, and watershed-scale approaches rely more on correlative data to try and make a case for causal inference. Correlation is used to rule out alternative hypotheses (note that we make our case as much if not more by disproving plausible alternatives as we do by showing that the data are consistent with a hypothesis). Although these approaches may allow robust inferences at small spatial scales (scales smaller than the population), inferences at the population scale are usually inferred from correlation. The following criteria are often used to demonstrate causation from correlative association approaches:

- *Strength of Association -*Measures the size of the change in performance measures associated with the incidence of treatments. In some respects, this is similar to gradient analysis. One can compare the percentage difference in average value of performance measures at locations that received treatments to those that did not.
- *Consistency of Association -*An association between performance measures and the treatment that is observed many times provides higher confidence than if no such consistency is observed.
- *Specificity of Association -*The association is only seen in the presence of the treatment (i.e., an observed change in the performance measures occurs after the onset of the treatment).

Table 1. Intrinsic and Extrinsic Constraints on Methods to Determine Population Scale Biological Effect of Tributary Habitat Restoration Actions

Monitoring Approach	Scale		Type of Inference		Certainty of Cause-and-Effect at Population Scale	Identify Mechanism (Action specific)	Sensitivity to Institutional Control	Notes
	Spatial	**Temporal**	**Design Based (Test/Control)**	**Model Based (Correlational)**				
Status/Trend	Large (population, MPG, ESU)	Long (decades)	No	Yes	Low-Moderate	No	Low	Confounded by lack of controls, replicates, and multiple treatments
Bottom-Up (Project-based)	Small (but scaled to population indirectly)	Long (decades)	Yes at small scale. No at population scale.	No at small scale. Yes at population scale.	Low-Moderate	Yes at small scale. No at population scale.	Medium at small scale. Low at population scale.	Low priority, cheap, and does not provide population level answers
Top-Down (Watershed scale)	Watershed-Population	Short-Moderate	Yes at all scales.	No	High	Yes at small scale. No at population scale.	High	Confounded with multiple treatments, rare opportunities
IMW (with one or many action types)	Watershed-Population	Short	Yes at all scales.	No	High	Yes at all scales for one action. No at population scale for many actions	High	Difficult to implement, rare opportunities

- Temporality - If the treatment causes some change, then the change must follow the onset of the treatment. Temporality is a particularly useful criterion, because it has the potential to discard explanations – either the treatment explanation or alternative ones.
- Biological or Ecological Gradient - If one can observe a distinct increase in the magnitude of effect with increasing intensity of the treatment, then there is further evidence of causality.

Given the uncertainty of maintaining the integrity of robust monitoring designs (e.g., BACI designs and IMWs), a combination of approaches seems appropriate. IMWs should be implemented in limited areas (i.e., where the integrity of the design can be maintained for at least 12 years, or about three generations), while project-based and/or watershed-based monitoring in concert with status/trend monitoring should be implemented where institutional control is less feasible.

The implementation of this monitoring approach will require reforms to some of our existing monitoring programs that:

- lack critical elements of experimental design;
- lack sufficient institutional control to maintain the integrity of the monitoring design over a time period sufficient to generate reliable results;
- are collecting data at the wrong spatial or temporal scales;
- are collecting data without an analytical framework to evaluate and adapt restorations and monitoring actions;
- are collecting data without using standardized monitoring protocols; and/or
- are reporting data inconsistent with regional data sharing standards.

7. USE OF HABITAT MODELS

Not all Tributary Habitat Actions can be monitored, nor can the effects of actions be measured for all populations. Therefore, analytical tools are needed to assess the potential effects of habitat actions on population productivity across the many populations that will be treated with habitat actions. Analytical tools range from the simple (professional-judgment-guided model of the Habitat Remand Workgroup) to the very complex (Ecosystem Diagnosis and Treatment Model). The goal is a transparent model that can be applied across different landscapes and populations, and provides reasonably accurate results.

One model that is transparent and has provided reasonably accurate results, at least in the Puget Sound area, is the Shiraz model (Scheuerell et al. 2006). Shiraz relies on a multistage Beverton-Holt model to describe the production of salmon from one life stage to the next. It includes density-dependent population growth, habitat attributes, hatchery operations, and harvest management in a time-varying, spatially explicit manner. The fact that it deals with hatchery operations is important because many of the populations that will be treated with habitat actions have hatchery programs, some of which will be going through modifications. This model should allow researchers to examine the separate and combined effects of habitat and hatchery actions on population parameters.

It is important that habitat monitoring support the development of analytical tools. This means that monitoring should be conducted at spatial and temporal scales sufficient to develop and populate models and to provide data to validate the models. This can probably be accomplished by monitoring extensively a select few populations across the Columbia River Basin.

Annex 1 provides additional information regarding the need and rationale to use a modeling approach to assess the population level effects of the proposed tributary actions.

7.1 CONFOUNDING HATCHERY OR HARVEST EFFECTS

Where hatcheries or terminal harvests are affecting tributary survival and productivity, the monitoring approach for habitat action effectiveness will need to appropriately account for and/or attempt to control these potential confounding factors. This may require attempts to maintain consistent hatchery or harvest effects over the life of the study to minimize confounding effects. Alternatively, an integrated, stratified research approach may need to be implemented that incorporates the habitat and the hatchery or harvest effects within the same research and monitoring design.

The Action Agencies are currently supporting a model-based design to simultaneously serve habitat and hatchery information needs within the Integrated Status and Effectiveness Monitoring Project (ISEMP) population and habitat status and trend monitoring project proposed for implementation in the South Fork Salmon River (SFSR) of Idaho. For more information on integrating Hatchery and Habitat Action effectiveness studies, see the section "Integrating Habitat and Hatchery RM&E Efforts" in Attachment B.2.6-5 Hatchery RM&E.

8. TRIBUTARY HABITAT RM&E ACTION

The Action Agencies propose to implement the following actions to provide the necessary biological and environmental performance measures to answer key management questions and provide guidance for adaptive management decisions.

8.1 MONITOR AND EVALUATE TRIBUTARY HABITAT CONDITIONS AND LIMITING FACTORS

Habitat status monitoring and limiting factor analyses are primarily the responsibility of agencies affecting or regulating tributary habitat areas. However, given the importance of this information to the diagnosis and effective planning of offsite mitigation actions, and the application of these data in complimentary action effectiveness evaluations, Action Agencies are proposing the following specific actions. In addition to these specific actions, ancillary population status and trend information is being obtained through several ongoing habitat improvement projects (see the FY 2007 to 2009 project tables in B.2.6-1).

- Implement research in select areas of the pilot study basins (Wenatchee, Methow and Entiat River basins in the Upper Columbia River, the Lemhi and South Fork Salmon River basins, and the John Day River Basin) to quantify the relationships between habitat conditions and fish productivity (limiting factors) to improve the development and parameterization of models used in the planning and implementation of habitat projects. These studies will be coordinated with the influence of hatchery programs in these habitat areas.
- Implement status and trend monitoring as a component of the pilot studies in the Wenatchee, Methow and Entiat River basins in the Upper Columbia, the Lemhi and South Fork Salmon River basins and the John Day River Basin.
- Facilitate and participate in an ongoing collaboration process to develop a regional strategy for limited habitat status and trend monitoring for key ESA fish populations and an associated regional memorandum of understanding (MOU) for joint funding and implementation. This monitoring strategy will be coordinated with the status monitoring needs and strategies being developed for hydro, habitat, hatchery, harvest and estuary/ocean.

8.2 EVALUATE THE EFFECTIVENESS OF TRIBUTARY HABITAT ACTIONS

The Action Agencies will evaluate the effectiveness of Habitat Actions through RM&E projects that support the testing and further development of relationships and models used for estimating habitat benefits. The actions follow the general monitoring approaches and adaptive modeling applications identified earlier for determining the effects of proposed Habitat Actions. These evaluations will be coordinated with hatchery effectiveness studies.

- Action effectiveness pilot studies in the Entiat River Basin to study treatments to improve channel complexity and fish productivity.
- Pilot study in the Lemhi Basin to study treatments to reduce entrainment and provide better fish passage flow conditions.
- Action effectiveness pilot studies in Bridge Creek of the John Day River Basin to study treatments of channel incision and its effects on passage, channel complexity, and consequentially fish productivity.
- Project and watershed level assessments of habitat, habitat restoration and fish productivity in the Wenatchee, Methow and John Day basins.
- Incorporate research and monitoring results within existing and newly developed habitat relationships and models.

See Table 2, Attachment B.2.6-1 for specific projects that have been currently identified for implementation in the FY 2007 to FY 2009 period to meet the proposed action for Tributary Habitat RM&E. Further information regarding the pilot studies in the Upper Columbia, John Day and Upper Salmon currently being implemented through the ISEMP project is provided as Annex 2.

9. PROJECT IMPLEMENTATION AND COMPLIANCE MONITORING

Tributary habitat projects will be monitored for implementation of planned deliverables and compliance to performance expectations. Implementation monitoring documents the type of Habitat Action, its location, and whether the action was implemented properly and completely or complies with established standards. It does not require collection of biological or environmental data. The Action Agencies will use standards for project tracking that are coordinated through regional forums [e.g., Pacific Northwest Aquatic Monitoring Program (PNAMP)] to support regional coordination of project implementation tracking and effectiveness monitoring designs.

