MULTI-SPECIES BIOLOGICAL ASSESSMENT OF THE FEDERAL COLUMBIA RIVER POWER SYSTEM

SUBMITTED TO THE NATIONAL MARINE FISHERIES SERVICE AND U.S. FISH AND WILDLIFE SERVICE

by
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U.S. Bureau of Reclamation
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ACRONYMS AND ABBREVIATIONS

Action Agencies	Corps, BoR, BPA
BA	Biological Assessment
BLM	U.S. Bureau of Land Management
BGS	behavioral guidance system
BIA	Bureau of Indian Affairs
BKD	bacterial kidney disease
BLM	Bureau of Land Management
BoR	U.S. Bureau of Reclamation
BPA	Bonneville Power Administration
cfs	cubic feet per second
Corps	U.S. Army Corps of Engineers
CRFMP	Columbia River Fish Mitigation Project
CRI	Cumulative Risk Initiative
CRITFC	Columbia River Inter-Tribal Fish Commission
CRTOC	Columbia River Treaty Operation Committee
DGAS	Dissolved Gas Abatement Study
DPS	distinct population segment
E	endangered
EDT	Ecosystem Diagnosis and Treatment
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act of 1973, as amended
ESBS	extended-length submersible bar screen
ESU	evolutionary significant unit
FCRPS	Federal Columbia River Power System
FGE	fish guidance efficiency
FPE	fish passage efficiency
FPP	Fish Passage Plan
FR/EIS	feasibility report/environmental impact statement
FY	fiscal year
IPC	Idaho Power Company
ISAB	Independent Science Advisory Board
ISG	Independent Science Group
ISRT	Integrated Scientific Review Team
KAF	thousand acre-feet
kcfs	thousand cubic feet per second
MOP	minimum operating pool
NA	not applicable

ACRONYMS AND ABBREVIATIONS

NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NRC	National Research Council
PATH	Plan for Analyzing and Testing Hypotheses
PIT	passive integrated transponder
QAR	Quantitative Analysis Report
RFP	request for proposals
RM	river mile
RPA	reasonable and prudent alternative
SBC	surface bypass collector
SCT	System Configuration Team
SOR	System Operation Review
sq mi	square mile
T	threatened
TDG	total dissolved gas
TMT	Technical Management Team
USFWS	U.S. Fish and Wildlife Service
VARQ	Variable (VAR) outflow (Q)
WQT	Water Quality Team

1. INTRODUCTION

1.1 PURPOSE

The U.S. Army Corps of Engineers (Corps), U.S. Bureau of Reclamation (BoR), and Bonneville Power Administration (BPA) (collectively termed the “Action Agencies”) carry out and coordinate the generation and marketing of power from the Federal Columbia River Power System (FCRPS). The FCRPS consists of the projects and facilities which are listed in Section 1.4. The projects were constructed and are operated for multiple purposes, including hydropower generation, flood control, irrigation, navigation, fish, wildlife, water quality, municipal and industrial water, and recreation.

In 1995, the Action Agencies consulted under section 7 of the Endangered Species Act of 1973, as amended (ESA), on the operation of the FCRPS with the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS). This consultation resulted in three separate biological opinions being issued by NMFS and USFWS (as listed in Section 1.2) covering anadromous and resident fish species which were listed at the time. The NMFS then issued a supplemental biological opinion in 1998 (also listed in Section 1.2), which addressed the additional listing, since 1995, of upper Columbia steelhead.

In 1999, NMFS listed six additional populations of anadromous fish as either threatened or endangered and USFWS listed one additional resident fish species pursuant to the ESA. In addition, system configuration changes have been made and operation of the FCRPS has been modified relative to that which existed in 1995. Finally, additional information has become available since 1995 concerning the species covered by NMFS’s and USFWS’s 1995 and 1998 opinions.

In light of these circumstances, the purpose of this Biological Assessment (BA) is to reinitiate consultation on the FCRPS and to describe ongoing and potential future actions being considered within the system. This BA evaluates the potential effects of the operation of the FCRPS on the continued existence of all species either listed, proposed, or designated as candidates for listing under the ESA that are potentially affected by these actions. With the reinitiation of consultation, the Action Agencies seek further biological opinions from NMFS and USFWS.

There are five main sections in this BA. The introductory section (Section 1) describes the extent of the geographic region covered, species addressed, and status of Section 7 consultation. Section 1 also includes a description of other actions and processes occurring in the Columbia River Basin that involve relevant information about the relationship of ESA species to the FCRPS. Section 2 describes the current operations and configurations of the FCRPS that are being implemented for the benefit of listed species. Additional operation and configuration modifications that have been proposed by various parties, but mainly from the NMFS and USFWS, to benefit to listed species, are presented in Section 3. Potential methods of implementing performance standards for the hydrosystem to prioritize actions, measure results, and experimentally manage key uncertainty are presented in Section 4. Section 5 summarizes the likely effects of the operation and configuration of the FCRPS on listed fish species.

1.2 DOCUMENTS INCORPORATED BY REFERENCE

This BA incorporates by reference the following:

- NMFS' 1995 *Biological Opinion - Reinitiation of Consultation on 1994-1998 Operation of the Federal Columbia River Power System and Juvenile Transportation Program in 1995 and Future Years* (NMFS, 1995);
- USFWS' 1995 *Biological Opinion on the Supplemental Biological Assessment for Operations of the Federal Columbia River Power System Projects* (USFWS, 1995);
- USFWS' 1995 *Biological Opinion of Effects of Operation of FCRPS on Kootenai River White Sturgeon* (Dwyer, 1995);
- NMFS' 1998 Supplemental Biological Opinion titled – *Operations of the Federal Columbia River Power System including the Smolt Monitoring Program and the Juvenile Fish Transportation Program: A Supplement to the Biological Opinion Signed on March 2, 1995 for the Same Projects* (NMFS, 1998);
- BoR's 1998 BA: *Biological Assessment, Bureau of Reclamation Operations and Maintenance in the Snake River Basin Above Lower Granite Reservoir* (BoR, 1998);
- USFWS' 1999 Biological Opinion: *Biological Opinion on the Bureau of Reclamation Operations and Maintenance Activities in the Snake River Basin Upstream of Lower Granite Dam Reservoir* (USFWS, 1999);
- NMFS' 1999 Biological Opinion: *Biological Opinion—Bureau of Reclamation Operations and Maintenance of its Projects in the Snake River Basin Above Lower Granite Dam: A Supplement to the Biological Opinions Signed on March 2, 1995 and May 14, 1998* (NMFS, 1999a);

- Action Agencies' 1999 BA: *Biological Assessment for Effects of FCRPS Operations on Columbia Basin Bull Trout and Kootenai River White Sturgeon* (Corps et al., 1999);
- USFWS August 20, 1999, letter requesting additional information for the 1998 bull trout and Kootenai River white sturgeon BA (Hallock, 1999); and
- Recent consultation on Lower Columbia River chum salmon outlined in NMFS' October 14, 1999 letter and Action Agencies' response in their letter dated December 8, 1999.

1.3 GENERAL OPERATIONS AND CONFIGURATION

1.3.1 Corps Projects in the Columbia River Basin

This and previous consultations have addressed the effects of the operation and configuration of certain Corps projects in the Columbia and Snake River Basins. Specifically, there are 12 Corps projects that are addressed in this BA. To the extent that other Corps projects in the basin impact listed ESA species, the Corps will conduct separate ESA Section 7 consultations.

The Corps operates these multi-purpose projects in coordination with the other Action Agencies, and the effects of this coordinated operation on listed species is the subject of this BA. Also identified in this BA are major modifications of certain Corps projects to improve survival of listed species and the process being used to evaluate and make configuration decisions.

1.3.2 BoR Projects in the Columbia River Basin

This consultation and those that have been previously conducted by the Action Agencies on FCRPS operations, include the hydrological effects on mainstem river flows of irrigation water depletions related to BoR projects. These depletions were accounted for in base flows at the 1990 level of use. There are a total of 32 BoR projects in the Columbia River Basin in the states of Montana, Idaho, Washington and Oregon. Most of these projects depend on a combination of natural flow and reservoir storage to meet irrigation water demands. To the extent that river flows are depleted by irrigation project withdrawals and/or storage, the effects relative to those withdrawals are accounted for in the Columbia River hydro regulation models used by the Action Agencies. Over half of the water diverted for irrigation is eventually returned to surface or groundwater systems. To the extent individual BoR projects may affect listed species locally, or in proximity to a particular project, or in ways which are discreet and distinct from downstream, flow-related impacts, BoR has and will engage in additional, separate ESA Section 7 consultations for such projects.

BoR has recently completed an overview report describing its Columbia River Basin irrigation projects and related water uses. The report, entitled, *Description of Bureau of Reclamation Projects in the Columbia River Basin*, is appended to this BA (see Appendix A).

Similar to Corps projects, the intent of this BA is to also initiate Section 7 consultation on BoR projects. For the BoR, this will include project diversions and return flows with respect to all 32 projects described in Appendix A. Likewise, this BA is explicitly intended to provide project descriptions for BoR's upper Snake River projects through incorporation by reference to the April 1998 *BA on the Bureau of Reclamation Operations and Maintenance in the Snake River Basin Above Lower Granite Reservoir*.

1.4 FCRPS ACTION AREA

The action area is defined as all areas affected by the actions. This includes: the Snake River Basin from the confluence with the Columbia River upstream to the Jackson Lake Reservoir and upstream on the Clearwater River to the upstream limit of Dworshak Reservoir on the North Fork; the Columbia River from the estuary at the mouth of the river to the upstream limits of Grand Coulee Reservoir (Lake Roosevelt); and upstream limits of Hungry Horse Reservoir, Lake Koocanusa, and Lake Pend Oreille. The specific areas to be addressed are listed below and their locations are shown in Figure 1-1. The hydrologic effects of all BoR projects are identified in Appendix A.

The major storage projects and associated areas included in the action area are:

- Dworshak Dam (operated by the Corps)
- Grand Coulee Dam and Banks Lake (operated by the BoR)
- Chief Joseph Dam (operated by the Corps)
- Hungry Horse Dam and associated Flathead River (operated by the BoR)
- Albeni Falls Dam and associated Pend Oreille River (operated by the Corps)
- Libby Dam and the Kootenai River below the dam (operated by the Corps)

Figure 1-1. Map of the Columbia River Basin Including the Major Facilities That Make Up the Federal Columbia River Power System (FCRPS)

Run-of-the-river hydropower facilities operated by the Corps included in the action area are:

- Lower Granite
- Little Goose
- Lower Monumental
- Ice Harbor
- McNary
- John Day
- The Dalles
- Bonneville

1.5 SPECIES ADDRESSED IN THE BA

The Corps, on behalf of the Action Agencies, submitted written requests to NMFS and USFWS for confirmation of a list of endangered and threatened species that could potentially be present in the action area or that could be affected by proposed actions. In these requests, the Corps identified the species it believes may be of potential concern and asked the agencies to confirm that these species are of interest and should be addressed in this BA. USFWS responded on December 3, 1998 by providing the Corps with a list of species under its jurisdiction. NMFS indicated that a response would be delayed, but suggested some additional species that may need to be added to the Corps' list. Since the submittal of the Corps' original list of anadromous species to NMFS, additional anadromous fish species have been proposed for listing. The complete list of species that were considered for possible inclusion in this BA is presented in Table 1-1.

As noted in Table 1-1, two species, the bull trout and Kootenai River white sturgeon, are addressed in a separate BA (Corps et al., 1999) and will only be referenced here.

After developing the list in Table 1-1, 10 of the species were eliminated from further review because they were not affected by FCRPS projects, exclusive of projects in the upper Snake River Basin (as noted in Table 1-1).