Implementation and compliance monitoring will answer two primary questions: (1) were the actions implemented completely and according to expected schedules? and (2) were the actions implemented correctly?. To help answer these questions, the Action Actions will:

- monitor the successful implementation of projects through standard procedures and requirements of contract oversight and management, and review of project deliverables and final reports.
- maintain BiOp databases to provide fish improvement and monitoring project and action level details for planning and reporting purposes. This approach will provide the most up-to-date information about the status of actions and projects being implemented.
- use the project level detail contained in the Action Agencies' BiOp databases to track results and assess our progress in meeting programmatic level performance targets.

10. RM&E COORDINATION AND DATA MANAGEMENT

The Action Agencies will coordinate RM&E activities with other federal, state and Tribal agencies, and will ensure that the information obtained under the auspices of the FCRPS RM&E efforts is archived in appropriate data management systems. See the RM&E Coordination and Data Management section of the RM&E Action for specific actions (Section B.2.6.5). Much of the RM&E coordination and data management related to tributary habitat will be carried out through regional coordination forums such as PNAMP and the Northwest Environmental Data (NED) network, and through the Pilot Studies in the Upper Columbia, John Day and Snake River basins currently being implemented through the ISEMP project (see Annex 2). Many of these products will be important to the advancement of more regionally shared and robust tributary habitat monitoring information.

The Action Agencies are currently providing cost-share funding and participation in Steering Committee leadership and Workgroups within PNAMP. Products currently being developed and regionally coordinated under PNAMP include:

- Standards for regional project tracking to support implementation and effectiveness monitoring;
- Management questions “white paper” to facilitate coordination by identifying relative importance of management questions (and their related hierarchical set of information needs) shared by the PNAMP partners;
- High level indicators “white paper” to recommend a core set of indicators that can be shared among all types of monitoring;
- Standard macroinvertebrate field and laboratory sampling protocols;
- Habitat protocols recommendations (watershed assessment methods);
- Assist with the advancement of a regional information management strategy for fish and habitat data;
- Develop regional data dictionary for monitoring and protocol catalogue tool (Protocol Manager);
- Advance development of a regional Aquatic Monitoring Activity Inventory;
- Fish Protocols: Marking/Tagging Techniques Guidance;
- Fish Protocols: Develop protocol comparison tests and further advance the recently developed *Salmonid Field Protocols Handbook;*
- Monitoring Survey Design recommendation for a regional aquatic status & trends monitoring design [using the Environmental Monitoring and Assessment Program (EMAP) probabilistic Generalized Randomized Tessellation Stratified design developed by the U.S. Environmental Protection Agency (EPA)];
- Effectiveness Protocols: facilitate adoption of standardized protocols across PNAMP partners;
- Effectiveness Protocols: recommend strategy for implementation of the PNAMP-recommended network of IMW and reach specific studies for effectiveness monitoring;
- Estuary Protocols: coordinate protocols for monitoring in estuaries;
- Facilitate application of remote sensing tools for aquatic monitoring; and
- Identify and implement a process for developing/refining common geographic information system (GIS) layers.

The Action Agencies are currently providing cost-share funding and participation in Steering Committee leadership and Workgroups within the NED network. Products being developed and regionally coordinated under the Northwest Environmental Data-network include:

- Develop and maintain a strategy to achieve improvements in regional data quality, quantity and access;
- Coordinate development and adoption of data stewardship responsibilities and data sharing agreements;
- Develop protocols to provide access to regional data networks, and management systems as they become available, for fish and wildlife and their aquatic and terrestrial habitat and water data via the World Wide Web;
- Maintain and populate a Web-based Pilot Data Portal;
- Pilot a Distributed Database Management System for Salmonid Abundance and Trend data and link to water quality data;
- Develop a draft Best Practices for Salmonid Trend and Abundance Data Quality Assurance and Quality Control; and
- Pilot a Regional Data Recovery Effort to capture and integrate existing regional fish and habitat data.

The Action Agencies are providing funding for the development of a pilot data management system for monitoring data under ISEMP. Associated products currently being developed and regionally coordinated include:

- Monitoring strategy for the upper Columbia Basin;
- Develop, test, and document indicators and metrics of status, trend, and effectiveness;
- Upper Columbia monitoring protocols for habitat, smolt trapping, snorkeling, electrofishing, water quality, spawning ground, PIT-tag deployment and detection, and macroinvertebrate data collection;
- Integration and testing of Protocol Manager, a protocol catalogue tool;
- Site Manager tool to support integration and tracking of regional monitoring sites;
- Data entry templates to facilitate data documentation, entry, validation, summarizing, reporting, and submission to central warehouses;
- Standardized database schema that integrates fish, habitat, and water quality data;
- Central data warehouse for spatial and tabular monitoring data;
- Web-based interface for viewing and downloading both raw and summarized monitoring data;
- Implementation and testing of monitoring survey designs including the GRTS survey design developed by the EPA;
- Current and historical monitoring data layers for Wenatchee, John Day, and Salmon sub-basins; and
- Data analysis framework for monitoring data in Wenatchee, John Day, and Salmon subbasins.

ANNEX 1
RATIONALE FOR A MODELING APPROACH

The direct programmatic assessment of a suite of tributary habitat restoration actions will be difficult, if not impossible on the scale of the Interior Columbia River Basin or even a single anadromous salmonid ESU. However, predicting the biological effect of these actions would be possible through a combination of models -- to generate hypotheses and experiments -- and data collection -- to test these hypotheses. Therefore, the Research, Monitoring and Evaluation (RM&E) program for the tributary off-site mitigation actions resulting from the FCRPS BiOp Opinion will be structured as a series of monitoring actions to refine a programmatic modeling approach that predicts the biological benefit of the complete suite of activities covered by the Proposed Reasonable and Prudent Alternative (RPA).

Why not directly measure the biological benefit of the tributary habitat restoration actions covered by the FCRPS Proposed RPA? A disparate suite of actions scattered across a wide range of ecoregions and ESUs will be difficult, if not impossible to assess in a programmatic fashion, particularly if the response variable is population productivity or life-stage specific survival. Actions might include:

1. Adding monitoring after-the-fact to reach scale habitat restoration projects will not be feasible on the scale of the Columbia River Basin.

   – On the scale of the Columbia River Basin reach scale habitat restoration projects will fall in watersheds across 10 ecoregions and represent 8 broad classes or types of restoration actions. Thus, to monitor the suite of possible actions will require stratifying actions by type and ecoregion, resulting in a total of 80 combinations of ecoregion x action-type. Even minimal sample sizes (n=10) for project types stratified by ecoregion will require the monitoring of 800 projects that conveniently fall in a balanced fashion across 80 categories.

     Since the constraint of balancing project type and ecoregion was not applied to select projects, the 800 projects will have to be drawn as a sub-set from a larger set of projects to create a balanced design. However, since there are fewer than 800 projects considered in the Proposed RPA, it will not be possible to directly monitor, on the scale of the Columbia River Basin, the programmatic effect of the Proposed RPA.

2. Adding monitoring after-the-fact to reach scale habitat restoration projects is not likely to result in measurable benefits at the scale of individual projects.

   – Adding effectiveness monitoring after the fact to reach scale habitat restoration projects means that the monitoring will be designed to test if the treated reach is different from a carefully chosen control reach. Due to naturally occurring spatial variation in physical and biological descriptors of habitat condition, sample size estimates for treatment-control pairings of habitat restoration actions at the reach-scale suggest that very large samples are required to detect treatment caused differences: sample sizes on the order of n=100. With sample sizes this large it is unlikely that the pool of replicate treatments and controls can be developed such that the 200 sites required for each action type are similar enough not to result in further increases in variance to be partitioned, and thus reduced power.

     Rather than adopt a treatment-control paradigm, the most parsimonious manner with which to assess the effect of reach scale habitat restoration actions is through a before-after (or one of its variants) time-series analysis. By comparing the same reach before and after treatment the issue spatial variance is side-stepped, and the ability to detect effects requires far fewer replicates. However, requiring pre-treatment data, often 3-5 years worth, is not compatible with adding effectiveness monitoring to projects after-the-fact.

3. Monitoring the physical and biological habitat effects of reach scale restoration actions cannot be used to assess the population level effects of the projects, either individually or collectively.

   - The response variables from before-after or treatment-control monitoring of reach-scale habitat restoration actions will be the physical or biological habitat condition affected by the restoration action, or in rare cases, an indicator of a biological process that is indirectly affected by the Habitat Action through the action's effect on habitat condition. As such, reach-scale actions will not be assessed with fish population process based response metrics, and thus not in the currency of the assessment required of the FCRPS Proposed RPA and BiOp.

     Furthermore, regardless if the response metric is indirectly or directly related to biological processes; it will only be on the spatial scale of the action (i.e., a reach). The assessment required of the FCRPS Proposed RPA and BiOp is the effect of off-site mitigation actions on population processes at the scale of an entire population or major fraction thereof. Therefore, monitoring individual or collections of reach-scale projects at the scale of the projects alone cannot be used to assess off-site mitigation actions due to a mismatch in the currency and scale of these assessments and that required for the FCRPS Proposed RPA and BiOp.

Therefore, to generate a programmatic assessment of the FCRPS Proposed RPA, an approach that is more than just the aggregate of project-scale effectiveness monitoring is required. Directly monitoring the population-level benefit of habitat restoration actions is possible, but difficult for a number of reasons, primarily due to the large scale presented by the "population" requirement, and the resulting effect size necessary to detect biological process changes at this scale. The goal will be to develop a transparent model that can be applied across different landscapes and populations, and provides reasonably accurate results. Such a model should allow researchers to examine the separate and combined effects of habitat and hatchery actions.

ANNEX 2

THE PILOT STUDY APPROACH INTEGRATED STATUS AND EFFECTIVENESS MONITORING PROGRAM

The Integrated Status and Effectiveness Monitoring Program (ISEMP – BPA project #2003-0017) has been created as a cost effective means of developing protocols and new technologies, novel indicators, sample designs, analytical, data management and communication tools and skills, and restoration experiments that support the development of a region-wide Research, Monitoring and Evaluation (RM&E) program. This program assesses the status of anadromous salmonid populations, their tributary habitat and the effectiveness of restoration, and management actions.

The most straightforward approach to developing a regional-scale monitoring and evaluation program would be to increase standardization among status and trend monitoring programs. However, the diversity of species and their habitat, as well as the overwhelming uncertainty surrounding indicators, metrics, and data interpretation methods, requires the testing of multiple approaches in order to develop the best guidance on strategies for standardizing regional RME. As such, ISEMP is developing a broad template that may differ in the details among subbasins, but one that will ultimately lead to the formation of a unified RM&E process for the management of anadromous salmonid populations and habitat across the Columbia River Basin.

ISEMP has been initiated in three pilot subbasins, the Wenatchee/Entiat, John Day, and Salmon. To balance replicating experimental approaches with the goal of developing monitoring and evaluation tools that apply as broadly as possible across the Pacific Northwest, these subbasins were chosen as representative of a wide range of potential challenges and conditions (e.g., differing fish species composition and life histories, ecoregions, institutional settings, and existing data).

ISEMP has constructed a framework that builds on current status and trend monitoring infrastructures in these pilot subbasins, but challenges current programs by testing alternative monitoring approaches. In addition, the ISEMP is:

1. Collecting information over a hierarchy of spatial scales, allowing for a greater flexibility of data aggregation for multi-scale recovery planning assessments, and
2. Designing methods that:
   a. Identify factors limiting fish production in watersheds;
   b. Determine restoration actions to address these problems;
   c. Implement actions as a large-scale experiment (e.g. Before After Control Impact, or BACI design), and
   d. Implement intensive monitoring and research to evaluate the actions' success.

The intent of the ISEMP project is to design monitoring programs that can efficiently collect information to address multiple management objectives over a broad range of scales. This includes:

- Evaluating the status of anadromous salmonids and their habitat;
- Identifying opportunities to restore habitat function and fish performance, and

- Evaluating the benefits of the actions to the fish populations across the Columbia River Basin.

The multi-scale nature of this goal requires the standardization of protocols and sampling designs that are statistically valid and powerful -- properties that are currently inconsistent across the multiple monitoring programs in the region. Other aspects of the program will also aid in the ability to extrapolate information beyond the study area, such as research to elucidate mechanistic relationships between habitat condition and population processes, and a classification of watersheds throughout the Columbia River Basin. In addition, ISEMP is working actively to develop analytical and data management approaches that incorporate existing data such that irreplaceable historical time series can be captured and utilized.

Obviously, the scale of the problem is immense and ISEMP does not claim to be the only program working towards this goal. As such, ISEMP relies heavily on the basin's current monitoring infrastructure to test and develop monitoring strategies, while acting as a coordinating body and providing support for key elements such as data management and technical analyses. ISEMP also ensures that monitoring programs can address large-scale management objectives (resulting largely from the ESA) through these local efforts. While ISEMP maintains a regional focus it also returns the necessary information to aid in management at the smaller spatial scales (individual projects) where manipulations (e.g., habitat restoration actions) actually occur.

A major difference between ISEMP and other monitoring design efforts is the integration of ISEMP with current sub-basin monitoring programs. We are relying on the current monitoring infrastructure to test and develop monitoring strategies, while acting as a coordinating body and providing support for key elements such as data management and technical analyses. The ISEMP also ensures that monitoring programs can address large-scale management objectives (resulting largely from the ESA) through these local efforts. While ISEMP maintains a regional focus it also returns the necessary information to aid in management at the smaller spatial scales (individual projects) where manipulations (e.g., habitat restoration actions) actually occur.

Therefore, explicit coordination with funding agencies is critical to ensure they understand that new programs must often address the information needs of existing projects in kind with their own. Explicit up-front participation of funding agencies in project coordination may also ease budget transitions and improve efficiency as existing and newly implemented activities are merged.

Standardizing protocols is another way ISEMP coordination has helped ensure that all available data are optimally utilized. For example, ISEMP developed interim protocols for the capture, handling, and tagging of wild salmonids in the Upper Columbia River Basin for projects that use PIT tags. The ISEMP collaborative process enabled information sharing among local field staff and outside experts. The initial success of this effort is reflected by the use of these protocols by all five state, federal, and Tribal agencies engaged in this work in the Wenatchee/Entiat sub-basin and by the adoption of these protocols in other near-by sub-basins. Other products developed to meet similar objectives include sub-basin-scale monitoring strategies, a habitat field-survey manual, data entry templates, and a data management system. In short, this collaborative process provides a forum for an exchange of information that otherwise may not occur.

The ISEMP project has also been applying ecological principles to develop relevant indicators and conducting research to test if these relationships are realized. For example, macroinvertebrate assessments in monitoring programs throughout the Columbia River Basin use benthic species composition to create indicators of water quality. These indices, however, do not provide information on the quantity or quality of food available for drift feeding salmonids. In the ISMEP invertebrate productivity monitoring study, we are comparing estimates of terrestrial and aquatic drift and benthic invertebrate biomass to estimates of juvenile anadromous and resident redband trout (O*ncorhynchus mykiss gairdneri*) growth and density across multiple reaches and watersheds differing in temperature and habitat characteristics. From this study, we expect to determine the most relevant invertebrate metric (e.g. total invertebrate biomass) to fish performance.

It is important to develop a quantitative understanding of the strengths, weaknesses and relatedness of different protocols and their resulting metrics. Quality assessments and control on the accuracy and precision of a protocol should be a standard component of monitoring programs that include the evaluation of variance associated with observers, sites, and time. Side-by-side comparison of the accuracy, precision, and cost of implementation of multiple protocols establishes the basis for deciding the most reasonable protocol to adopt or whether to create "crosswalks" to convert values collected from one protocol to values collected from another. In this vein, ISEMP is conducting assessments of protocols for the development of physical and biological habitat condition metrics, and juvenile salmonid density and population estimation.

In addition to focusing on protocols or response designs, ISEMP is explicitly testing key aspects of sampling designs. The ability to extrapolate a collection of samples to provide an accurate assessment at the appropriate scale is dependent on the sampling design. The sampling design describes where, when, and how much to sample. The design is not only dependent on the protocols used to collect the information but on how the information will be used. In the John Day Basin, status and trend monitoring for juvenile and adult steelhead and Chinook salmon populations and their habitat are conducted by the Oregon Department of Fish and Wildlife (ODFW), based on a monitoring program that has been implemented in Oregon's coastal watersheds.

A sampling program similar in design and effort to the John Day Basin project is being implemented in the Wenatchee sub-basin; however, the Wenatchee sub-basin is about 1/8 the size of the John Day Basin, therefore the density of sample sites is effectively much higher. Thus, ISEMP can compare the influence of an increased density of sample sites on the precision of summary metrics. Analysis of variance structures will be evaluated as information becomes available to describe the power of the different sampling designs. In addition, subsampling routines of the data will be used to evaluate whether current designs are too intensive and thus wasteful for addressing relevant management objectives.

The ISEMP is initiating a test of an entirely different habitat and population status and trend project in the South Fork Salmon River (SFSR) watershed. This monitoring program will test a different set of protocols and sample designs in a "common garden" with existing programs to determine whether a single sampling design can return the information needed for multiple species/life histories, and whether relationships can be constructed to enable programs to employ alternative sampling methods without losing the time series of information that has been generated by existing infrastructure/sampling designs. This program also highlights the idea that the elements discussed thus far will not be evaluated in isolation but rather as an integrated approach to designing a monitoring program.

Large-scale experiments are arguably the most direct method available for predicting a population or environmental response to management. These experiments have contributed greatly to our understanding of ecological processes within watersheds, and results from many of these studies have led to changes in management strategies. However, generalization beyond a single system requires knowledge of mechanistic interactions or multiple ecosystem studies. To build on this tradition, Intensively Monitored Watershed (IMW) studies to evaluate population level responses to large-scale restoration efforts have been initiated throughout the region. The ISEMP has proposed or is involved in IMWs in each of the pilot projects to evaluate large-scale restoration actions in an experimental framework approach.

Decreased habitat complexity has been implicated as the primary factor that limits freshwater productivity of ESA-listed bull trout, spring Chinook salmon, and steelhead in the Entiat River Basin. Approximately 60 artificial structures will be placed in a 16-mile section of the Entiat, which are expected to increase habitat complexity by encouraging pool scour and other geomorphic changes. In addition, six relict side-channels will be reconnected to the mainstem. The benefit of these restoration actions will be evaluated under the ISEMP Entiat IMW study.

An assessment of Bridge Creek (John Day River, Oregon) and several other interior Columbia River Basin watersheds suggests that channel incision is a widespread problem for fish populations. Channel incision results in the lowering of floodplain water tables, the loss of off-channel habitat and riparian forest and a general simplification of stream habitat. In order to restore the aggradation, or stream-bed rebuilding, processes, ISEMP has initiated a large-scale restoration project in Bridge Creek through the application of two types of restoration structures that mimic strong, long-lasting beaver dams.

Implemented actions should restore floodplain processes that will result in increased baseflow, lower summer temperatures, decreased sediment loads and greater habitat complexity such as more off-channel habitat, more riparian vegetation, and more frequent and deeper pools.