1.6 OTHER COLUMBIA BASIN SECTION 7 CONSULTATIONS

Actions by some of the Action Agencies within specific areas of the Columbia-Snake River System have also been addressed in separate BAs, which are incorporated by reference in this BA. Separate BAs have been, or are being prepared for the following areas:

Table 1-1. Species Initially Considered for Evaluation

Species	Scientific Name	Status[1/]
Anadromous Fish (NMFS oversight species)		
Snake River Sockeye Salmon	*Oncorhynchus nerka*	E
Snake River Spring/Summer Chinook Salmon	*Oncorhynchus tshawytscha*	T
Snake River Fall Chinook Salmon	*Oncorhynchus tshawytscha*	T
Snake River Steelhead	*Oncorhynchus mykiss*	T
Upper Columbia River Spring Chinook Salmon	*Oncorhynchus tshawytscha*	New Listing, E
Upper Columbia River Steelhead	*Oncorhynchus mykiss*	E
Middle Columbia River Steelhead	*Oncorhynchus mykiss*	New Listing, T
Lower Columbia River Coho Salmon	*Oncorhynchus kisutch*	Candidate species for listing in 1999
Lower Columbia River Chinook Salmon	*Oncorhynchus tshawytscha*	New Listing, T
Lower Columbia River Steelhead	*Oncorhynchus mykiss*	T
Columbia River Chum Salmon	*Oncorhynchus keta*	New Listing, T
Upper Willamette River Chinook Salmon	*Oncorhynchus tshawytscha*	New Listing, T
Upper Willamette River Steelhead	*Oncorhynchus mykiss*	New Listing, T
Resident Fish, Wildlife, and Plants (USFWS oversight species)		
Bull Trout[2/]	*Salvelinus confluentus*	T
Southwestern Washington/Columbia River Coastal Cutthroat Trout	*Oncorhynchus clarki clarki*	New Proposed T
Westslope Cutthroat Trout	*Oncorhynchus clarki lewisii*	Status under review
Kootenai River White Sturgeon[2/]	*Acipenser transmontanus*	E
Bliss Rapids Snail [3/]	*Taylorconcha serpenticola*	T
Idaho Springsnail [3/]	*Foutelicella idahoensis*	E
Snake River Physa [3/]	*Physa natricina*	E
Utah Valvata Snail [3/]	*Valvata utahensis*	E
Oregon Spotted Frog [4/]	*Rana pretiosa*	Candidate species
Water Howellia [4/]	*Howellia aquatilis*	T
McFarlane's Four-o'-clock [4/]	*Mirabilis macfarlanei*	T
Ute's Ladies Tresses [3/]	*Spiranthes diluvialis*	T
Howell's Spectacular Thelypodium [3/]	*Thelypodium howellii* ssp. *spectabilis*	T
Basalt Daisy [3/]	*Erigeron basalticus*	Candidate species
Bald Eagle	*Haliaeetus leucocephalus*	T, Proposed for delisting
Peregrine Falcon	*Falco peregrinus*	Recently delisted
Grizzly Bear	*Ursus arctos*	T
Gray Wolf	*Canis lupus*	E
Canada Lynx	*Lynx canadensis*	Newly Proposed T

[1/] T = listed under the ESA as threatened; E = listed under the ESA as endangered
[2/] Covered in the FCRPS' BA on bull trout and Kootenai River white sturgeon (Corps et al., 1999).
[3/] Species not affected by FCRPS' actions, exclusive of the upper Snake River Basin.
[4/] Species not affected by FCRPS' actions.

- Yakima River Basin - ongoing
- Willamette River Basin - ongoing
- Snake River upstream of Hells Canyon (BoR, 1998)
- Umatilla River Basin - ongoing

At this time, the Snake River upstream of Hells Canyon is the only one of these areas with completed BAs and Biological Opinions (BoR, 1998; USFWS, 1999; NMFS, 1999a).

1.7 OTHER RELATED REGIONAL FORUMS

Information from many sources was used to develop this BA, including coordination with other ongoing Federal and regional processes as follows:

1.7.1 Federal Caucus/All H Paper

The Federal Caucus includes the NMFS, Corps, BoR, BPA, Environmental Protection Agency (EPA), Bureau of Indian Affairs (BIA), Bureau of Land Management (BLM), USFWS, and U.S. Forest Service. The primary role of the Federal Caucus is to develop a multi-species paper that describes ranges of potential federal activities for consideration to meet ESA obligations and to rebuild Columbia Basin stocks. Non-Federal (state, local, and private) activities would also be considered as they contribute toward recovery of ESA-listed species in the Columbia River Basin.

The Federal Caucus is describing and analyzing recovery options across each stage of the ESA-listed fish life cycles: habitat, hatcheries, harvest, and hydropower system. These options are broadly described, to engage a regional discussion. The measures in each “H” will vary depending on the companion measures in the other Hs. This will ensure that hydropower improvements, in combination with other factors that affect fish, achieve the desired results.

This BA reinitiates consultation between the operating agencies (BPA, BoR, and Corps) and NMFS and USFWS which is intended to lead to a formal determination of hydrosystem actions necessary to achieve survival of the listed species. Hence, the Biological Opinion is highly dependent on further resolution of the overall recovery goals set by the region, and the allocation of those goals among the Hs.

To address the relationships and importance among the Hs, a work group comprised of members from the Federal and regional partners is developing a concept paper (“All H Paper”) on integrated actions affecting each life stage of listed salmon, which could achieve species survival and recovery if implemented. The All H Paper identifies management options for each of the Hs (i.e., habitat, harvest, hatcheries, and hydrosystem).

This BA cannot be matched directly to any of the hydro options in the All H Paper. Although sections in the BA describe actions similar to the "Current Program" hydro option, it also defines a decision process for development of additional measures on the hydrosystem that could be used to achieve survival improvements (see Section 4.0).

The All H Paper work group will coordinate with the analytical work of the Cumulative Risk Initiative (CRI), the Ecosystem Diagnosis and Treatment (EDT), Plan for Analyzing and Testing Hypotheses (PATH), and Quantitative Analysis Report (QAR). These are summarized below in the following subsections.

1.7.2 Plan for Analyzing and Testing Hypotheses (PATH)

The Plan for Analysis and Testing of Hypotheses (PATH) is a structured program of formulating and testing hypotheses involving the fundamental biological issues surrounding recovery of ESA-listed salmon and steelhead species in the Columbia River Basin. The PATH decision analysis has been focused on alternative hydrosystem actions that may be used to prevent the extinction and aid in the recovery of listed stocks.

1.7.3 Cumulative Risk Initiative (CRI)

In the Federal agencies' All H process, matrix modeling is being conducted under the NMFS Northwest Fisheries Science Center's CRI. The modeling is being used to evaluate the sensitivity of population growth for each evolutionarily significant unit (ESU) to changes in survival in specific life history stages as a result of management actions. The analysis will determine potential combinations of All H strategies to achieve the biological objectives related to recovery of ESA-listed species.

1.7.4 NMFS White Papers

NMFS has synthesized existing information on salmonid passage through the FCRPS. Four papers ("White Papers") have been prepared that address existing data on dam passage, transportation, the flow/survival relationship, and predation. The papers also characterize uncertainties associated with existing data, and the uncertainties raised in recent analyses by regional forums. NMFS distributed these papers in the region for review and comment in October 1999 (NMFS, 1999b, c, d, and e). Because the White Papers are in the draft stage and are not final, information derived from them may be subject to future revision.

1.7.5 Quantitative Analysis Report (QAR)

NMFS, in cooperation with other parties, is developing the QAR for the listed species that may be affected by the non-Federal mid-Columbia projects (i.e., those operated by Douglas, Chelan, and Grant County Public Utility Districts). The QAR will quantitatively assess the biological requirements and survival and recovery for endangered upper Columbia spring chinook salmon and endangered upper Columbia River steelhead.

1.7.6 Northwest Power Planning Council's Multi-Species Framework Project/ Ecosystem Diagnosis and Treatment (EDT) Analysis

The Northwest Power Planning Council's Multi-Species Framework Project is developing visions, strategies, and alternatives for recovering fish and wildlife resources in the Columbia River Basin and analyzing the biological and social/human effects of alternatives. The Hydro Work Group of the Federal Caucus and the Framework staff jointly evaluated alternative measures for system configuration and operations and agreed to the specifications of these measures in seven Framework alternatives and three Federal scenarios. The joint group also coordinated the analysis of hydrosystem operations, the biological studies and evaluations, and other Federal and Framework tasks related to the hydrosystem.

The Framework Project will characterize a set of alternative futures for the Columbia River Basin that focus on a long-term vision for the region. The Framework uses an analytical technique called EDT to compare the ecological impacts of various alternatives and describe their economic, social, and cultural impacts. The analysis focuses on long-term conditions and places an emphasis on habitat actions. In contrast to other analytical methods, the EDT is not statistically based. Instead, it provides a way to compare alternatives with regard to their effect on species' life histories, in addition to the more traditional values of abundance and productivity.

2. NEAR-TERM OPERATIONS

2.1 FLOWS AND OPERATIONS

The operations and configurations of the FCRPS that are currently being implemented for the benefit of listed species are described in this section. This includes descriptions of flow measures, fish transportation, reservoir operations, structural configurations and predator control actions to enhance juvenile anadromous fish passage survival. Additionally, existing actions for improvement of adult anadromous passage survival are described. Also, flow and operational actions being implemented to aid other species including resident fish are characterized.

2.1.1 Objectives

2.1.1.1 Salmon/Steelhead

Flow recommendations are based on the 1995 Biological Opinion and were continued in the 1998 Biological Opinion with some modification on flow objectives and planning dates. These flows are intended to benefit salmon and steelhead migration. In addition, recent consultation discussions regarding chum salmon also identified flow objectives for spawning and incubation below Bonneville Dam.

For Snake River salmon and steelhead, the seasonal average flow objectives range from 85 to 100 thousand cubic feet per second (kcfs) from April 3 to June 20, 50 to 55 kcfs from June 21 to August 31 in the lower Snake River measured at Lower Granite, and 220 to 260 kcfs from April 20 to June 30 and 200 kcfs from July 1 to August 31 in the lower Columbia River as measured at McNary. The flow objectives in any year are determined using a sliding scale based on forecasted runoff as specified in the 1995 Biological Opinion. For upper Columbia steelhead, the seasonal average flow objective is 135 kcfs from April 10 to June 30 as measured at Priest Rapids Dam.

These flows are managed on a weekly basis in the context of seasonal flow objectives. In addition, management of flow augmentation is also conditioned on deference to refill to the upper rule curve by June 30, subject to in-season considerations. Reservoir drafts are also limited to 10 feet at Grand Coulee, 20 feet at Hungry Horse, and 20 feet at Libby.

Some flood control reallocation has occurred from Mica Dam and Arrow Dam in Canada to other projects relative to that occurring prior to 1998 (Corps et al., 1998) as recommended by the Columbia River Treaty Operation Committee (CRTOC). The result has been some changes in the Grand Coulee Dam flood control rule curve. Additionally, the Treaty has allowed for mutually beneficial agreements for up to 1 million acre-feet of flow storage in Arrow Reservoir.

For chum salmon below Bonneville Dam, the FCRPS is being operated in an attempt to meet 125 kcfs from approximately early November to early April, to the extent possible while maintaining Biological Opinion requirements to be at the upper rule curve on April 10. To the extent natural conditions allow, and in a conservative, step-wise approach, higher flows will be made available.

It is recognized that in some years, it will not be possible to sustain these flows and still meet required reservoir levels in the spring, as required for flow augmentation for juvenile spring migrants. In all events, the refill requirements of the 1995 Biological Opinion and 1998 Supplement will be met to the maximum extent possible.

2.1.1.2 Bull Trout

Bull trout can be adversely impacted by rapid elevation fluctuations in both reservoirs and unimpounded river reaches below projects. Sudden increases or decreases in flows can dewater stream banks, strand juvenile fish, disrupt adult fish populations, and reduce availability of aquatic insects and small fish for food. In order to reduce impacts, the Action Agencies intend to limit ramp-up and ramp-down rates as needed to reduce rapid changes in wetted perimeter. Reservoir levels will be managed until August 31 to provide protection for listed resident fish while providing downstream flows for sturgeon spawning and salmon migration. In some cases, fall lake elevations will be managed to provide favorable conditions for prey base spawning and incubation of species such as kokanee, which may be a part of the prey base for bull trout. Measures to protect bull trout are described by project in a separate BA prepared by the Action Agencies (Corps et. al., 1999).

2.1.1.3 Kootenai River White Sturgeon Flow Objectives

Specific flow requirements for natural spawning by white sturgeon and successful recruitment in the Kootenai River remain largely unknown. Until flows that contribute to successful recruitment are established, annual Kootenai River flow augmentation for white sturgeon should be based on water availability in the upper Kootenai River Basin. The *White Sturgeon: Kootenai River Population Recovery Plan* proposes implementing new Libby Dam operational guidelines, such as using tiered flows (Kootenai Integrated Rule Curves) to set aside water volumes for spring sturgeon flows, and variable outflow (see Section 3.5.2), to ensure that more water is available for white sturgeon, salmon, and all species in lower water years. The Montana Department of Fish, Wildlife, and Parks has shown that storing water behind Libby Dam in winter not only increases water availability for sturgeon flow augmentation, but also reduces impacts to the Lake Koocanusa fishery. This operation may also benefit westslope cutthroat trout, rainbow trout, and burbot in the Kootenai River since water releases under this operating strategy would correspond to their life cycle requirements.

Under these operational guidelines, flow objectives will vary annually by water temperature, water volume, duration, and shape. A tiered approach for sturgeon flows is proposed with higher releases in high runoff years and no releases for sturgeon in the lowest runoff years. When flows are provided, the current plan is for flow release including a “pulse” of maximum powerhouse discharge for 3 days followed by flows of 11 to 25 kcfs. The effects of flow and water temperature on various life stages of white sturgeon will also be monitored. The intent of this operation would be to store more water in Lake Koocanusa before the spring runoff to increase its refill probability. This operational strategy was designed to balance resident fish concerns with power production, flood control, and Lake Koocanusa refill under varying water availability ranging from drought to flood conditions.

2.1.1.4 Water Quality

Presently, the main water quality objectives are to reduce higher temperatures during periods of juvenile and adult migration and to reduce harmful effects on anadromous and resident fish of high total dissolved gas (TDG) concentrations resulting from spill. As a result of recommendations from the Technical Management Team (TMT) (see Section 4.5), flows will be released from Dworshak Dam to help reduce water temperatures in the Snake River for migrating fall chinook and steelhead. Gas concentrations are controlled by amount of spill and structures that reduce TDG production.