An IMW has also been designed for the Lemhi River, a tributary to the upper mainstem of the Salmon River. In the Lemhi River, habitat modifications and irrigation withdrawals have hydraulically isolated 28 of the 31 tributaries from the mainstem. A number of habitat restoration actions are intended to provide access to historical spawning and rearing habitat and increase habitat quality: (1) removing or reducing upstream and downstream migration barriers (e.g., pushup dams); (2) increasing tributary and mainstem flow; (3) maintaining or enhancing riparian conditions; (4) increasing the abundance and quality of off-channel habitat; and (5) increasing pool frequency and quality to improve productivity and over-winter survival.

Ongoing and proposed Habitat Actions are aggressive and anticipated to result in measurable biological responses, both in terms of physical habitat attributes (e.g., quality and quantity of accessible habitat) and fish vital rates (survival/productivity, distribution, and abundance) both at the scale of individual reaches and at the scale of the watershed.

ISEMP’s primary objective is to aid in the design of efficient and comprehensive monitoring programs to address multiple management objects, but it relies on current monitoring infrastructure for the implementation of monitoring. The ISEMP is also aiding in the development and application of tools to evaluate the diverse, extensive, and hierarchical nature of data collected as part of the pilot projects.

Analytical needs include the assessment of the utility of the different variables and indicators, which is related to the identification of potential causal mechanisms. Regression and multiple regression approaches will be common tools to evaluate whether predictor variables can explain the variation observed in the response variables, and can at least generate hypotheses about these relationships.

The precision and accuracy of different protocols, and the efficiency of sampling designs will have to be evaluated. Random effects analysis of variance models are the appropriate statistical tool to partition the spatial and temporal environmental heterogeneity, observation and measurement error and will be used to compare protocols and assess and refine sampling designs. Power analyses and sample size calculations will also be used to complement these evaluations.

The development of limiting factor analyses and the ability to address management questions are also analytical requirements of ISEMP. Reference and managed systems can be compared using ANOVA and ANCOVA approaches, and Partial Mantel tests can be used to identify a potentially important set of environmental relationships at multiple spatial scales from a large set of variables while accounting for spatial autocorrelations, while hierarchical models and structural equation modeling show promise in testing hypotheses about multiple factors regulating fish performance metrics using spatially explicit data.

The ISEMP is also developing classification tools to apply lessons learned from small-scale efforts to broader scale problems. The ISEMP has classified the watersheds of the Columbia River Basin based on their potential to support anadromous salmonids, represented by a multidimensional numerical score for each watershed (6^{th} field hydrologic unit code or HUC) based on reducing multiple spatial data layers. Generating the watershed scale descriptors requires the compilation of existing spatial data layers to generate consistent and complete coverages of biophysical conditions.

Developing a regional monitoring and evaluation program must overcome significant data organization and management challenges in order to meet program objectives. Regional projects produce an enormous volume of data from a plethora of collaborates, sites, and years. For example, in 2004, ISEMP data collection in the Wenatchee sub-basin produced nearly 250,000 unique data records. This sheer volume of data results in issues of storage capacity, retrieval, and distribution. Data collected by disparate collaborators is often stored in inconsistent formats and typically do not follow consistent rules of quality assurance, making automated processing nearly impossible. Most importantly, metadata about who, when, and how data were collected are not stored directly with data and is often lost or misplaced. In order to facilitate data quality assurance and transfer to regional databases, the ISEMP data management strategy is based on the integration of both localized and centralized data management efforts.

A central database provides the storage capacity, metadata tracking, and data processing functionality to meet the needs of the regional monitoring and evaluation program. Unlike most centralized database programs, ISEMP also provides data management tools and guidance to encourage best data management practices within local agencies. Data management tools and guidance help ensure that newly collected data and historic data are structured in a format consistent with regional databases, that metadata is directly linked to raw data, and that a minimum level of data quality is assured at the time of data entry.

Attachment B.2.6-4
Estuary and Ocean Research, Monitoring, and Evaluation Action

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1. INTRODUCTION

Research, monitoring, and evaluation (RM&E) for the Estuary/Ocean Action draws on the "*Plan for Research, Monitoring and Evaluation of Salmon in the Columbia River Estuary*" (Estuary/Ocean RM&E Subgroup 2004) and the "*Research, Monitoring and Evaluation – Conceptual Framework Outline*" (Sovereign Collaboration Group 2006). For the purposes of this attachment, the estuary/ocean is defined as the tidally-influenced portion of the river and its tributaries from Bonneville Dam to and including the plume and nearshore ocean; lower Columbia River tributary watersheds above tidal influence are not part of the study area.

RM&E has been a key component of past and ongoing evaluations of actions to improve survival for Endangered Species Act (ESA)-listed salmon and steelhead in the Columbia River Basin. The Action Agencies are committed to a continuation of this process for the forthcoming Biological Opinion (BiOp).

This attachment describes the proposed approach to the Estuary/Ocean RM&E Actions. It involves the following sections:

- Management Questions
- Performance Measures
- Estuary and Ocean RM&E Actions
- Estuary and Ocean RM&E Projects

2. MANAGEMENT QUESTIONS

The following are the primary management questions that have emerged with respect to Estuary Habitat Actions. The RM&E Actions described in this section are focused on providing information needed to answer these questions to support ongoing and adaptive management decisions.

- Are aquatic, riparian, and upland Estuary Habitat Actions achieving the expected biological and environmental performance targets?

  This management question concerns primarily status and trends monitoring, in combination with action effectiveness research. Status monitoring is the "measurement of environmental characteristics over an extended period of time to determine status or trends in some aspect of environmental quality" (from Suter 1993, cited in Noon 2003). Status monitoring can describe differences in values of given monitored indicators among locations at a given moment in time (snap-shot) or changes in their values across time at a given location (trend).

- Are the offsite habitat actions in the estuary improving juvenile salmonid performance and which actions are most effective at addressing the limiting factors preventing achievement of habitat, fish, or wildlife performance objectives?

  This management question concerns action effectiveness evaluation. Action effectiveness evaluation determines the biological and ecological effects of management actions relative to project and program objectives. The conclusions generated from action effectiveness evaluation will inform decision making in the adaptive management process for the Action Agencies' estuary restoration effort as a whole.

- What are the limiting factors or threats in the estuary/ocean preventing the achievement of desired habitat or fish performance objectives?

This management question concerns critical uncertainties research. The resolution of uncertainties in the existing estuary/ocean knowledge base is required for implementation of appropriate management actions as well as associated status and trend monitoring and action effectiveness evaluation. "Uncertainties" are those pieces of information currently unavailable that managers require for informed, effective decision making. Critical uncertainties that pertain to the estuary but are rooted in the Hydrosystem (e.g., delayed mortality, are addressed under Hydrosystem RM&E [see Attachment B.2.6-2] and are not included here).

3. PERFORMANCE MEASURES

Performance measures for the Columbia River Estuary include reach survival, life history diversity, growth rates, and predation rates of juvenile salmonids and the bathymetry, topography, connectivity, and hydrology of estuary habitats. Survival benefits for Actions implemented in the periods FY (fiscal year) 07-09 and FY10-17 for Estuary Habitat Actions have been estimated for stream and ocean-type life histories and used within the biological assessment based on methods discussed in the Remand Collaboration Process. These estimated benefits provide the long-term biological performance targets. Performance standards have also been set for annual tracking of project implementation projected for the periods FY07-09 and for FY10-17 used to estimate the long-term survival benefits. RM&E will be used to confirm and improve our understanding of the relationships between different Estuary Habitat Actions, the environment and the survival and productivity performance measures. As this information is developed and relationships and models are updated, the Action Agencies will re-confirm the modeling estimates of expected survival improvements associated with Actions. More specific information on performance standards, targets and contingencies is provided in the Accounting, Adaptive Management and Contingencies section for the Estuary/Ocean Action.

4. ESTUARY AND OCEAN RM&E ACTION

4.1 MONITOR AND EVALUATE FISH PERFORMANCE IN THE ESTUARY AND PLUME

The Action Agencies will biological responses and/or environmental attributes, and report in the following areas:

- Monitor and evaluate smolt survival and/or fitness in select reaches from Bonneville Dam through the estuary.

  Survival is a fundamental performance measure. Survival rates will be estimated using tagging techniques for juveniles of selected species and life history types for the reach from Bonneville Dam to the mouth of the Columbia River, and also for selected areas of the estuary.

- Develop an index and monitor and evaluate life history diversity of salmonid populations at representative locations in the estuary.

  An index for life history diversity is needed to monitor trends in this important indicator of salmon performance. An understanding of trends in life history diversity is important to assessing the performance of restoration projects.

- Monitor and evaluate juvenile salmonid growth rates and prey resources at representative locations in the estuary and plume.

Growth rate is calculated as the change in length or weight of the sampled juvenile salmon population per unit time. It is a direct indicator of ecological benefits from estuarine habitats when coupled with monitoring of prey resources.

- Monitor and evaluate temporal and spatial species composition, abundance, and foraging rates of juvenile salmonid predators at representative locations in the estuary and plume.

  Predation on juvenile salmonids is a concern throughout the Columbia River Basin, as it is in the estuary and plume. Monitoring predators and their foraging rates will help determine the extent of this limiting factor on salmonid performance.

4.2 MONITOR AND EVALUATE MIGRATION CHARACTERISTICS AND ESTUARY/OCEAN CONDITIONS

The Action Agencies will monitor and evaluate selected ecological attributes of the estuary. The Actions include:

- Map bathymetry and topography of the Estuary as needed for RM&E.