2.1.2 Specific Project Actions

2.1.2.1 Libby Operations

Lake Koocanusa typically begins fall drawdown near its August 31 interim draft limit at elevation 2,439 feet or 20 feet (recently 0 to 15 feet due to other operations) from full pool (except for Libby/Canadian storage swap operations noted in Section 2.1.2.7) because of operations to meet downstream salmon objectives. Drawdown of Lake Koocanusa begins August 31 and continues to be at the December 31 flood control elevation. Minimum releases begin in January except for flood control or power emergencies. The reservoir is maintained throughout the fall and winter to insure a 75 percent chance of being at the April 10 flood control elevation. Beginning April 10 and continuing through July, releases are made to try and achieve the goals set for white sturgeon in the Kootenai River. If at the conclusion of sturgeon operations, Lake Koocanusa is above elevation 2,439 feet, flows are provided to meet salmon objectives without spilling. Efforts to minimize flow fluctuations for benefit of bull trout below Libby are made until August 31. Ramping from power generation below 10 kcfs is reduced in an attempt to minimize potential adverse effects to aquatic resources. As with other reservoir operations, the TMT makes recommendations regarding operations for listed species. The Corps considers these recommendations along with others, like the Northwest Power Planning Council's Fish and Wildlife Program which requests the implementation of Integrated Rules Curves at Libby, in making final operational decisions.

2.1.2.2 Hungry Horse Operations

Hungry Horse Dam is operated to meet year-round local minimum streamflow needs in the Flathead River for protection of resident fish populations and to provide summer storage releases for Columbia River anadromous fish flow augmentation. The reservoir levels from January to June are based on water supply forecasts and the project is operated in an attempt to refill it completely by June 30. Throughout the year, releases from the reservoir are managed to provide a 3,500 cfs minimum flow on the mainstem Flathead River near Columbia Falls for the benefit of native resident fish.

Following Hungry Horse Reservoir's refill, storage is released to assist in meeting anadromous fish flow objectives on the Columbia River at McNary. These releases are coordinated through the TMT. Depending on the water year, up to 20 feet of storage is released to meet this need. When the reservoir refills completely to elevation 3,560 feet, a draft to elevation 3,540 feet is allowed for the McNary flow.

Hourly flow changes, though not formalized, are typically limited to 1,800 cfs/hour in the summer. Limits during other periods are based on turbine capacity. Spill is generally limited unless needed for flood control. Spill has, at times, resulted in exceedance of Montana's 110 percent dissolved gas saturation limit. A selective withdrawal water temperature control system has been installed on Hungry Horse Dam. Releases are made to try to meet recommended water temperature guidelines developed by the Montana Department of Fish, Wildlife, and Parks from June 1 through October (Corps et al., 1999).

2.1.2.3 Grand Coulee Operations

Per the 1995 Salmon Biological Opinion and the 1998 Supplemental Biological Opinion, Lake Roosevelt will usually be near elevation 1,280 feet following Labor Day weekend. It is usually refilled to elevation 1,283 feet or higher by the end of September for kokanee spawning needs. Following kokanee spawning, drafting in the fall is limited to elevation 1,265 feet by December 31. The operation from January through April 10 is to ensure an 85 percent confidence of refill to flood control on April 10 per the 1998 Supplemental Biological Opinion and to be consistent with historical operations and studies conducted during ESA consultations. Lake Roosevelt flood control criteria are established by the Corps. A minimum space of 500,000 acre feet (about elevation 1,283 feet) may be required starting in January. Additional draft is required based on water supply forecasts for The Dalles, with adjustments made for flood space provided at other reservoirs upstream of The Dalles. Drafting in the winter is generally limited to elevation 1,260 feet, 1,250 feet, and 1,240 feet in January, February and March, respectively, unless needed for flood control or power emergencies. The Gifford-Inchelium Ferry will need an elevation of 1,225 feet to operate after proposed repairs are completed in 1999. The flood control operation is managed to store in April, May, and June while reducing flooding downstream and refilling to elevation 1,290 feet by June 30. From April 10 to August 31, releases will be made to augment flows for anadromous fish. The reservoir will be drafted to as low as elevation 1,280 feet by August 31 in average and above average water conditions.

There are daily draft limits at Grand Coulee for purposes of reservoir bank stability. The limit between elevation 1,260 and 1,290 feet is 1.5 feet per day, between 1,240 and 1,260 feet is 1.3 feet per day, and below 1,240 feet is 1 foot per day.

Grand Coulee has a minimum flow requirement of about 30 kcfs or larger as needed to meet the minimum flows at Priest Rapids Dam. The Priest Rapids minimum flow is the higher of 36 kcfs or the Vernita Bar flow requirements during the December through May period. The Grand Coulee minimum flow is an average daily flow requirement; instantaneous flows may be less. Grand Coulee also has limits to the hourly rates of change for discharge. The Action Agencies will continue to coordinate with regional interests to develop operations to minimize potential stranding of post-emergent fall chinook.

2.1.2.4 Albeni Falls Operations

Like other storage projects, this reservoir is used for flood control and is drafted from late summer to winter and filled with spring runoff. However, the reservoir for this dam is a natural lake, Lake Pend Oreille, with changes in operations controlling lake level. The typical maximum reservoir range is elevation 2,051 to 2,062.5 feet. The reservoir is drawn down beginning on Labor Day and typically achieves lowest elevation between November 15 and 20. The earlier date has been established to enhance kokanee spawning. Levels are controlled within 1 foot after this date to protect the kokanee spawning areas. If the lake level increases in December, then a new minimum level is established within 0.5 feet of this elevation. January to March 31 operations allow for some reservoir fluctuation for power operations, but levels cannot decrease below the last established minimum water level in December. From April to June, the reservoir fills. During the summer, the reservoir is typically maintained within a 0.5-foot fluctuation (i.e., elevations 2,062 to 2,062.5 feet).

Experimental operations have occurred for the last several winters to examine the relationship between winter lake elevations and kokanee spawning. Under these operations, winter levels have been increased to elevation 2,055 feet in the winters of 1996-1997, 1997-1998 and 1998-1999. For the winter of 1990-2000, a winter lake elevation of 2,053 feet is being monitored. Prior to this experimental operation, Albeni Falls is drafted down to elevation 2,051 feet during winter operations.

2.1.2.5 Dworshak Operations

In recent years, Dworshak Reservoir has been used to augment flows downstream for the intended benefit of juvenile and adult salmon and steelhead passage in the summer. Releases in winter through early spring are also used to reduce losses of kokanee salmon. Dworshak begins the fall period near its August 31 interim draft limit of elevation 1,520 feet or 80 feet from full pool to provide for salmon/steelhead flow objectives. Dworshak is operated on minimum releases through winter in order to enhance the probability of being on the flood control rule curve by the beginning of April. Flow augmentation occurs through increased releases from April to August for juvenile fish migration. This project contains a temperature control outlet facility that is now used to provide cold water to cool mainstem Snake River during late summer months. Current hatchery facility configurations limit the extent of cool water releases. Cool water typically is released sometime during July/August when deep cool water from the reservoir can be selected by the multi-level outlet. The minimum release is 1,300 cfs from September to April, which is after fish migration flow objectives are required.

2.1.2.6 Upper Snake/Brownlee Operations

As directed in the Reasonable and Prudent Actions (RPAs) in the FCRPS 1995 and 1998 Supplemental Biological Opinions, BoR provides 427,000 acre-feet of water for flow augmentation each year from the upper Snake Basin to improve survival of juvenile salmonids that are migrating downstream through the lower Snake River and mainstem Columbia River dams. BoR releases are managed to limit the amount of spill through mid-Snake hydropower facilities. State authority under Idaho Code 1763B facilitates flow augmentation from Idaho. This code will expire at the end of 1999; BoR is currently seeking Idaho cooperation in extending or renewing it.

Since 1993, BoR has met this ESA mitigation measure (i.e., flow augmentation) as indicated in the Table 2-1. BoR relies on uncontracted and uncommitted reservoir space, some 60,000 acre-feet of reservoir space permanently reacquired for flow augmentation, 17,650 acre-feet of natural flow rights in Oregon permanently acquired for flow augmentation, and rentals of stored water from Idaho rental pools. In 1999, BoR was able to use 38,000 acre-feet of Palisades Reservoir space, in a five-year lease agreement with the Shoshone-Bannock Tribes of the Fort Hall Indian Reservation.

Table 2-1. Upper Snake Flow Augmentation Volumes

Year	Total Provided	BoR Space (in 1995)	Permanent Acquisitions	Multi-Year Rentals	Annual Rentals
1993	424,588	324,617[1/]			99,971
1994	428,112	383,788[1/]			44,325
1995	427,235	119,242	22,396		285,597
1996	422,141	98,000	57,396		266,745
1997	437,281	98,000	75,045		264,236
1998	427,000	98,554	77,923		250,523
1999	427,000	98,554	76,851	38,000	213,595

[1/] Because of extreme drought conditions in 1993, 1994, and prior years, very little water was available for rental in rental pools, and BoR released water held in power head space, that had theretofore never been released, for flow augmentation purposes.

BoR provides water for flow augmentation from the following sources:

- The Minidoka and Palisades Project - Between 208,000 and 330,000 acre-feet have been provided from reservoirs in the Minidoka and Palisades projects in southwestern Idaho. Flow augmentation releases are measured downstream at Milner Dam near Twin Falls. In consideration of the needs of ESA-listed middle Snake River snails and other aquatic species, BoR initiates releases when the flows past Milner recede below 1,500 cfs, which occurs sometime between April and mid July. The flow augmentation releases are maintained at a level of 1,500 cfs; and when completed, are slowly down-ramped in accordance with agreement among BoR, Idaho Power Company (IPC), and the USFWS.
- The Payette Division of the Boise Project - Between 62,000 and 160,000 acre-feet have been provided from Cascade and Deadwood reservoirs since 1993. Releases

begin when the spring freshet is essentially over and are made at a rate of 1,000 cfs to avoid washing out push-up diversion dams. In order to maintain better water quality conditions in Cascade Reservoir, the Payette River Watershed Council, with participation by BoR and IPC, has brokered an arrangement where 60 percent of the flow augmentation releases are made in the summer months, and the remaining 40 percent are made in the winter. The IPC has agreed with this operation, and releases all of the identified Payette River flow augmentation water during the fish migration season, as called for by the TMT (see Section 4.5).

- The Arrowrock Division of the Boise Project - Between 23,000 and 41,000 acre-feet have been provided from Anderson Ranch, Arrowrock, and Lucky Peak reservoirs in southwest Idaho. Augmentation flows are provided at a rate of 400 cfs. This rate is necessary to avoid impacts to gravel push-up dams, and for public safety, as numerous people float the Boise River above the City of Boise during the summer months.
- Natural flow rights - BoR has permanently acquired 17,650 acre-feet of natural flow rights from the mainstem on the Snake River in Oregon and rented between 64 and 198 acre-feet through a cooperative agreement with the Oregon Water Trust. This water is accounted at a rate of approximately 100 cfs during the fish migration season.

For a variety of reasons discussed above, flow augmentation releases from the Boise, Payette, and Snake River systems do not necessarily occur when they are needed for listed salmon and steelhead. Travel time of water to Lower Granite is an added difficulty in making releases that will arrive at Lower Granite exactly when they are needed. These discrepancies are resolved in favor of listed fish under an agreement between IPC and BPA, which provides that IPC will "shape" spring and summer releases at Brownlee Dam, and provide the desired flows when requested by the TMT. This arrangement does not apply to Payette releases which IPC shapes under separate arrangements with the Payette River Watershed Council.

2.1.2.7 Canadian Treaty and Non-Treaty Storage

The objective of this action is to improve the likelihood of meeting flow objectives.

BPA and the Corps have continued to develop annual mutually beneficial operating agreements with BC Hydro under the authority of the Treaty Detailed Operating Plan (DOP) and the Non-Treaty Storage Agreement (NTS).

a) For the DOP, these include:

   i) One million acre-feet (MAF) flow augmentation for salmon flows in the United States and flow limits for trout spawning and dust storm avoidance in Canada. The 1 MAF is stored above treaty storage space during January-April 15th, and released during May-July. Canadian benefits are realized through shaping of springtime storage releases and do not significantly affect salmon flow objectives in the United States.

   ii) Winter flow limits at Arrow for Canadian White Fish. These agreements do not provide additional flows for salmon, but they meet Canadian fishery concerns and thus help encourage agreements that meet our fishery needs.

   iii) Storage exchanges between Libby and Canadian reservoirs. These agreements have not provided additional flows for salmon, but reduce potential for adverse impacts on recreation, resident fish, and power in the U.S. and Canada.

b) Under the NTS Agreement, BPA and BC hydro have both stored water in Mica Reservoir during May and June for release in July and August. BPA releases all of its water stored in the spring during July-August for salmon flows. Canada releases one-half of the water stored in the spring during the summer, and releases the other half at their discretion to maintain benefits it insists are necessary to continue with the NTS.

2.2 SPILL FOR FISH PASSAGE

Spill is used to reduce turbine related mortality at lower Snake River and Columbia River projects. The 1998 Supplemented Biological Opinion identifies spill at each project, assuming waivers to exceed 110 percent of the state standard are obtained by NMFS. Table 2-2 provides the 1998 Supplemental Biological Opinion recommended spill level amounts and procedures.

Currently, Clean Water Act (CWA) water quality criteria (EPA) and standards from the sate call for TDG levels to not exceed 110 percent of saturation at ambient temperature and pressure. For the past several years, state water quality agencies have issued waivers or modifications to these standards to allow increased spill. The Action Agencies will continue their policy of providing spill for fish passage in accordance with the TDG standard, waiver, or modification which is in place at the time. Waivers or modifications will be obtained by NMFS or other entities desiring spill in excess of the CWA standard.

Table 2-2. Estimated Spill Caps for the Operations Specified in the 1998 Supplemental FCRPS Biological Opinion (NMFS, 1998)

Project	Estimated Spill Level [1/]	Hours	Limiting Factor
Lower Granite	60 kcfs	6 pm – 6 am	gas cap
Little Goose	45 kcfs	6 pm – 6 am	gas cap
Lower Monumental	40 kcfs	6 pm – 6 am	gas cap
Ice Harbor	75 kcfs (night) 45 kcfs (day)	24 hours	Nighttime – gas cap daytime – adult passage
McNary	150 kcfs	6 pm – 6 am	gas cap
John Day	180 kcfs/60%[2/]	1 hour before sunset to 1 hour after sunrise	Gas cap/percentage
The Dalles	64%	24 hours	Tailrace flow pattern and survival concerns (study planned in 1998)
Bonneville	120 kcfs (night) 75 kcfs (day)	24 hours	Nighttime – gas cap daytime – adult fallback

1/ The estimates of fish passage efficiency used to derive these spill levels are conservative in that they are based on the guidance efficiencies of hatchery spring/summer chinook instead of those estimated for wild or hatchery steelhead. Estimates for hatchery spring/summer chinook were used because the spill levels set in the 1998 Supplemental FCRPS Biological Opinion must be equally protective of the weakest listed stock present in the river during the steelhead outmigration period.

2/ The TDG spill cap at John Day Dam is estimated at 180 kcfs and the spill cap for tailrace hydraulics is 60 percent. At project flows up to 300 kcfs, spill discharges will be 60 percent of instantaneous project flow. Above 300 kcfs project flow, spill discharges will be 180 kcfs (up to the hydraulic limit of the powerhouse).

2.3 JUVENILE TRANSPORTATION PROGRAM

Juvenile salmonids are collected at specific dams in the lower Snake and Columbia rivers and transported downstream below Bonneville Dam by truck or barge to improve survival over in-river passage.

Using the latest PATH and NMFS White Paper information (NMFS, 1999b, c, d, and e), in-river survival typically ranges from 40 to 60 percent (59 percent in 1998, 53 percent in 1999). Spill to the "spread-the-risk" levels results in approximately half the fish being transported (60 percent in 1999), and half are left to migrate in-river. Using PATH's 1998 percent transport survival value, and 50 percent in-river survival, spread-the-risk results in system survival of approximately 80 percent. Minimizing in-river passage and maximizing transport, at the PATH and White Paper survival rates, results in over 90 percent system survival that can be realized with the existing system.

Juvenile salmonids are collected at three lower Snake River hydropower facilities (Lower Granite, Little Goose, and Lower Monumental) and at McNary Dam. The fish are then transported downstream by truck or barge for release below Bonneville Dam. Since 1998, increased spills have decreased the portion of fish transported from what occurred in other recent years. Because spill initiation occurs at Lower Granite at a lower flow (85 kcfs compared to 100 kcfs projection) during the spring, it is likely that far fewer juvenile spring migrants have been transported from this facility and coincidentally an increased number were transported from Little Goose. Additionally, no spring migrants are transported from McNary Dam. Generally, all collected summer juvenile migrants (primarily after June 20) are transported from all facilities because spill is limited during this period so a greater portion of fish are diverted by screens to collection facilities. Once collected, nearly all are transported by barge or truck to below Bonneville Dam.

The number of barges has been increased to allow direct loading at more of the facilities and to reduce the holding times at these sites. In addition, barge exits were modified in 1997 to provide a larger opening that reduces the exit time from barges from about 4 minutes to 1 minute.

Pollution levels in fishways and collection systems have been reduced. Monitoring of the water quality conditions in the gatewells and other areas will continue to help indicate where additional changes are needed.

2.4 MINIMUM OPERATING POOLS (MOP)

Mainstem FCRPS reservoirs on the lower Snake River and John Day Reservoir on the Columbia River are lowered to increase water velocity through the reservoirs with the goal of increasing migration rate and survival of salmonid smolts during spring and summer outmigration periods.

Three of the lower Snake River Project reservoirs (Little Goose, Lower Monumental, and Ice Harbor) are operated within one foot of MOP from April 3 until adult fall chinook begin entering the Snake River, as determined by the TMT. Lower Granite operates within 1 foot of MOP from April 3 until November 15. After November 15, all four facilities are operated within their normal ranges.

McNary, The Dalles, and Bonneville dams are operated within their normal ranges. From April 20 to September 30 each year, John Day is operated within a 1.5-foot range above elevation 262.5 feet as long as irrigation withdrawal is not affected, and if additional space is not needed for flood control. The pool is raised if irrigation pumping problems occur.

During fall and winter, all four lower Columbia River projects are operated within their normal operating range, with the exception of temporary flood control at John Day.

2.5 PEAK TURBINE EFFICIENCY GUIDELINES

The Corps attempts to operate turbines at the four lower Snake River and four lower Columbia projects at a high efficiency (within 1 percent of peak efficiency) with the goal of reducing the mortality of fish passing through turbines. Operations outside of this range are highly limited and are usually at the direction of the TMT for the purpose of dissolved gas supersaturation abatement. When the number of turbines in operation is limited, turbines near the shore fishway entrances (turbines 1 and 2) are operated first with the intention of optimizing adult fish attraction to the shore ladder entrance. However, the order of turbine operation has not been demonstrated to affect adult passage (Bjornn et al., 1997). Some modifications of the order in which turbines are operated depends on spill conditions and time of day. The specifics are reported in the Corps' annual Fish Passage Plans (FFPs) (Corps, 1999a). Additionally, the range of turbine operations that achieve 1 percent efficiency is also reported annually in the FPP.

2.6 FISH PASSAGE

2.6.1 Juvenile Fish Bypass

All juvenile fish bypass systems are operated and maintained according to the criteria in the Corps' FPP. The FPP has been incorporated into the 1995 FCRPS Biological Opinion and 1998 Supplemental Biological Opinion by reference. The FPP is updated annually after coordination with regional fish agencies and Indian tribes and consultation with the NMFS.

Juvenile fish bypass is provided at Corps mainstem projects by a variety of methods, including screened turbine intakes with collection/bypass facilities (Lower Granite, Little Goose, Ice Harbor, Lower Monumental, McNary, John Day, and Bonneville), ice and trash sluiceway (The Dalles), transportation (see Section 2.3), and/or spill (see Section 2.2). Surface bypass technology is also being evaluated at Lower Granite and Bonneville dams. The bypass facilities are operated continuously during the passage period from April through November. In-season changes to operating criteria and maintenance schedules may be recommended by the TMT.

2.6.2 Adult Fish Passage

Criteria for operation and maintenance of adult passage facilities are also contained the FPP. All of the mainstem dams in the migration corridor have fish ladders and associated auxiliary water supply and powerhouse collection facilities. The adult passage period is March through November at Bonneville, The Dalles, and John Day dams and March through December at McNary, Ice Harbor, Lower Monumental, Little Goose, and Lower Granite dams.

Adult salmonids (and other incidental species) are counted at each dam with the schedule varying according to location and time of year. The counting program was expanded as identified in the 1995 Biological Opinion (incidental take measure 13) and 1998 Supplement (incidental take measure 2.j.).

2.6.3 Other Activities

A number of research studies covering various aspects of juvenile and adult passage have been identified in several Biological Opinions and through regional coordination efforts. These are primarily intended to provide information for improving operational criteria, modifying existing facilities, and constructing new facilities. The research activities will continue as needed and agreed to through regional coordination forums.

2.7 PREDATOR CONTROL PROGRAM

The objective of this program is to evaluate predation on juvenile salmonids and implement measures to reduce its effects.

Predation on juvenile salmonids by both native and exotic resident fishes and birds has been exacerbated by development of the hydrosystem. Reservoirs provide habitat for resident predators, particularly northern pikeminnow, walleye, and smallmouth bass, which have enabled their populations to thrive. Juvenile salmonids are also more vulnerable to predation by both resident fishes and birds, such as gulls, terns, and cormorants, because of increased concentration after release from hatcheries, when they congregate in forebays and after passing dams.

Research conducted in the 1980s in the John Day reservoir suggested that 14 percent of all juvenile salmonid migrants that passed McNary Dam were lost annually to predation by northern pikeminnow. Monthly losses ranged between 7 percent in June to 61 percent in August. Subsequent assessments suggested that relative losses increased in reaches downstream of John Day Dam and decreased in reaches upstream of McNary Dam. It was estimated that system-wide, millions of juvenile outmigrants were lost to northern pikeminnow each year. Other researchers concluded that unlike the lower Columbia River, where northern pikeminnow are the dominant predator, smallmouth bass are the dominant predator in the Snake River.

BPA's Northern Pikeminnow Management Program was designed to substantially reduce predation losses of juvenile outmigrants. The Program includes harvest technology research, prey protection measures, basic biological research, and a "bounty" or sport-reward system to encourage people to harvest northern pikeminnows. The "bounty" system has been employed since 1990 as a tool to reduce these losses. To date, over 1.3 million northern pikeminnow have been removed from the system, resulting in an estimated 25 percent reduction in system-wide predation mortality compared to pre-program levels. Smallmouth bass and a number of other introduced predators are protected by the state fisheries agencies for resident fisheries.

The sport-reward fishery is the primary tool to achieve the desired 10 to 20 percent annual system-wide exploitation rate on northern pikeminnow. Sport-reward registration stations are primarily located in the lower Columbia below its confluence with the Snake River where losses of juvenile salmonids are greatest. Opportunity also exists for participation in the sport-reward fishery in the lower Snake River. Site-specific fisheries are managed to address specific "problem areas" such as around dams, hatchery release sites, or other locations where losses to northern pikeminnow are significant.

Caspian terns have been identified as a major predator on juvenile salmonids, particularly in the Columbia River estuary near Rice Island. In 1997, an estimated 6 to 25 million juvenile salmonids were consumed by Caspian terns; this equates to approximately 6 to 25 percent of the smolts that survived to the estuary. Juvenile salmonids made up approximately 75 percent of the diet, with the diets of other avian predators also comprised of juvenile salmonids (approximately 24 percent for double-crested cormorants and 11 percent for some species of gulls). Juvenile salmonids were particularly prevalent in diets of avian predators in May, with steelhead most prevalent in early May, followed by coho in late May through early June, and chinook in late June through late July. Analysis of passive integrated transponder (PIT) tags recovered on Rice Island suggests that steelhead are preyed on in greater proportion to availability than other species. Likewise, hatchery fish appeared to be preyed on in greater proportion to availability than wild fish.

Caspian tern foraging behavior and the diversity of available non-salmonid prey at East Sand Island suggests that relocating the Rice Island colony downstream to East Sand Island could reduce mortality due to predation by up to 50 percent. A pilot relocation project was initiated in 1999 to assess the feasibility of relocating the colony from Rice Island to East Sand Island. Nesting was discouraged on Rice Island through habitat alterations (planting of grasses, installation of silt fences) and active deterrents (human presence and eagle decoys) while concurrently encouraging nesting on East Sand Island through habitat improvements (providing bare sand substrate), decoys, and sound attractant. Preliminary results from 1999 were encouraging. Relocation of the colony appears to be feasible, and the diet composition for terns nesting on East Sand Island is comprised of a lower proportion of juvenile salmonids than for terns nesting on Rice Island.

3. LONG-TERM ALTERNATIVES AND DECISION PROCESSES

The long-term actions that are being considered or evaluated as potentially of benefit to listed species are presented in this section. This includes a description of ongoing studies evaluating the feasibility of lower Snake River actions, such as dam breaching, and the John Day Phase 1 report that addresses juvenile anadromous fish passage. A variety of actions being considered to improve dissolved gas and temperature conditions, for the intended benefit of anadromous and resident species, are also described. Various system modifications including new turbine designs, surface collectors, and improved transport facilities are discussed. In addition, changes in storage project operations and configurations in the Snake and Columbia rivers for the benefit of anadromous and resident fish, such as gas abatement and increased downstream flow, are described in this section.