  Bathymetry is a collection of depth points that represent the gradients of elevation and depth change along a surface. Topography measures of the height of a point on the surface of the sediment or soil of a location, expressed relative to a datum point. These data are essential to quantify and characterize estuary habitats for salmonids.

- Establish a hierarchical habitat classification system based on hydro-geomorphology, ground-truth it with vegetation cover monitoring data, and map existing habitats.

  Maps generated from surveys using aerial photos and photo points and completing then applying the hierarchical classification currently in development will allow the Action Agencies to monitor trends in estuary habitats beneficial to juvenile salmonids.

- Develop an index of habitat connectivity and apply it to each of the eight reaches of the study area.

  Habitat connectivity is a landscape-level indicator that shows the linkages between different habitat types in the ecosystem. This Action would include an inventory of dikes, levees, tidegates, culverts, which restrict access by salmon to wetland habitats. The habitat connectivity index will provide a way to track habitat Actions, although such an index remains to be developed. This Action is needed because of the importance of habitat connectivity to the ecology of juvenile salmonids in the estuary.

- Tabulate the amount of absolute acreage by habitat type that is restored or protected every year.

  This is straightforward, routine tracking of habitat restoration and protection Actions, organized by habitat type. This Action requires knowledge from the hierarchical habitat classification system.

- Evaluate migration through and use of various shallow water habitats from Bonneville Dam to the mouth towards understanding specific habitat use and relative importance to juvenile salmonids.

  Travel times indicate the amount of time juvenile salmonids spend in the estuary. Migration pathways characterize the corridors and habitats where juvenile salmonids are predominately found migrating through the system.

- Monitor habitat conditions periodically, including water surface elevation, vegetation cover, plant community structure, substrate characteristics, dissolved oxygen, temperature, and conductivity, at representative locations in the estuary as established through RM&E.

  Habitat conditions reflect the quality of ecological support for juvenile salmonids. Since the Action Agencies desire to conserve and restore habitats that benefit juvenile salmonid performance, it is prudent to monitor the status and trends in the quality and quantity of these habitats.

- Monitor and report on indices of productivity in representative locations in the estuary and ocean.

  Productivity indices, such as primary and secondary production rates, reveal the capability of ecosystems to support salmonids.

4.3 MONITOR AND EVALUATE HABITAT ACTIONS IN THE ESTUARY

The Action Agencies will monitor and evaluate the effects of a representative set of habitat projects in the estuary. The Actions include:

- Develop a limited number of reference sites for typical habitats, e.g., tidal swamp, marsh, island, and tributary delta, to use in action effectiveness evaluations.

  A network of reference sites representing tidal marshes, tidal swamps, and other estuary habitats and having relatively undisturbed ecosystem structures and processes is required for action effectiveness monitoring of restoration projects. These sites can also serve as status and trend monitoring locations.

- Evaluate the effects of selected individual habitat restoration Actions at project sites relative to reference sites and evaluate post-restoration trajectories based on project-specific goals and objectives.

  This Action consists of monitoring at the site or project scale. Trends in core monitored indicators at restoration sites and a network of corresponding reference and status monitoring sites are analyzed to meet this objective.

- Develop and implement a methodology to estimate the cumulative effects of habitat conservation and restoration projects in terms of cause-and-effect relationships between ecosystem controlling factors, structures, and processes affecting salmon habitats and performance.

  This Action consists of research and monitoring at landscape, watershed, and site/project scales. The validation objective is to answer a question: "what was the cumulative effect of all habitat conservation and restoration efforts in the estuary relative to the program goal?" The answer to this question is critical to objectively determining whether habitat restoration Actions in the estuary are positively affecting salmon.

4.4 INVESTIGATE ESTUARY/OCEAN CRITICAL UNCERTAINTIES

The Action Agencies will fund selected research directed at resolving critical uncertainties that are pivotal in estuary mitigation and understanding ocean effects. These Actions include:

- Continue work to define the ecological importance of the tidal freshwater, estuary, plume and nearshore ocean environments to the viability and recovery of listed salmonid populations in the Columbia River Basin.

  This is a major uncertainty, the resolution of which will determine the importance of Estuary/Ocean Actions in the overall recovery effort for listed salmonids. This Action includes studies to determine:

  1. the linkage between habitat conditions and growth and survival of juvenile salmonid fishes in the estuary and ocean, and
  2. which ecosystem controlling factors, structures, and processes of the estuary and ocean are limiting for the salmon Evolutionarily Significant Units (ESUs).

- Continue work to define the causal mechanisms and migration characteristics affecting survival of juvenile salmon during their first weeks in the ocean.

  The research need is to collect concurrent environmental and juvenile salmonid data during the first weeks in the ocean and correlate these data with adult salmonid returns.

- Investigate the importance of early life history of salmon populations in tidal freshwater of the lower Columbia River.

  Shallow water habitats in the tidal freshwater reach of the lower Columbia River and estuary are hypothesized to be important to the growth and survival of ocean-type salmon, such as Snake River Fall Chinook Salmon, but scientific knowledge specifically addressing this hypothesis is sparse and current monitoring efforts are fragmented.

- Continue development of a hydrodynamic numerical model for the estuary and plume to support critical uncertainties investigations.

  This Action will entail hydrodynamic modeling to examine water velocity regimes and water surface elevations in order to understand the effects of the hydrosystem on habitat and salmonid performance. This information may provide the basis for management actions to aid recovery.

4.5 COORDINATE RM&E ACTIVITIES

The Action Agencies shall coordinate estuary/ocean RM&E activities with other Federal, State and Tribal agencies. Proposed Actions include:

- Organizing and supporting the Corps Anadromous Fish Evaluation Program (AFEP);
- Support and participate in the Northwest Power and Conservation Council (Council) Columbia River Basin Fish and Wildlife Program (Fish and Wildlife Program) planning efforts;
- Support the standardization and coordination of tagging and monitoring efforts through participation and leadership regional coordination forums such as the Pacific Northwest Aquatic Monitoring Partnership (PNAMP); and
- Coordinate RM&E through the Estuary/Ocean RM&E Subgroup.

4.6 MANAGE AND DISSEMINATE DATA

The Action Agencies will ensure that the information obtained under the auspices of the estuary/ocean RM&E Program is archived in an appropriate data management system. Proposed Actions include:

- Work with regional agencies and forums such as the Northwest Environmental Data-network to establish an integrated and networked regional database system; and
- Contribute funding for data system components that support the information management needs of Estuary/Ocean RM&E.

5. ESTUARY AND OCEAN RM&E PROJECTS

See Table 3, Attachment B.2.6-1 for specific projects that have been currently identified for implementation in the FY 2007 to FY 2009 period to meet the Actions for Estuary and Ocean RM&E.

REFERENCES

Estuary/Ocean RM&E Subgroup. 2004. Plan for Research, Monitoring, and Evaluation of Salmon in the Columbia River Estuary.

Sovereign Collaboration Group. 2006. Research, Monitoring and Evaluation—Conceptual Framework Outline.

Attachment B.2.6-5
Hatchery Research, Monitoring, and Evaluation Action

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ACRONYMS AND ABBREVIATIONS

AHSWG	Ad Hoc Supplementation Workgroup
BA	Biological Assessment
BiOp	Biological Opinion
BMP	Best Management Practice
CWT	coded wire tag
CSMEP	Collaborative Systemwide Monitoring and Evaluation Project
DPS	Distinct Population Segments
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FCRPS	Federal Columbia River Power System
FY	Fiscal Year
ISAB	Independent Scientific Advisory Board
ISRP	Independent Scientific Review Panel
Council	Northwest Power and Conservation Council
MPG	Major Population Group
PNAMP	Pacific Northwest Aquatic Monitoring Partnership
PNI	Proportion of Natural Influence
RM&E	Research, monitoring, and evaluation
RRS	relative reproductive success

1. INTRODUCTION

This attachment to the research, monitoring, and evaluation (RM&E) Hatchery Action provides additional details regarding monitoring and evaluation that will be implemented to answer key management questions regarding the achievement of hatchery performance standards/targets, the effectiveness of hatchery actions, and critical uncertainties regarding the relationships of hatcheries to the viability of Endangered Species Act (ESA)-listed populations. Performance metrics, monitoring approaches, and proposed actions needed to answer these management questions are identified, along with the associated proposed actions needed for tracking implementation of hatchery projects, coordination of these research and monitoring actions with regional agencies, and management of hatchery RM&E data.

RM&E has been a key component of past and ongoing evaluations of actions to improve survival for ESA-listed salmon and steelhead in the Columbia River Basin. The Action Agencies are committed to a continuation of this process for the forthcoming Biological Opinion (BiOp).

This attachment describes the approach to the proposed action for hatchery RM&E. It involves the following sections:

- Management Questions
- Performance Measures
- Best Management Practices (BMPs)
- Hatchery RM&E Actions
- RM&E Approach
- Integrating Habitat and Hatchery RM&E Efforts
- Project Implementation and Compliance Monitoring
- RM&E Coordination and Data Management

2. MANAGEMENT QUESTIONS

The following are the primary management questions with respect to hatchery actions. Hatchery RM&E Actions are focused on providing information needed to answer these questions to support ongoing and adaptive management decisions.