3.1 LOWER SNAKE RIVER JUVENILE SALMON MIGRATION FEASIBILITY REPORT/EIS

This feasibility study (FS) and Environmental Impact Statement (EIS) addresses alternatives for improving salmon passage survival in the 140-mile river reach impounded by four Corps dams on the lower Snake River. The FR/EIS, which documents feasibility study results, is evaluating four alternatives:

- **Alternative 1—Existing Condition**—the existing hydrosystem operations under the 1995 and 1998 Biological Opinions.
- **Alternative 2—Maximum Transport of Juveniles**—the existing hydrosystem operations and maximum transport of juvenile salmon, but without surface collectors.
- **Alternative 3—Major System Improvements**—the existing hydrosystem operations and maximum transport of juvenile salmon, but with major system improvements that could be accomplished without a drawdown.
- **Alternative 4—Dam Breaching—**natural river drawdown of the four lower Snake River reservoirs (Lower Granite, Little Goose, Lower Monumental, and Ice Harbor).

Engineering, economic, and biological information is being developed in this study. The draft Feasibility Report (FR)/EIS was released for public review in December 1999 (Corps, 1999b). The final FR/EIS is scheduled for completion in 2000.

3.2 JOHN DAY PHASE 1 REPORT AND LOWER COLUMBIA FEASIBILITY STUDY CALLED FOR IN 1998 BIOLOGICAL OPINION

A study of John Day Reservoir drawdown to spillway crest was requested in the NMFS 1995 Biological Opinion (NMFS, 1995). Through regional discussions and congressional direction, a plan was developed to conduct the study in two phases and to address both spillway crest and natural river level alternatives. Phase 1 was to be an approximately one year long study, based primarily on existing information, and intended to provide the region and Congress with preliminary benefits and costs and a recommendation with regard to proceeding to the second phase. The Phase 1 report is scheduled to be forwarded to Congress by April 2000. In the 1999 Appropriations, Congress has prohibited study beyond Phase 1 without specific congressional direction to proceed. If the study proceeds beyond Phase 1, it is anticipated that a feasibility level study requiring at least several years to complete will be conducted.

In the 1998 Biological Opinion, NMFS recognized the scope of the Phase 1 study and the fact that initiation of the study was subject to Congressional direction (NMFS, 1998). In the 1998 Biological Opinion, NMFS also requested a feasibility study for long-term alternative system configurations for the Lower Columbia River to be completed by 2004. The feasibility study would include appropriate NEPA and ESA documentation and include study of drawdowns at John Day and McNary projects, subject to congressional approval as well as other configuration alternatives. The scope and direction, and possibly the need, for a comprehensive Lower Columbia study are directly intertwined with the decision as to whether further drawdown studies beyond John Day Phase 1 are undertaken. Direction from Congress is not anticipated in a timeframe such that the study would be initiated in earnest in fiscal year (FY) 2000. It is possible that, if directed by Congress, the feasibility level study could be initiated in FY2001. If drawdown studies are not carried further, the approach for Lower Columbia configuration decisions should be reevaluated, taking into account performance related criteria, which may result from consultation.

3.3 WATER QUALITY

Forthcoming decisions about Columbia River configuration and operation for the protection of listed species represent an opportunity to take a comprehensive, system-wide approach to integrate ESA/Clean Water Act (CWA) based ecosystem improvements that will also facilitate attainment of state and tribal water quality standards. The goals of CWA and ESA are generally compatible and complementary. Through integration, complementary processes to address the goals of both statutes can be completed in a manner that better serves the environment and the public. It is also an opportunity to try to ensure that efforts taken to improve water quality will be sufficient to restore salmon and other listed species. For instance, elevated temperatures and dissolved gas at sufficiently high concentrations within the FCRPS can adversely affect salmonid populations and resident aquatic species. A separate group called the Transboundary Gas Group is currently addressing TDG as the Columbia River enters the United States. If water quality improvements can enhance fish passage and the habitat of federally listed and resident fish populations, then Federal government action will result in a greater net benefit to the FCRPS and the public. The following sections discuss current actions being taken by the Action Agencies to address ESA and CWA.

Several studies and processes (either planned or ongoing) address water quality concerns in the FCRPS. These include:

- Dissolved Gas Abatement Study
- Chief Joseph Spillway Flow Deflector Study
- Grand Coulee Gas Abatement Study
- Water Temperature

The following summarizes the background and current status of these studies.

3.3.1 Dissolved Gas Abatement Study (DGAS)

Water passing over spillways can entrain air when the water plunges into the spillway basin. This can result in elevated concentrations of dissolved gas that, if high enough, can be harmful to salmon and other fish and aquatic organisms.

The Corps' DGAS began in 1994. Phase 1 of the study identified potential methods of reducing dissolved gases created during spillway operations at the Lower Columbia and Snake River dams. The Phase 1 report recommended that a Phase 2 report be pursued for further analysis of identified alternatives in the Phase 1 report which was completed in April 1996. Phase 2 is to further evaluate and recommend structural and operational measures which can be implemented to reduce TDG supersaturation in the lower Snake and Columbia rivers to the extent technically, economically, and biologically feasible in response to the NMFS Biological Opinions on listed species.

Phase 2, to be completed in FY2000, includes a detailed evaluation of gas abatement alternatives at Bonneville, The Dalles, John, McNary, Ice Harbor, Lower Monumental, Little Goose, and Lower Granite. This study will be at a feasibility level.

FY2000 will likely be the last year of major efforts for the Phase 2 DGAS. Remaining tasks include:

- Model workshop and technical peer review of the 1-dimensional and 2-dimensional numerical models for dissolved gases in the Lower Snake and Columbia rivers.
- Development of system-wide alternatives for abating dissolved gas.
- The continuation and completion of the system-wide analysis.
- Preparation of system-wide implementation schedules and system costs on selected alternative.
- Preparation of the draft final report with recommendations.

3.3.2 Chief Joseph Dam Dissolved Gas Abatement Study

High concentrations of TDG produced at one dam tend to persist far downstream. Chief Joseph Dam is the upper boundary for the geographic range of the Upper Columbia River Evolutionarily Significant Unit (ESU) within which steelhead and chinook salmon have been listed as "endangered."

The primary objective of this study is to evaluate the feasibility of gas abatement measures to improve water quality in the 545 miles of the Columbia River below Chief Joseph Dam. A general Re-evaluation Report is being prepared that will evaluate two structural measures (spillway flow deflectors and a side channel canal) in conjunction with operational changes (joint operation of Chief Joseph and Grand Coulee Dams). The report is scheduled for submittal to Corps Headquarters in January 2000.

During FY1999, the following major tasks were accomplished:

- Physical model studies for spillway flow deflectors at Chief Joseph Dam were initiated. Construction of the sectional model was completed and construction of the general model was nearly complete.
- Near-field testing was conducted at and below Chief Joseph Dam to document existing conditions at the project and downstream.
- Dissolved gas production equations were developed for Chief Joseph Dam from the near-field data.
- A system numerical model was partially developed which will quantify the effects of joint operation of Chief Joseph and Grand Coulee Dams.

Major planned activities for FY2000 include:

- Continuation and completion of physical model studies.
- Continuation and completion of the system numerical model.
- Completion of the general Re-evaluation Report and initiation of the preparation of plans and specifications.

3.3.3 Grand Coulee Gas Abatement Study

In 1998, BoR completed a conceptual design report (Frizell, 1998) that evaluated five structural modification alternatives to reduce dissolved gas from spills at Grand Coulee Dam. Three of those alternatives were carried forward by BoR into a feasibility study. The alternatives being evaluated are: 1) cover and extend the mid-level outlet works; 2) construct spillway flow deflectors; and 3) construct a forebay outlet pipe and diffuser. The feasibility study will be completed in September 2000 and will be released to the System Configuration Team (SCT) (see Section 4.5) for its review and recommendations for further action.

3.3.4 Water Temperature

The Corps has conducted monitoring and evaluations related to water temperature conditions and potential effects on migrating anadromous fish under its operations and maintenance (O&M) and Columbia River Fish Mitigation (CRFM) programs.

Several research activities are proposed and being discussed within the region for initiation in 2000. An evaluation of temperature and dissolved gas exposure of adult salmon and steelhead migrants, including those in the lower Snake River, and the effects of water quality on survival and reproductive success is planned. The objectives of this evaluation would be to determine the relationship of river temperatures and total dissolved gas exposures of adult salmonids to subsequent egg and fry survival at hatcheries, determine thermal exposure of migrants between Bonneville and Lower Granite dams, and determine whether cool water releases from Dworshak affect migration patterns. Development of a numerical model to support the objectives of the above evaluations is also proposed.

An evaluation of energy expenditure of adult fish migrating through the system to include development of an understanding of the influence of water temperature (as well as other factors) on fish performance is also proposed.

A review of past John Day fish ladder water temperature data related to problems of adult fish holding in the ladder is being conducted. The purpose of the review would be to determine whether the holding problem could reasonably be attributed to water temperature issues and whether an investigation of alternative temperature modification measures would be warranted in the future.

3.4 SURFACE BYPASS

Investigations into the application of surface bypass technology at Lower Snake and Columbia projects was requested by NMFS in the 1995 Biological Opinion. The Corps has been testing a prototype surface bypass collector (SBC) at Lower Granite Dam since 1996. Tests were expanded in 1997 and 1998 and included the addition of a behavioral guidance structure (BGS) to help direct fish to the collection facility. Testing continues in 1999. Testing of a deep-slot surface bypass prototype at Bonneville Dam's 1st powerhouse has been conducted since 1998. A decision on further pursuit of this application is expected following the 2000 test program. At Bonneville's 2nd powerhouse, surface bypass is being developed and tested employing the existing trash chute as a corner collector at the south end of the powerhouse. Resolution of high flow outfall location and design is expected to lead to a decision in 2000 to construct permanent facilities.

At John Day Dam, a design to employ one or more of the powerhouse's four skeleton bays for surface bypass has been developed. A decision to implement this design will be part of an overall evaluation of passage improvement options for this project.

At The Dalles Dam, studies for a major powerhouse surface bypass system are on hold, while investigations continue regarding long-term spill levels, as well as investigations into enhancing surface guidance into the existing ice and trash sluiceway and employing partial blockages of the powerhouse intakes' trash racks.

Surface bypass concepts are also being tested at spillways. Various weirs and slot configurations in front of existing spillway gates have been tested at several locations. Currently under development at Lower Granite and John Day is the concept of a raised spillway crest to provide a high volume surface flow through an existing spillbay. Prototypes are planned to be tested at Lower Granite in 2001 and at John Day in 2002. The concept of this type of facility in combination with a BGS would be considered. Also, the prototype test at John Day will provide some insight with regard to the expected performance for the skeleton bay concept.

3.5 FLOOD CONTROL

3.5.1 General

In response to requests by NMFS, USFWS, Northwest Power Planning Council, and the state of Montana, the Corps conducted a preliminary analysis to review system flood control operations, *Columbia River Basin, System Flood Control Review, Preliminary Analysis Report, February 1997* (Corps, 1997). The review consisted of two separate but related studies.

The first was a preliminary analysis of a new flood control procedure for Libby Dam called VARQ that would benefit Kootenai River sturgeon and resident fish in Lake Koocanusa while preserving the same level of system flood control for the lower Columbia River. (VARQ is a term used to refer to modified flood control curves at Libby and Hungry Horse dams, which consider variable (VAR) outflow (Q) during the spring for listed species.)

The second study was a preliminary analysis of alternative levels of system flood control as determined by flows objectives at The Dalles, Oregon: the existing level of control, which is 450 kcfs; an alternative flow of 550 kcfs; and an alternative flow of 800 kcfs. The scope of the study was limited to gross changes in flood control storage requirements at major flood control projects in the United States and Canada to emulate the alternative control flow objectives of 550 kcfs and 800 kcfs. An analysis of the effects on flood damages, the production of TDG, and the impacts to the production of hydropower was conducted for each alternative. The objective was to determine if changes in the system flood control operation to benefit listed species of anadromous fish could potentially be feasible. In that study, the Corps concluded that no major changes be made to the system flood control operating criteria and procedures due to the impacts to flood protection works, increased annual flood damages, loss of operating flexibility for flood control, increased risk of flooding, increase in production of TDG, and increased cost of system power production. A detailed analysis to develop new flood control procedures to modify the system flood control operation was not initiated.

3.5.2 VARQ Flood Control Procedure

The positive results of the analysis of the VARQ procedure in the 1997 Preliminary Analysis Report led to the pursuit of a feasibility study of impacts to local flood control on the Kootenai River and the Flathead River, and a determination of the impacts to the FCRPS. This work was fueled by the continued regional interest in the procedure. In January 1999 the Corps (1999c) released the report entitled, *Status Report, Work to Date on the*

Development of the VARQ Flood Control Operation at Libby Dam and Hungry Horse Dam, January 1999, in response to the 1998 Supplemental Biological Opinion (NMFS 1998). In general, the studies showed that the VARQ procedures at Libby and Hungry Horse dams have a minor impact on local and system flood control in the United States, and do not diminish the ability to control major floods. The impact to hydropower production appears to be marginal depending on modeling assumptions. However, the VARQ procedures cause higher annual elevations and higher springtime outflows of Kootenay Lake in Canada, and cause some additional flood control draft at Grand Coulee. The status report defined work that still needs to be done before VARQ can be implemented. These tasks are summarized below:

- Coordinate with Canada as required by the Columbia River Treaty
- Additional economic analysis of impacts of the VARQ operation in the Kootenai River, Flathead River, and the Columbia Basin
- Coordinate with the BoR on the VARQ operation at Hungry Horse and the effects at Grand Coulee
- Complete appropriate ESA compliance and National Environmental Policy Act (NEPA) documentation.

3.5.3 System Flood Control Studies

If it is decided in the future to pursue a detailed analysis to develop a new system flood control operation, there are a number of critical tasks that need to be addressed. A feasibility level report would be completed. Congressional authorization of changes of flood protection levels would be required as well as coordination with state, tribal and regional agencies, and the public. In addition, coordination with Canada per the Columbia River Treaty would be necessary. The following is an example of many of the work items for such a feasibility study that would need to be completed:

- Floodplain Damage Inventory. The last survey was done in the early 1970's. A new survey would need to be done in light of the objective to increase the frequency of occurrence of flows in the lower Columbia above 450 kcfs, the current zero damage flow level.
- Levee Stability Analysis. The last survey was done in the early 1970's. A new analysis would need to be done due to the subsequent increase in the frequency and duration of higher flows in the lower Columbia that could impact the stability of the levee system.

- Develop Stage-Damage Curves. New stage-damage curves would be developed from the results of the floodplain damage inventory and the levee survey.
- Hydrologic Analysis of Extreme Events. Update the standard project and probable maximum floods using the latest hydrologic and regional meteorological information. This was last done in 1969.
- Reservoir Regulation Analysis. Construct alternative flood control procedures and conduct flood control reservoir simulations. Perform statistical analysis of results.
- Impact Analysis. Evaluation of impacts to dam safety, hydropower production, waters quality, cultural resources, navigation, etc. for alternative flood control procedures. Local flood control remediation costs would be estimated.
- Risk and Uncertainty Analysis. Statistical analysis to determine the probability of flooding during the life of the system operation.
- Environmental Analysis. Complete appropriate ESA compliance and NEPA documentation. This includes coordination with the public, state, and Federal agencies, and the Tribes.

3.6 TURBINE IMPROVEMENTS

The Corps continues to study methods for improved turbine passage survival (Corps et al., 1998). A report of these activities will be prepared by 2001, with a recommendation regarding continuing into a second phase of studies. The objectives of the current study are:

1) Develop modifications to the way existing Kaplan turbines are currently operated to improve fish passage survivability and conditions as they pass through existing turbines;

2) Identify biological design criteria that will provide the basis for the development of improved turbine designs;

3) Investigate improved fish passage turbine designs or modifications to existing designs that could be implemented to assist the recovery of Columbia and Snake River stocks; and

4) Provide information on turbine passage survival, which can be factored into future system configuration decisions.

Under the Bonneville 1st Powerhouse Rehabilitation Program, a new turbine design has been developed and is under installation (referred to as a “minimum gap runner turbine”). Testing of the new design is underway in the first unit outfitted with the new design. The results of this study will be considered when the turbines at The Dalles Dam are rehabilitated and potentially for future rehabilitation projects at other projects. Turbine design improvements are most relevant in the context of older units/projects where aging turbines need major rehabilitation or replacement. "Improved" turbines may not be installed immediately to replace relatively new turbines (less than 25 to 30 years old) solely on the basis of small incremental survival benefits.

3.7 EXISTING SYSTEM IMPROVEMENTS

In addition to the gas abatement, surface bypass, and turbine passage studies described above, the 1995 and 1998 Biological Opinions requested a number of measures to evaluate and/or implement improvements to existing juvenile and adult passage systems. For juvenile passage, these include improvements in guidance efficiency into existing bypass systems through extended-length bypass screens (ESBS) and related debris control, gatewell and orifice modifications. Also included are improvements in flow characteristics and dewatering systems in the downstream migrant facilities and improvements and modifications to separators and holding/loading facilities at transport projects and relocation of bypass system outfalls. Juvenile passage monitoring facilities have been completed or are near completion at several projects. A juvenile bypass system for The Dalles Dam is 90 percent designed, but is on hold pending future decisions on spill and surface bypass.

For adult passage, the primary focus areas relate to assuring that existing facilities can be maintained to meet fish passage plan criteria throughout the passage season, minimizing incidence of delay or holding within the passage facilities, reducing the risk of failures of auxiliary water supply systems which could interrupt efficient adult entrance and passage, and addressing the issue and effects of fallback (a situation where adult fish successfully pass upstream of a dam, but "fall back" over the spillway, through the turbine, or through navigation locks).

3.8 LIBBY ADDITIONAL UNITS

The USFWS has requested additional flow capacity at Libby Dam for the benefit of sturgeon spawning. Presently, flows for sturgeon are limited by the volume of water that can be released without spilling water at Libby Dam. Turbine capacity limits the volume of flow augmentation water that can be discharged from Libby Dam to about 27 kcfs. Additional flow augmentation could be provided by spilling water at Libby Dam; however, spill is limited by Montana's TDG water-quality standard of 110 percent saturation.

Two approaches have been proposed to provide additional flow without increasing TDG concentrations. These include installing additional turbine generation capacity and constructing spillway flow deflectors. Presently, there are three unused turbine bays at Libby Dam that, if operable, could provide a greater volume of water without spilling. The Water Resources Development Act of 1996, Sec. 549, authorized completion of the additional units. Installation of spillway flow deflectors at Libby Dam has not been investigated in detail. Either of these measures would provide greater flexibility to increase flows for sturgeon and to refill the reservoir.

3.9 ADDITIONAL OPERATIONS

3.9.1 Transport

To meet the goals of allowing direct loading to fish transport barges, three 150,000-gallon and six 100,000-gallon barges would be needed in addition to the six barges that are in use. Currently, only two have been added. The fisheries and tribal managers (members of the SCT) stated that the decision on when or if additional barges would be added should wait until finalization of the Corps' FR/EIS (see Section 3.1) (Corps, 1999b).

3.9.2 Fish Passage Spill

Potential modifications to the fish spill program are under consideration to ensure that spill is optimized in relation to overall operations for juvenile and adult passage. Performance standards developed during consultation, as discussed in Section 4 and Appendix B would serve as the basis for assessing modifications of fish spill. Potential modifications to fish spill could include management to increase its effectiveness and efficiency; increased spill volumes that may be possible with enhanced structural modifications (see discussion, below, on gas fast track); and/or increased daily duration of spill (at those projects where spill is currently provided during nighttime hours). Outstanding biological issues that will be addressed include spill efficiency, effectiveness, and survival; passage delay; effects on adult passage and fallback; total project passage survival; and effects on system survival. Non-biological constraints that will be considered include incremental benefits relative to cost, and impacts to transmission, navigation, and water quality.

3.9.3 Gas Abatement Fast Track Program

Spillway flow deflectors are used to decrease the concentration of dissolved gas by producing a more horizontal spill flow that limits the plunge depth of water through the dam spillway. Spillway flow deflectors are in place on all Lower Snake and Columbia River dams except The Dalles Dam. However, not all spillway basins at all projects have flow deflectors, and in some cases, the performance of the existing deflectors can be improved.

NMFS has called for a study (referred to as the "Fast Track" Program) to determine the potential effectiveness of installing additional spillway deflectors and/or providing modifications to existing deflectors on the spillways of the Lower Snake and Columbia River dams. These spillway flow deflectors and/or modifications would allow higher spill levels for passing juvenile salmonids while keeping TDG concentrations as low as possible. Recent installations of spillway flow deflectors at Ice Harbor and John Day have shown improved performance over other installations. Therefore, NMFS has requested additional spillway flow detectors and modifications to existing deflectors at other dams. The first step in this process will be to conduct general and sectional model studies to assess the potential for additional or modified deflectors.

During FY1999, field studies were conducted at Bonneville and The Dalles to obtain near-field data. In addition, bathymetric data was collected at Bonneville, The Dalles, Lower Monumental, Little Goose, and Lower Granite to determine underwater bathymetry for accurate representation in the physical models. Construction of physical hydraulic models was initiated for the Bonneville, McNary, and Lower Monumental general models. In addition, sectional models were completed for McNary and Lower Monumental.

Model testing to develop new spill patterns for Ice Harbor was completed. These new spill patterns were incorporated into the Corps' annual FPP for the spring of 1999. Test plans were completed or initiated for the Bonneville general spillway model and the McNary and Lower Monumental sectional models.

The following are activities planned for FY2000:

- Near-field tests will be initiated on John Day and Lower Granite dams to better define gas production estimates for these two projects. Supplemental data collection for The Dalles Dam will be attempted (supplemental efforts in FY1999 were not successful due to loss of equipment).
- Construction will be continued and completed for the McNary, Bonneville, and Lower Monumental models.
- Model construction will be initiated for Little Goose Dam. Both a general and sectional model will be started.

- Model testing will be completed for the McNary and Lower Monumental sectional models and for the Bonneville spillway general model. McNary and Lower Monumental general model testing will be initiated.
- Numerical modeling is being conducted under the DGAS, but will be used to provide supplemental information under the Fast-Track Program.
- Several reports are anticipated for initiation during FY2000 including McNary, Lower Monumental and Bonneville design documenting reports. Reports will also be completed for the John Day and Lower Granite near-field tests.

3.9.4 Upper Snake River Water

3.9.4.1 Snake River Basin Adjudication

Flows from the upper Snake River and from IPC's Hells Canyon Complex are currently the subject of mediated settlement discussions in the Snake River Basin Adjudication, an Idaho state court proceeding that is determining the nature and extent of all water rights in the Snake Basin in Idaho. The United States, on behalf of the Nez Perce Tribe, and the Nez Perce Tribe have filed instream flow claims for the Snake Basin and several of its tributaries to maintain fish runs. These claims have been made under the Federal reserved water rights doctrine with a priority date of time immemorial (i.e., earliest in priority). The State of Idaho and Idaho water users have opposed the claims, but, because the claims overlap with flow objectives under the ESA, are actively engaged with the United States in discussing a negotiated resolution to flow augmentation out of the upper Snake basin. The Federal negotiating team should know by late January 2000 whether these settlement discussions have a significant chance of resolving these issues.

3.9.4.2 Increase Reliability of Flows from the Upper Snake Basin

BoR continues to seek new sources of water to further strengthen its ability to provide the requested water in all water conditions. Hydrologic studies indicate that, from the sources available at the end of 1998, BoR can provide a full 427,000 acre-feet about 82 percent of the time (51 of 62 years analyzed), at least 300,000 acre-feet 92 percent of the time (57 of 61 years), and at least 250,000 acre-feet 95 percent of the time (59 of 61 years). These analyses do not reflect adaptive decisions that BoR would explore in dry years, so the percentages should be considered on the low side of probability.

BoR has attempted to secure changes in state law that it believes will strengthen its ability to provide 427,000 acre-feet and has requested Idaho authority to rent and permanently acquire natural flow rights. Another potential flow augmentation source may be the opportunity in good water years for late summer reservoir storage releases in anticipation of the need to provide space for system flood control.

3.9.5 Canada Water

BPA and the Corps have attempted to gain additional water from Canada every year since 1995. During preparation of the Detailed Operating Plan, BPA and the Corps have requested that the Canadian Entity consider expanding arrangements for Flow Augmentation Storage. The Canadian Entity's response has consistently been that additional storage would not provide additional net benefits in Canada.

3.9.6 Banks Lake Operations

Banks Lake is a 715,000 acre-feet off-stream equalizing reservoir in the Columbia Basin Project. Water is pumped into Banks Lake from Lake Roosevelt through 6 pumping and 6 pump/generating units. Banks Lake provides irrigation storage regulation for BoR's 671,500-acre[1] Columbia Basin Project. Depending on pool elevations of the two reservoirs, there is short duration capability to transfer flow to and from Banks Lake using the pump and pump/generator facilities. During higher load demand periods, the pump-generating units can provide up to 300,000 kilowatts of valuable peaking power. Significant outdoor recreation occurs through much of the year at Banks Lake, which has a normal reservoir drawdown limit of 5 feet imposed to maintain the resident fishery and to provide full use of shoreline recreational facilities as recommended by Northwest Power Planning Council.

There may be opportunity to operate Banks Lake to improve conditions in the Columbia River for anadromous fish runs, even with a 5-foot drawdown limit. When generating power with the 6 pump-generating units, up to 15 kcfs can be discharged back into Lake Roosevelt which can then be passed through Grand Coulee Dam to boost flows during the spring and summer anadromous fish migration season. With a 5-foot draft from full pool, about 120,000 acre-feet of Banks Lake storage could be provided to increase mainstem flows over a four day period.

During times of high TDG in the Columbia River, reducing spill at Grand Coulee Dam by pumping water into Banks Lake could be beneficial. During high flow and spill periods, there could be opportunity to pump 21 to 26 kcfs into Banks Lake from Lake Roosevelt.

[1] Includes lands served under artificial groundwater storage program and blocks 2 and 3 of platted farm units.

This action would reduce spill at Grand Coulee and lower TDG in the Columbia River. Banks Lake would need to be below full pool to accommodate the operation and could be expected to refill in just a few days.