- Are hatchery improvement programs and actions achieving the expected biological performance targets?
- What is the proportion and origin of hatchery fish within naturally spawning salmon and steelhead populations?
- Can hatchery reforms reduce the deleterious effects of artificial production on listed populations, thereby contributing to a reduction in extinction risk for affected natural populations?
- Can properly designed intervention programs using artificial production make a net positive contribution to recovery of listed populations?
- What is the reproductive success of hatchery fish spawning in the wild relative to the reproductive success of wild fish?

Answers to these questions will require a combination of status monitoring, action effectiveness research, critical uncertainty research, and project implementation and compliance monitoring. Information from monitoring and research will inform assessments of fish performance relative to annual performance standards and longer term targets and guide adaptive management decisions.

Existing BPA-funded hatchery RM&E (Table 5, Attachment B.2.6-1) identified for implementation in the FY (fiscal year) 2007 to FY 2009 period is anticipated to partially serve the information burden required to address many of the questions described in the previous paragraph. Further review and recommendations for modification of ongoing RM&E work as well as identification of any additional, essential RM&E projects are planned (see the "*Next Steps*" section in this document). The process outlined in the "*Next Steps*" section includes a means to prioritize existing and proposed RM&E based on its value towards satisfying the research requirements that accompany the Hatchery Action.

3. PERFORMANCE MEASURES

Although ongoing hatchery RM&E has targeted many of the research needs described in the Hatchery Action, existing information remains insufficient to quantitatively estimate the effects of many of the actions proposed in the HatcheryAction. Thus, the expected benefits of the proposed actions were qualitatively assigned as high, medium, or low. These benefits represent our performance targets for adaptive management. Hatchery action effectiveness research will be used to help confirm and update our qualitative expectations of these benefits as new information becomes available.

These benefits (performance targets) are relative to the following objectives of the hatchery actions:

- Safety-net programs reduce extinction risk for target populations in Snake River Sockeye Salmon, Snake River Spring/Summer Chinook Salmon, Mid-Columbia River Steelhead, Lower Columbia River Steelhead, and Columbia River Chum Salmon Evolutionarily Significant Units (ESUs).
- Conservation hatchery programs increase abundance of target populations in Snake River Spring/Summer Chinook Salmon, Snake River Fall Chinook Salmon, and Upper Columbia River Steelhead ESUs/Distinct Population Segments (DPSs), thereby reducing the time to recovery.
- High-priority hatchery reform actions (i.e., those needed to address hatchery programs that are considered major limiting factors by NMFS, result in improved abundance, productivity, diversity, and/or spatial structure of target populations.
- Future implementation of additional hatchery reforms identified through Columbia River Hatchery Scientific Review Group's hatchery review process, combined with use of BMPs at Federal Columbia River Power System (FCRPS) hatchery facilities, improve abundance, productivity, diversity, and/or spatial structure of target populations, depending on the nature of the reform.

In addition to these qualitatively rated benefits (performance targets) associated with the objectives identified above, a more quantitative assessment approach has been applied within the BA for the benefits associated with improved hatchery management practices. This assessment associates changes in hatchery management practices that have been implemented to date, to a change from historic-to-current relative reproductive success (RRS) of hatchery origin fish spawning under natural conditions. This change in reproductive success of hatchery fish and the number of hatchery fish spawning over time has been used to estimate a survival improvement for supplemented populations. Ongoing and proposed research on the reproductive success of hatchery fish spawning in the wild will be used to help confirm the estimated current RRS used in the historic-to-current improvement in RRS and update modeled population effects where needed.

Programmatic performance standards will be developed for BMPs that are being set for various hatcheries based on ongoing regional program reviews.

4. BEST MANAGEMENT PRACTICES

The Hatchery Action identifies the implementation of numerous BMPs as a means to limit risks and increase the potential benefits of hatchery operations. In some cases the BMPs are required to ensure compliance with the provisions of the ESA (e.g., broodstock transitions). The BMPs can be categorized based on their anticipated impact(s):

- Broodstock transition – replace production derived from non-local or composite broodstock with local-origin fish
- Follow the Hatchery Scientific Review Group's recommended guidelines for Proportion of Natural Influence (PNI) [1] – requires the ratio of hatchery to natural adults used for broodstock and released for natural production to conform to specific standards to reduce risks to the natural population
- Improve broodstock collection practices – change broodstock collection practices to better represent natural genetic and life history diversity in the broodstock
- Terminate artificial propagation – end programs that are believed to incur high risk and have a low probability of providing benefits
- Decrease production – limit production to achieve a better balance of hatchery and natural influence
- Link hatchery production goals to biological controls – match production and the escapement of hatchery origin adults to carrying capacity and/or recovery targets
- Implement reintroduction – utilize hatchery production to stimulate natural production in areas formerly occupied by now-extinct populations
- Implement supplementation – implement artificial propagation programs that utilize broodstock composed of local natural-origin adults to increase abundance, decrease extinction risk, maintain genetic and life-history diversity.
- Improve facilities – for example, to minimize impacts from water withdrawals, decrease impedance at broodstock collection structures, and, improve rearing conditions
- Implement acclimation – build facilities to hold juveniles in targeted habitat for a period prior to release; often used to improve homing

[1] PNI (Proportion of Natural Influence) = pNOB/(pHOS + pNOB), where pNOB is the proportion of natural-origin fish included in the hatchery broodstock and pHOS is the proportion of hatchery-origin fish in the natural spawning escapement.

5. HATCHERY RM&E ACTION

5.1 MONITOR HATCHERY EFFECTIVENESS

The Action Agencies will fund selected ongoing and proposed monitoring and evaluation of the effectiveness of proposed hatchery actions. The Action Agencies propose two primary actions to address the effectiveness of hatchery actions:

- Determine the effect that safety-net and conservation hatchery programs have on the viability and recovery of the targeted populations of salmon and steelhead
- Determine the effect that implemented hatchery reform actions have on the recovery of targeted salmon and steelhead populations

The evaluation of hatchery projects will be coordinated with the Tributary Habitat monitoring and evaluation program.

5.2 INVESTIGATE HATCHERY CRITICAL UNCERTAINTIES

The Action Agencies will fund selected ongoing and proposed research directed at resolving artificial propagation critical uncertainties:

- Estimate the relative reproductive success of hatchery-origin salmon and steelhead compared to reproductive success of their natural-origin counterparts
- Determine if hatchery reforms reduce the deleterious effects of artificial production on listed populations, thereby contributing to a reduction of extinction risk for the affected natural populations
- Determine if properly designed intervention programs using artificial production make a net positive contribution to recovery of listed populations

The Action Agencies will place a priority on hatchery critical uncertainties research in areas where answers to hatchery management questions are most critical to the success of the Action. Answers to hatchery critical uncertainties are most critical for Upper Columbia River Steelhead, Snake River Spring/Summer Chinook Salmon, Snake River B-run Steelhead, and Snake Fall Chinook Salmon.

6. RM&E APPROACH

The research needs of the Hatchery Action range from the identification of very specific information requirements, such as the effectiveness of improving specific hatchery facilities, to very general questions such as estimates of relative reproductive success. Given the range of research specificity identified in the Hatchery Action, we have taken the approach of identifying both:

- large-scale design alternatives that will satisfy all or part of the information needs of multiple questions and
- program-specific research that is more directly targeted at individual BMPs, uncertainties, or action effectiveness questions developed in the Hatchery Action.

Within each of the classes of actions included in the Hatchery Action, there exist at least two common questions, namely:

- what is the distribution and abundance of hatchery origin adults relative to natural origin adults?
- what is the reproductive success of hatchery origin adults spawning under natural conditions relative to their natural origin counterparts?

6.1 DISTRIBUTION AND ABUNDANCE OF HATCHERY ORIGIN ADULTS RELATIVE TO NATURAL ORIGIN ADULTS

Generally, the escapement of hatchery origin adults into targeted populations is routinely measured by RM&E accompanying conservation and safety-net hatchery programs. However, the destination of "strays" from conservation and safety-net programs as well as mitigation facilities is not currently well understood. These strays have the potential to confound actions by:

- Altering mean productivity of recipient populations, potentially masking improvements in freshwater survival that are expected to accompany habitat actions
- Decreasing productivity of populations targeted by conservation or safety-net hatcheries
- Increasing the complexity of productivity estimates, owing to uncertainty regarding the fraction of escapement composed of stray adults and subsequent uncertainty about how to "count" hatchery origin adults in escapement estimates. This is particularly problematic for ESA evaluations of recovery and delisting criteria

Currently, many artificial propagation programs evaluate the stray rate of their production groups using an existing network of coded wire tag (CWT) recovery locations. However, there are numerous shortcomings of this method, not the least of which is that recovery sites are non-randomly selected thus making extension of results to un-sampled locations impossible. The Collaborative Systemwide Monitoring and Evaluation Project (CSMEP) has designed a Columbia River Basin scale approach for evaluating stray ratios (the fraction of a population composed of stray hatchery origin adults) of stream-type Chinook salmon using a stratified sampling approach to distribute effort. That design is being evaluated by the *Ad Hoc* Supplementation Workgroup (AHSWG[2]) and should be completed by early 2008. Implementation of that design, or a similar method, would enable managers to predict stray ratios for streams where estimates cannot be directly calculated. Likewise, the design enables an evaluation of which types of hatchery programs and which specific hatchery programs contribute to straying; thus enabling an evaluation of hatchery practices that contribute to straying. The completion of similar designs for steelhead and ocean-type Chinook salmon are proposed for completion by the CSMEP in 2008.

6.2 RELATIVE REPRODUCTIVE SUCCESS

The need for a large-scale design to evaluate the reproductive success of hatchery origin adults relative to natural origin adults under natural conditions has been reiterated by multiple groups [e.g., Independent Scientific Advisory Board (ISAB)/ Independent Scientific Review Panel (ISRP) 2005]. Generally, there are two related questions:

[2] The AHSWG is a voluntary group of hatchery researchers intended to satisfy a request by the ISAB and ISRP (2005) to convene an *ad hoc* group to evaluate the potential to use "Basinwide" designs to address several remaining critical uncertainties that accompany supplementation.

- What is the RRS of conservation or safety-net hatchery origin adults in their targeted populations?
- What is the impact of stray hatchery origin adults (from either supplementation or harvest augmentation programs) on the productivity of non-target populations?

Information relative to those two questions would enable habitat, conservation, and safety-net hatchery monitoring projects to estimate the impacts of strays on freshwater productivity estimates; potentially enabling disentanglement of the often confounding influences of hatchery and habitat actions. Additionally, that information would enable the impacts of strays to be directly evaluated when calculating measures of productivity for the purposes of ESA listing decisions. Finally, addressing these two questions would provide some of the information necessary to address two of the primary uncertainties regarding the effectiveness of hatcheries – namely their potential benefits for targeted populations and the magnitude of the potential impact that hatchery might have on non-targeted populations (i.e., the “net” impact of hatcheries).

The CSMEP group has designed a Columbia River Basin scale approach for evaluating the RRS of hatchery origin stream-type Chinook salmon adults in target and non-target populations using a stratified sampling approach to distribute effort. That design is being evaluated by the AHSWG and should be completed by early 2008. Importantly, the primary stratum for that design is PNI; thus enabling a direct evaluation of the influence of PNI on relative reproductive success. Additional designs to evaluate RRS for steelhead and ocean-type Chinook salmon are proposed for development in CSMEP in 2008.

6.3 COMBINING LARGE-SCALE AND PROGRAM SPECIFIC EVALUATIONS

The large-scale designs described earlier are capable of providing representative estimates of stray rates/ratios of hatchery origin adults and their anticipated reproductive success in target and non-target populations. Those designs also enable evaluations of BMPs 2, 5, and 10 (implementation of PNI targets, balancing escapement of hatchery and natural origin adults, and use of acclimation to reduce stray ratios) and directly address at least part of the information requirements associated with uncertainties and effectiveness research required by the Hatchery Action. Generally, the application of the large-scale designs reduces the remaining RM&E burden to evaluating:

- BMPs 1, 3, 4, 6, 7, 8, and 9
- Whether conservation and safety-net programs can decrease extinction risk and contribute to recovery
- Evaluating whether specific hatchery operations can increase benefits and reduce risks

BMP 1 (broodstock transition) could be viewed simply as an ESA compliance issue. In short, non-local or composite broodstock is considered unacceptable for ESA purposes, so simply documenting the transition (implementation and compliance monitoring) may be all that is necessary. If effectiveness monitoring is desirable, one could conduct simple paired comparisons of the performance of the non-local or composite brood relative to the new local brood.

In practice it is unlikely that most programs will undergo the transition instantaneously due to the logistics involved (e.g., there may not be an adequate number of local fish available for broodstock), thus, it is likely that the existing brood and the new local brood would be used simultaneously for some period. Therefore, paired comparison should be possible and could be cost-effectively achieved for many performance measures by simply marking the release groups (composite or non-local versus local) differentially.

BMPs 3, 4, and 9 (collection of representative broodstock, program termination and facility improvements) represent specific actions recommended for specific programs. We assume that these recommendations are based on the results of existing RM&E given that some information would be required to determine that existing practices are problematic and to prescribe the BMPs to remedy the problem(s). We further assume that simply continuing the existing monitoring would, therefore, likely be sufficient to evaluate the effectiveness of implementing the BMPs.

BMP 6 (linking hatchery production to habitat capacity) provides the opportunity for a clear linkage between habitat action effectiveness and/or status and trend monitoring with hatchery action effectiveness. Designs to address this BMP are described in the following section on combining habitat and hatchery monitoring.

BMPs 7 and 8 (implementing reintroduction and supplementation programs) will likely require extensive monitoring. However, the two large-scale designs dramatically reduce the uncertainties research burden that would otherwise accompany the implementation of these BMPs.

6.4 NEXT STEPS

The previous discussion summarizes how a combination of large-scale designs and site specific evaluations can be used to satisfy the RM&E requirements identified in the Hatchery Action. We now describe a proposed process to ensure that the information provided by existing hatchery RM&E is efficiently utilized, identify remaining information needs, and identifying how the existing suite of hatchery RM&E can be modified, if necessary, to at least partially satisfy the identified gaps in information.

Our approach consists of eight steps:

1. Translating the BMPs, uncertainties questions, and action effectiveness information needs described in the Hatchery Action to statistically tractable large-scale and project-specific designs.
2. Development of balanced stratified designs to address issues related to straying and RRS in a representative manner over a specified time interval.
3. Development of efficient designs to address project-specific information needs that are not satisfied by large-scale designs.
4. Identification of ongoing hatchery RM&E that provides information relevant to large-scale and program specific designs.
5. Identification of existing RM&E that is not necessary to satisfy information needs and evaluation of the necessity of those programs.
6. Identification of remaining information needs.
7. Recommendations for transition, modification, or elimination of current hatchery RM&E efforts coupled with development of a request for proposals to implement monitoring activities sufficient to meet the remaining information needs.
8. Development of standardized performance measures, associated analyses, and standardized reporting requirements to accompany existing and proposed research undertaken to provide the necessary information.

Steps 1 through 3 will require significant collaboration between on-the-ground researchers, statisticians, and program managers through RM&E collaborative workgroup efforts. The hatchery RM&E effort will also require significant collaboration and coordination with the Northwest Power and Conservation Council (Council), the relevant hatchery operators, and fishery co-managers. Once the actions proposed in the Hatchery Action are described in a statistically tractable manner, a significant effort will be required to determine the degree to which existing hatchery RM&E can populate those designs (ISAB 2004). In short, we must determine which questions can be addressed given current RM&E and sufficient time.

Researchers must also evaluate information needs that cannot be sufficiently addressed given current RM&E, and devise an implementation plan to address those deficiencies. This evaluation could build upon the "gaps" analysis conducted for hatchery RM&E in 2003. Similarly, the workgroup should identify existing and proposed hatchery RM&E that is unnecessary to meet the information needs specified in the designs.

Those RM&E elements deemed unnecessary to evaluate the impact of the Hatchery Action should then be scrutinized to determine if their termination would adversely impact the ability to make decisions with regard to other BiOp related elements (e.g., hydrosystem evaluations or the ability to assess the status and trends of populations) and/or would impact the ability to successfully operate the hatchery program. Elements that cannot be terminated should be appropriately categorized within the Council's Columbia River Basin Fish and Wildlife Program with regard to the monitoring activities that they support (e.g., hydrosystem evaluations, hatchery operations[3] etc.).

Finally, reports describing progress towards meeting design objectives, evaluating sufficiency of the implemented program, and reporting the results when appropriate.

Although the implementation of the approach described above is challenging, there are numerous benefits. For example, under the *status quo*, every hatchery program must be accompanied by a relatively extensive RM&E plan. Under this proposed approach, a subset of hatcheries could be selected for research, and because the selection process utilizes a balanced stratified design, the results of that research could be applied to the remaining hatcheries which could then be accompanied by a significantly reduced RM&E burden. Thus, this enables a prioritization of hatchery RM&E activities on a regional scale and at the scale of individual programs. In short, hatchery programs could be grouped into strata, for example based on the ecoregion where they are located, species/life-history(ies) that they propagate, purpose (integrated versus isolated), or some other grouping. Each program would likely meet a number of status and trend, effectiveness, and uncertainties information needs. With an appropriate statistical design, it would be possible to select hatchery programs based on their existing RM&E programs, potential to meet additional information needs, and their ability to populate strata in order to meet the information needs of the designs.

[3] For example, many supplementation programs employ risk-aversion methods that require a specified proportion of natural origin fish in broodstock and place limits on the proportion of escapement to natural production that consists of hatchery origin adults. Implementation of this management feature requires the ability to estimate hatchery ratios in escapement and relatively strict control on the number of hatchery origin adults allowed to spawn naturally. Typically the information required to implement this type of risk-aversion is funded through RM&E, but should more appropriately be considered part of hatchery operations.

7. INTEGRATING HABITAT AND HATCHERY RM&E EFFORTS

The success of hatchery production hinges, among other factors, on the availability of high quality habitat of sufficient capacity to support either deliberate (i.e., in the case of supplementation, safety-net, or conservation programs) or unintended (in the case of mitigation or production hatcheries) increases in juvenile and adult abundance in freshwater spawning and rearing habitat. The success of habitat actions, measured as an improvement in freshwater productivity (e.g., smolts per redd or smolts per female), rests on the correct identification of habitat factors that limit productivity or survival, implementation of actions that modify physical attributes of the environment and the mechanistic translation of those actions to increased productivity or survival. Thus, the relationship between hatchery and habitat actions is clear. This relationship transfers in a more complex manner to the evaluation of the effectiveness of hatchery and habitat actions.

Hatchery production adds to the complexity of evaluating habitat actions by at least two mechanisms:

- If hatchery production significantly exceeds habitat capacity prior to and following the implementation of a habitat action; even a habitat action that successfully increases habitat capacity or quality may have no detectable influence on freshwater productivity.
- If hatchery origin juveniles or adults decrease freshwater productivity (e.g., through the introduction of disease, predation, competition, or a decrease in reproductive success), a habitat action that might otherwise have improved freshwater productivity may have no detectable impact.