3.9.7 Grand Coulee Operations

Lake Roosevelt is currently drafted annually from elevation 1,290 feet (full pool) to elevation 1,280 feet during the July-August period to augment flows in the lower Columbia River. In a Record of Decision on the 1995 Biological Opinion, BoR agreed to consider additional draft from Lake Roosevelt if the April flood control elevations are not reached or if the April through August runoff at The Dalles is less than 65 MAF. The recent NMFS White Paper on Flow Augmentation (NMFS, 1999b) provided information that suggests a more positive correlation between flow and survival for Snake River fall chinook. Based on that information, BoR requests that the conditions allowing for a call for additional draft in low water years be identified and that any additional draft volume in low water years be quantified.

4. ADAPTIVE MANAGEMENT FRAMEWORK THROUGH PERFORMANCE MEASURES

The immediate focus of this BA is to establish a course of action for the FCRPS that avoids jeopardy to listed stocks. For salmon and steelhead, NMFS has defined “no jeopardy” to mean a high likelihood of survival and a moderate to high likelihood of recovery under a given set of management actions. In addition, the Action Agencies’ goal is to facilitate the future recovery of the listed stocks. The jeopardy standard and facilitation of recovery necessarily require the Action Agencies to consider actions and improvements in the hydropower system in connection with actions and improvements expected for the other Hs (habitat, harvest, and hatcheries).

The actions outlined in Section 2 of this BA represent current operations for the hydropower system. The Action Agencies intend the specific operations in Section 2 to provide a base for future operations (subject to adjustment over time). Additional long-term actions, including those outlined in Section 3, may be provided as NMFS, USFWS, and the Action Agencies develop and refine a proposed action to avoid jeopardy and enable recovery of listed stocks.

Rather than propose at this time specific actions in addition to those identified in Section 2, this section outlines a proposed Construct for Achieving Survival Improvements (Construct) that would establish measurable performance standards for the hydro system, prioritize actions, and measure results. The Construct would provide a basis for some experimental management actions to improve understanding of key uncertainties and thus the ability to implement future actions to achieve recovery.

4.1 CONSTRUCT FOR ACHIEVING SURVIVAL IMPROVEMENTS (CONSTRUCT)

Figure 4-1 depicts the Action Agencies’ proposed methodology for defining long-term actions and assessing the efficacy of current operations and configurations of the FCRPS (i.e., the operations, configurations, and actions described in Section 2). The Construct the Action Agencies are proposing is premised on the establishment of an overall recovery goal. It would provide a methodology for defining desired levels of improvement in all Hs, developing performance standards associated with these levels of improvement, evaluating and prioritizing possible actions in each H, and selecting the most appropriate combination of actions in each H. The Action Agencies propose to use this methodology as they evaluate

Figure 4-1. Construct

Construct for Achieving Survival Improvements

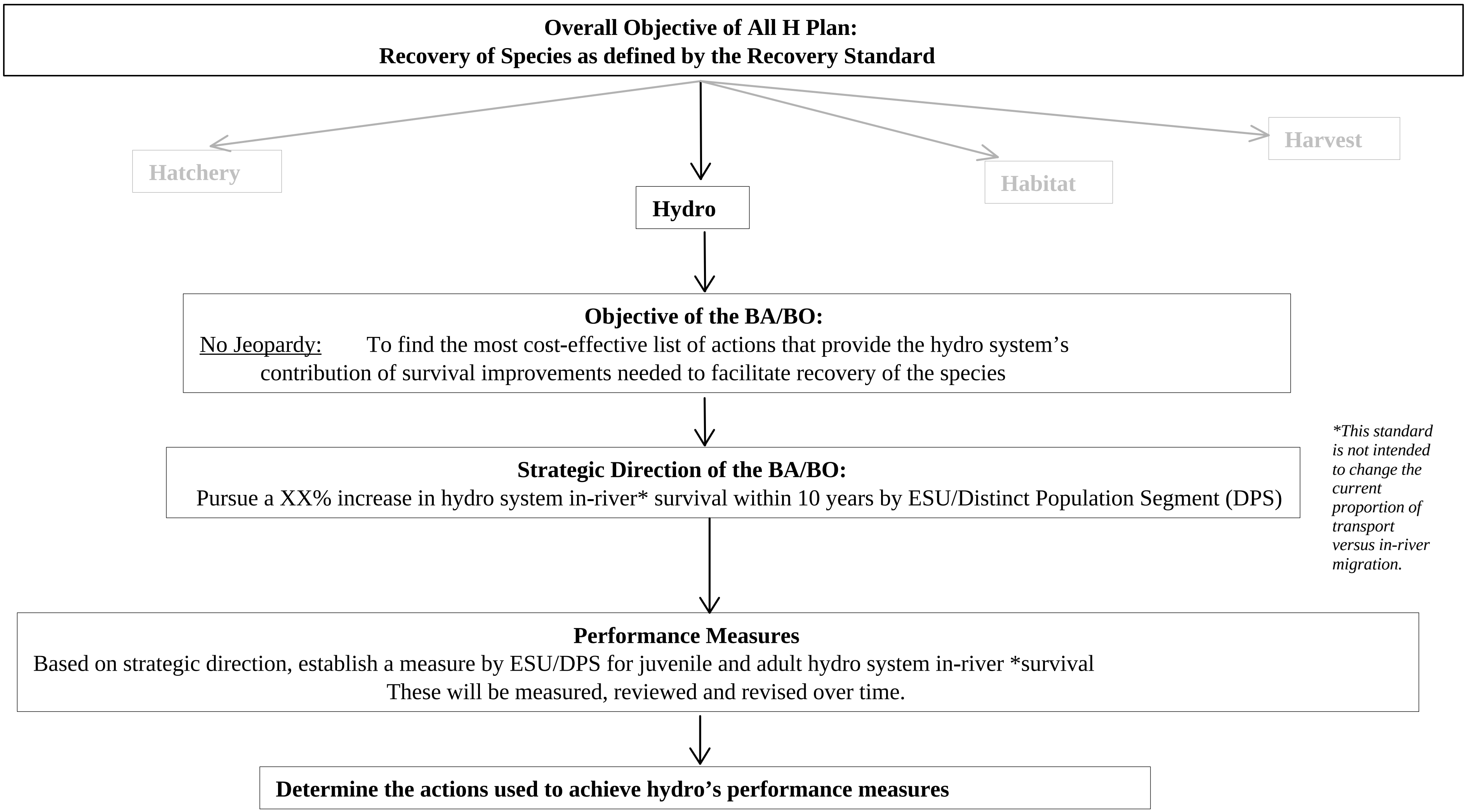


Figure 4-1, continued

Defining Hydro System Actions

Independent Science Review

Priority Factors for Actions

- Experimental Management of Key Uncertainties
  - Delayed Mortality--transport, juvenile, adult
- Balance Listed Anadromous and Listed Resident
- Mainstem Spawning and Rearing Flows
- Lower Columbia River over Snake River
- Summer Migrants Flow over Spring Migrants Flow
- Mainstem and Estuary Habitat
- Water Quality
- Maintain Biological Diversity

↓

What is the sequence for developing and defining proposed actions?

Experimental Management

System Wide Considerations: Transport, Flow Augmentation, Flood Control, TDG, Temperature

Project by Project starting first with projects with the lowest survival levels

↓

How do we decide among actions?

- Biological Benefit
  - Time to Implementation
  - Number of ESUs Benefited
  - Contribution to Achieve Performance Measures
- Economic Cost
- Learning
- Regional Support

possible hydro actions during their consultations on the FCRPS, although it remains to be seen whether the proposed Construct will prove to be workable in the time available for this consultation.

The Action Agencies recognize that the approach presented by the proposed Construct would eventually entail establishing life-stage specific survival standards as a performance measure for the FCRPS. While these life-stage specific standards would be one component of performance measures, such measures must also focus on survival over the entire salmon life-cycle.

In addition, the Construct must recognize that many key uncertainties will probably not be resolved to all parties' satisfaction. Therefore, it is recognized that development of the proposed Construct will need to focus on how to make decisions about management actions in an uncertain environment, while minimizing the risk to the fish populations and ensuring recovery.

With these considerations in mind, the Construct starts with recognition that recovery of fish would require changes in the way people affect fish in each stage of their lifecycle: habitat, hatcheries, harvest, and hydropower systems. Ideally, we would have an overall recovery goal that applies to all four of the Hs. Using best available scientific information and policy guidance, the survival improvements necessary to meet the jeopardy standard and recovery goal would be allocated among the Hs. The allocation among the Hs would be modified over time based on actual performance, feasibility of potential improvements, and resolution of key uncertainties.

Allocation of survival improvements across the Hs would include a specific objective(s) for hydro. Under the Construct, this objective would be stepped down into various measurable performance standards. The section below entitled "Performance Standards" describes initial thinking on how to develop performance standards and gives examples of potential performance standards for hydro (one of the four Hs).

With definition of a hydro objective and performance standards, hydro may select particular actions designed to meet the standards. The section entitled "Setting Priorities and Making Decisions" expresses how the Action Agencies intend to prioritize possible actions for hydro needed to meet the expected level of improvement for hydro.

The Construct places importance upon undertaking actions in a fiscally responsible manner. The section entitled "Efficacy/Feasibility Screen" addresses how to select actions that meet applicable objectives and standards to guide investment decisions.

The Construct also presents a methodology for addressing uncertainty. The section entitled "Uncertainty Resolution" identifies uncertainties that, if resolved, would improve the ability to select the most effective options for improving survival and increase confidence in the selections.

The Action Agencies anticipate that the overall recovery goals and the associated survival improvement obligations among the Hs may not be established within the timeframe of consultation. The Action Agencies recommend that interim performance standards be collaboratively developed with NMFS and USFWS during the course of this consultation to enhance decision making and provide a model for development of performance standards for all Hs.

In summary, the Construct provides a methodology for avoiding jeopardy and facilitating recovery, setting performance standards, and adopting and revising standards and actions over time consistent with resolution of uncertainties and receipt of new information. The long-term nature of this decision-making process may provide a basis for a multiple-year Biological Opinion.

4.2 PERFORMANCE STANDARDS

In this section, the Action Agencies define what a performance standard is and how it can be used to improve decision making for management actions. However, the Action Agencies believe that interim performance standards based on best available scientific information and assumed contributions in other Hs are necessary to enhance decision making and ensure management actions yield the needed survival improvements. These interim standards will be refined as the All H process matures.

The primary purpose of this section is to stimulate regional debate on establishing appropriate performance standards**.** Outlined in this section are examples of interim standards that are based on a lifecycle approach. The Action Agencies want to emphasize that this document is meant to suggest *examples* of performance standards, and *not* to prescribe specific standards for the Region. The Action Agencies intend to complete consultation with a set of interim hydro system performance standards for inclusion in the NMFS Biological Opinion. The Action Agencies recognize that these interim performance standards may be modified over time as the All H process matures, actual performance is measured, key uncertainties are resolved, and feasibility in all Hs is better understood.

4.2.1 What is a performance standard?

A performance standard is a specified goal that is a measurement or estimate of either a biological or environmental condition. For example, the parties that have participated in the Mid-Columbia Habitat Conservation Plan (HCP), have established one key performance standard as 95 percent total juvenile survival past the dam. This standard is likely a composite of measurable and estimated attributes, which will be referred to as performance standards in this BA.

Performance standards are indicators of population or ecological responses to management actions. Performance standards can be used: 1) as a yardstick on which to assess progress toward survival objectives, 2) to assess the effects of experimental actions, 3) to provide information to assess model assumptions, 4) to select and implement new actions, and 5) to compare the effectiveness of alternative actions.