As detailed in prior sections, it is likely that some habitat and hatchery effectiveness evaluations will require contrasts between “treated” and “reference” streams. From an experimental design perspective, the relationship between hatchery and habitat actions is potentially problematic for the following reasons:

- Unless the distribution and magnitude of habitat actions is similar in treated and reference streams used for hatchery evaluations, comparisons of freshwater productivity between them will be confounded.
- Unless the distribution and magnitude of hatchery actions/impacts (e.g., stray ratios) ares similar in treated and reference streams used for habitat evaluations, comparisons of freshwater productivity between them will be confounded.

Unfortunately the impacts of habitat and hatchery actions on freshwater productivity are not well quantified, and are, in fact, the subject of the RM&E proposed in this document. Thus, we lack the information required to disentangle the impacts of one from the other. In this attachment, we evaluate the potential for improving habitat and hatchery designs by considering them jointly. Two opportunities are considered:

- Implementation of intensive monitoring in select locations to validate and evaluate the performance of model-based approaches that evaluate freshwater productivity as a function of habitat features, explicitly incorporating the impacts of hatcheries
- Identification of opportunities to implement population and habitat status and trend monitoring to serve the reference requirements of both habitat and hatchery designs.

7.1 IMPLEMENTATION OF INTENSIVE MONITORING TO VALIDATE AND EVALUATE MODEL-BASED DESIGNS

In the following, we provide three examples of proposed projects that combine elements of status and trend and effectiveness monitoring to jointly evaluate the effectiveness of habitat and hatchery actions. Although rare, the identification of opportunities such as those described below should be a high priority for evaluating the habitat and hatchery Actions.

Numerous model-based designs have been identified in Appendix B, Attachment B.2.6-3 Tributary RM&E. An example of how those designs can be leveraged to simultaneously serve habitat and hatchery information needs is provided by the Integrated Status and Effectiveness Monitoring Project (ISEMP) population and habitat status and trend monitoring project proposed for implementation in the South Fork Salmon River in Idaho. The South Fork Salmon River contains both a safety-net artificial propagation program that supplements the Spring/Summer Chinook Salmon population in Johnson Creek, and a large mitigation program that propagates Spring/Summer Chinook Salmon to support fisheries targeting the population residing in the mainstem South Fork Salmon River. In addition, a third population of Spring/Summer Chinook Salmon that is not targeted by hatchery actions resides in the Secesh River. Combined, the three populations form a single Major Population Group (MPG) of Spring/Summer Chinook Salmon.

A model, similar in nature to Shiraz, was developed to investigate life-stage specific mortality and abundance as a function of habitat quantity (capacity) and quality (survival) for these three populations. Given sufficient information, the model framework can explicitly incorporate survival and productivity functions for hatchery and natural origin adults and juveniles as well as crosses.

The South Fork Salmon River provides a somewhat unique opportunity to simultaneously address habitat, hatchery, and status and trend information requirements of the Actions owing to the operation of two hatchery programs that represent a large range in hatchery management, and their proximity to a potential reference stream (the Secesh River).

Implementation of an RRS study in Johnson Creek would enable an evaluation of the reproductive fitness of adults produced by a safety-net hatchery with a mean PNI of 0.79 (Craig Rabe, Nez Perce Tribe, Personal Communication, 27 February 2007) as well as the reproductive fitness of stray hatchery adults from the large mitigation facility (McCall Hatchery) located in the adjacent mainstem SFSR. From the perspective of habitat RM&E, implementation of this project would enable a direct evaluation of the impacts of hatchery origin adults on freshwater productivity in targeted and non-targeted populations and enable an evaluation of whether model-based approaches can remove the influence of hatcheries from evaluations of the effectiveness of habitat actions. From the perspective of hatchery RM&E, the implementation of the RRS study in Johnson Creek would enable an evaluation of the reproductive fitness of adults produced by a safety-net program and would enable an evaluation of the impacts of stray mitigation adults on productivity of a supplemented population.

The Upper Columbia River provides an example of how model-based and design-based studies can be integrated to address both hatchery and habitat treatment effects. The Wenatchee River Basin contains both a supplementation/conservation hatchery program and a mitigation hatchery program. In addition, there are several habitat actions that will be implemented in the Wenatchee Basin, most of which address primary limiting factors such as connectivity, off-channel and riparian habitat, and stream flows. The following RM&E activities presently occur within the Wenatchee Basin:

- Status and trends of habitat and population characteristics (at the population scale) are monitored under ISEMP using a rigorous design-based approach.
- The effectiveness of the supplementation/conservation program is monitored at the population scale using a paired control-treatment design. Potential reference streams being evaluated by the Hatchery Evaluation Technical Team include the Naches River in the Yakima basin, the Secesh River in the Salmon River Basin and Marsh and Lake creeks in the Salmon River Basin
- Relative reproductive success of supplemented Spring Chinook Salmon is being studied in the Wenatchee Basin.
- Some of the habitat actions (e.g., off-channel habitat actions) are monitored for effectiveness at the reach scale.

The status/trend, effectiveness monitoring studies, and reproductive success studies are all integrated to provide maximum spatial coverage at the lowest cost. Finally, a Shiraz-type model is being developed by the NOAA Science Center for the Wenatchee Basin. This model relies on data collected under the monitoring programs and will help tease apart the effects of hatchery and habitat actions on population metrics. In summary, the identification of opportunities such as those provided by the South Fork Salmon River and the Upper Columbia River to coordinate habitat and hatchery RM&E could provide information that would not otherwise be produced by isolated implementation of research.

7.2 COORDINATED IDENTIFICATION OF REFERENCE OPPORTUNITIES FOR HABITAT AND HATCHERY RM&E

In this section, we provide two examples of proposed projects that utilize one or more reference streams to jointly evaluate the effectiveness of habitat and hatchery actions. Because of the cost-savings associated with the use of a reference location for both types of effectiveness monitoring, the identification of multipurpose references should be a high priority in both the habitat and Hatchery Action appendices.

As described in the introduction, reference streams/populations will likely be required to satisfy both the habitat and hatchery RM&E requirements described in the Action. The identification of locations that serve as references for both habitat and hatchery evaluations would increase the efficiency of the monitoring program and would decrease the likelihood of implementing management actions that would confound treatment and reference comparisons. Again, the South Fork Salmon River provides a good example of one such opportunity. The Secesh River (a tributary to the South Fork Salmon River) is not affected by any current habitat actions, with the exception of grazing limitations, and likewise has never been directly supplemented. In fact, the Secesh River and its largest tributary (Lake Creek) are currently used as a reference stream by the Idaho Supplementation Studies project.

Other potential reference streams for stream-type Chinook salmon include the Naches River in the Yakima River Basin and Marsh Creek in the Salmon River Basin. These streams are currently being evaluated by the Upper Columbia Hatchery Evaluation Technical Team as potential reference areas for the hatchery supplementation programs in the Upper Columbia River Basin. The streams could potentially serve as a reference system for habitat actions proposed for the East Fork South Fork Salmon River and in the Upper Columbia River.

In short, the designation of streams such as Lake Creek as references for both hatchery and habitat actions could improve our ability to exclude management actions in those locations that otherwise might confound comparisons. Likewise, by using those locations as references for multiple studies the overall cost of monitoring would be reduced.

8. PROJECT IMPLEMENTATION AND COMPLIANCE MONITORING

Hatchery projects will be monitored for implementation of planned deliverables and compliance to performance expectations. Implementation monitoring documents the type of hatchery action, its location, and whether the action was implemented properly and completely or complies with established standards. It does not require collection of biological or environmental data. The Action Agencies will use standards developed under regional coordination forums [e.g., Pacific Northwest Aquatic Monitoring Partnership (PNAMP)] where applicable for project tracking to support regional coordination of project implementation tracking and effectiveness monitoring designs.

Implementation and compliance monitoring will answer two primary questions:

- Were the actions implemented completely and according to expected schedules?
- Were the actions implemented correctly?

To help answer these questions, the Action Agencies will:

- Monitor the successful implementation of projects through standard procedures and requirements of contract oversight and management, and review of project deliverables and final reports.
- Maintain BiOp databases to provide fish improvement and monitoring project and action level details for planning and reporting purposes. This approach will provide the most up-to-date information about the status of actions and projects being implemented.
- Use the project level detail contained in the Action Agencies' BiOp databases to track results and assess our progress in meeting programmatic level performance targets. This performance tracking will be reported through annual progress reports and the 2012 and 2015 comprehensive reports.

9. RM&E COORDINATION AND DATA MANAGEMENT

The Action Agencies will coordinate RM&E activities with other federal, state and Tribal agencies, and will ensure that the information obtained under the auspices of the FCRPS RM&E efforts is archived in appropriate data management systems. See the RM&E Coordination and Data Management section of Appendix B.2.6 for specific actions (Section B.2.6.8). Much of the RM&E coordination and data management related to hatcheries will be carried out under regional coordination forums such as PNAMP and the Northwest Environmental Data-network, and the pilot studies in the Upper Columbia River, John Day River, and Upper Snake River currently being implemented through the ISEMP project.

REFERENCES

Independent Scientific Advisory Board. 2004. Review of the Action Agencies and NOAA Fisheries' Draft Research, Monitoring & Evaluation Plan for the NOAA-Fisheries 2000 Federal Columbia River Power System Biological Opinion (RME Plan). January. Available at: http://www.nwcouncil.org/library/