Figure 4-2. Performance Standards

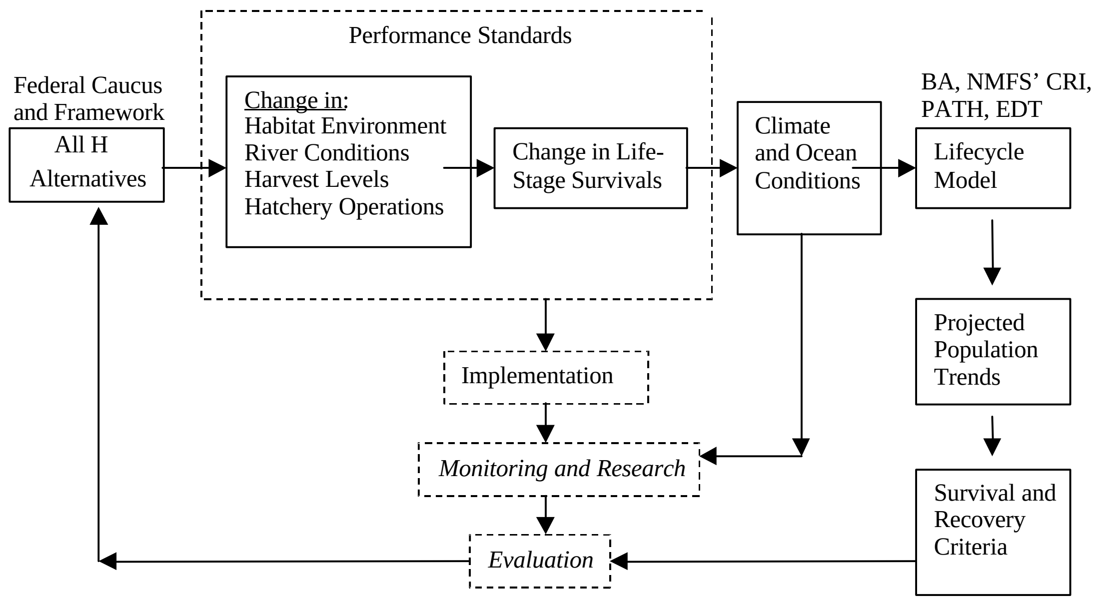


Figure 4-2 illustrates the iterative nature of the performance standard process that Action Agencies envision. Similar to efforts currently underway in the Federal Caucus, development of performance standards begins with an iterative process of evaluating various H alternatives and their ability to achieve survival and recovery of listed species. Using best available information and policy guidance, an initial all H approach would be selected that is expected to result in changes in life stage survival that would meet overall survival and recovery criteria. This would establish initial performance standards for each H that would include estimated improvements in life stage survivals to be achieved over a specified period of time. Actions would then be designed in each H to facilitate achieving the performance standards. Once the actions are implemented, they are monitored and evaluated to determine whether they are achieving the intended results. If actions in a particular H are not achieving life stage survival estimates, new actions need to be contemplated. If life stage survivals are achieved, and the stocks are not approaching recovery goals, either the H-specific standards, the allocation among the Hs for improvement in life stage survival, or both would be revisited.

4.2.2 Examples of interim performance standards by life stage

The discussion of steps necessary to establish performance standards in the context of an all H approach is described in Appendix B. The process described is comprehensive and may be used as part of a long-term recovery plan that includes numerous feedback loops, which would ensure the dynamic development of appropriate standards.

Ideally, development of performance standards for all Hs would be done simultaneously and in a coordinated fashion. However, interim performance standards can be developed for a particular H alone, and revisited as the other Hs develop their standards. In fact, the Action Agencies believe it is essential to establish interim performance standards in this consultation process. Although these standards would be subject to change, they would ensure appropriate prioritization and selection of actions that would deliver survival improvements needed.

Although this consultation focuses on the FCRPS, any hydrosystem performance standards, whether interim or not, should be viewed in the context of life stage survival. Information on salmon populations does not always lend itself to a compartmentalization across hydro, harvest, hatchery and habitat, and is more appropriately viewed in the context of life stage. Therefore, by nesting hydro performance standards in the life stages, it is more reflective of the data and thereby improves probability of recovery of the listed stocks. Therefore, the example interim performance standards are broken down by life stage.

To facilitate regional discussion on this topic, the Action Agencies think it is valuable to provide an example of how life stage performance standards might be used, while acknowledging that the example is not complete. The following is intended to provide an overview of how performance standards could be defined by life stage and includes some existing data on survival levels in each life stage that could be used to define interim standards.

Snake River spring chinook have been selected for these illustrations as they have the most robust set of data, and have been the focus of attention of several other efforts. During consultation, the Action Agencies intend to develop similar interim performance measures by life stage for other anadromous stocks and resident species.

ILLUSTRATIVE EXAMPLE

SPRING/SUMMER SNAKE RIVER CHINOOK

The following examples are not reflective of a complete review of existing science. The Action Agencies intend that a more thorough review occur during consultation.

4.2.2.1 Egg-to-Smolt Survival Standard

Survival during this stage reflects effects incurred during egg incubation, fry and parr rearing, and over-wintering. These life stages are particularly sensitive to habitat conditions in higher order streams. As such they are susceptible to both habitat and hatchery management actions in these environs.

In the Yakima River, Fast et al. (1988) estimated survival as averaging 6.3 percent from 1984 to 1987. In the same river during the 1960s, Major and Mighell (1969) estimated egg-to-smolt survival ranging from 5.4 percent to 16.4 percent. However, Healey (1991) cautions that these estimates may be biased on the high side. Over several years in the Deschutes River, Lindsay et al. (1989) estimated survival ranging from 2.1 percent to 8.7 percent, with an average of 4.6 percent.

In the Snake River system estimates of egg-to-smolt survival have generally been lower. Keifer et al. (1997) estimated egg-to-smolt survival for fish arriving at Lower Granite Pool, in the Salmon (1987-1992) and Crooked River (1989-1992). Depending on the estimation method, those estimates ranged from 3.6 percent to 4.1 percent and 2.7 to 4.0 percent for each population, respectively.

The data ranges from 2.1 to 16.4 percent. This information could be used to establish an interim performance standard that could reasonably be expected under suitable habitat conditions.

4.2.2.2 Smolt Passage Survival Standard

This life stage reflects *in-river* survival from entry into Lower Granite reservoir to Bonneville tailwater. In Marmorek et al. (1998), seasonal average smolt survival estimates were reported for yearling chinook salmon for the years 1966 to 1997. The *average* smolt direct survival from the years 1966 to 1968 is reported as 63 percent. The Snake River stock was still comprised of robust wild populations during that period and was able to withstand hydrosystem-induced mortality of this level even under the pressure of intense harvest. Additionally, CRI and PATH assumed direct system survival to be 62 percent after breach of the Lower Snake River dams. Further, the 1995 Biological Opinion included a performance standard of 95 percent survival past each project. The 1995 Biological Opinion made no assumption for reservoir survival. For illustration purposes, a standard 98 percent reservoir survival assumption combined with the 1995 Biological Opinion's 95 percent project survival yields a 56 percent direct system survival.

Though this is not an exhaustive data set, it represents a reasonable range of 56 to 63 percent to work from in establishing an interim performance standard for this life stage. The Action Agencies recognize this is a measure of direct survival only. See Section 4.2.3 for a summary on indirect effects.

The Action Agencies advocate the use of a system survival standard as the main measure of smolt survival. It has been suggested that a system survival standard can be broken down to into minimum survival levels per project. The 62 to 63 percent system survival standard referenced above equates to approximately 94.2 to 94.4 percent per project. The Action Agencies assert that the system survival standard is the main measure of smolt survival and that project minimums be used as targets, but not hard limits that may result in poor investment choices. For instance, a $100 million investment for a 0.2 percent increase to meet the project minimum standard should not take priority over a $10 million investment at another project that improves survival from 96 to 98 percent.

The Action Agencies support the idea of a hydrosystem survival standard based on natural river survival (i.e., pre-hydro development, but not pristine). There are sources of data that attempt to estimate natural river survival by taking survival estimates from small reaches of free-flowing river and extrapolating them to below Bonneville Dam. Although the mean values range significantly and may not be instructive in developing performance standards, the Action Agencies are willing to contemplate natural river standards during consultation.

Role of Transport: This standard is not intended to change the current proportion of transport versus in-river migration. Further, the Action Agencies advocate maintaining the current proportion of transport versus in-river migration until further resolution on the effects of delayed mortality.

4.2.2.3 Marine Survival Standard

This is one of the more problematic survivals to translate into a performance standard. For this discussion marine residence includes the period from estuarine entry to return to the mouth of the Columbia as an adult. Survival during this stanza is highly variable and poorly predictable for any fish species. Furthermore, survival during this stage reflects natural as well as human effects (e.g. pollution, measured and unmeasured harvest impacts, marine mammal management). Additionally, if delayed freshwater mortality exists, it is most likely measurable during this period. The Action Agencies propose to work with NMFS and other appropriate regional partners to determine the magnitude of delayed freshwater mortality.

Recent estimates of marine survival, which include the effects of ocean harvest, are less than 1.0 percent (Welch et al., 1997).

4.2.2.4 Adult Passage Survival Standard

This life stage reflects adult passage survival from Bonneville Dam past Lower Granite.

Chapman et al. (1991) reviewed estimates of interdam loss for spring chinook as reported in the Columbia system. Loss, or mortality, estimates were based on dam counts and adjustments for tributary turnoff and harvest. They concluded that for lower Columbia and Snake projects, loss was generally near 5.0 percent per project. In 1992, Bjornn et al. (1994) reported telemetry-based survival estimates for spring chinook from the ladder exit at Ice Harbor Dam to the exit at Lower Granite Dam. Survival was 84.9 percent passing three projects, or 94.5 percent per project.

Some analyses have indicated survival may be lower than that under some conditions. For example, PATH analysts reported survival rates as low as 88 to 93 percent in several years since 1970, albeit the majority of estimates were consistent with the aforementioned.

The data ranges from 84.9 to 94.5 percent per project. Although the lower end of the range appears low for a performance standard, this information could be used to develop an interim standard.

4.2.2.5 Adult Pre-spawning Survival Standard

In this discussion, pre-spawning survival is defined as that realized from the point fish pass Lower Granite Dam to the time they deposit eggs in gravels. These estimates are difficult to obtain and usually several indirect estimates or extrapolations are required. Chapman et al. (1991) reviewed estimates reported in the Columbia system. They suggested that survivals of 50 to 60 percent are generally representative for Snake River stocks since the 1960s. This information could be used to develop an interim standard.

4.2.3 Indirect Effects

Potential indirect effects of a fish's exposure history on its fitness and survivability must be considered as performance standards are developed. Two relevant scenarios are of concern: *non-hydrosystem effects* that are manifested within the hydrosystem, and *hydrosystem effects* that are manifested outside the hydrosystem. These are not trivial matters to address. To the extent feasible and appropriate, performance standards should include appropriate parameters to capture known indirect effects; routine monitoring and evaluation would make observations on these parameters. When potential indirect effects are only hypothesized or it is not feasible to develop performance standards that include the indirect effects, then research would be used to test the hypotheses to determine if they are valid or not. In either case, information from monitoring and evaluation or hypothesis testing on these indirect effects provides critical feedback on the fish's performance and the adequacy of established performance standards.

4.2.4 Routine Monitoring and Evaluation

Routine monitoring and evaluation is integral to the step-wise and iterative process of performance standards as a means to improve decision making for management actions. Importantly, explicit performance standards provide a clear context for design of the monitoring and evaluation. Monitoring and evaluation is the primary mechanism to assess the actual performance of the fish in relation to established performance standards. With the integration of monitoring and evaluation across all life stages, necessary information is available to determine the effectiveness of actions across all life stages or H's, in relation to overall objectives.

The Action Agencies would institute a standardized method for monitoring and evaluation designed specifically to provide feedback on the effectiveness of specific actions and the contribution of the collection of actions to the overall performance standard. If the monitoring and evaluation finds that the hydrosystem's actual performance is exceeding or not meeting the performance standard, those with management responsibility may modify the list of actions. Further, if routine monitoring and evaluation finds that life stage survivals are being achieved, but the stocks are not approaching recovery goals, the H-specific standards, the allocation among the Hs, or both would be revisited.

4.3 SETTING PRIORITIES AND MAKING DECISIONS

One of the benefits of establishing performance standards is that they provide guidance about priorities for management actions. The Action Agencies assert that effective performance standards would be broken down by stock and life stage. With this, the difference between the performance standard and actual performance provides guidance for which management actions should take higher priority.

In addition to the priorities inherent in the performance standards, the Action Agencies propose the following **priority factors** that are not made evident by the use of performance standards. These factors are not intended to be mutually exclusive. Actions in all of the areas listed below will be taken to some degree.

- Experimental Management of Key Uncertainties. The Action Agencies believe it is of highest priority to get good, reliable information on the following key uncertainties: Delayed Transport Mortality, Delayed Effects of Hydrosystem Passage on Juveniles and Adults, Estuarine and Early Ocean Survival, Optimizing Passage Conditions at Dams, and Improving Mainstem Habitat. (For further elaboration see Section 4.4 and Appendix C).
- Balancing Listed Anadromous and Listed Resident Fish.
- Mainstem Spawning and Rearing Flows.
- Lower Columbia River over Snake River, where conflicts exist, because lower river actions benefit a greater number of stocks.
- Summer Migrant Flow over Spring Migrant Flow where conflicts or questions exist; based on the strong relationship between summer flows and survival and the need for improved temperatures in the mainstem.
- Mainstem and Estuary Habitat.
- Water Quality.
- Biological Diversity.

In addition to these general approaches, the Action Agencies have also identified a further sequence of specific priorities that would be applied to decision making for the hydropower system: first, Experimental Management; second, System-wide Considerations such as Transportation, Flow Augmentation, Flood Control, TDG, and Temperature; and third, Project by Project, starting first with projects with the lowest survival levels.

4.3.1 Efficacy/Feasibility Screen

The Construct for Achieving Survival Improvements gives priority to actions that more effectively contribute to meeting performance standards than other actions. All management actions would be evaluated based on their estimated biological benefits, the certainty of those benefits, the number of ESUs or distinct population segments (DPSs) benefited, and the amount of time to realize the benefits. Further, it is also relevant to evaluate the cost to implement all management actions. An unacceptably high cost, or a cost disproportionate to the benefits provided, should reduce the measure's desirableness as a reasonable investment. Additional criteria for management actions should include the amount of learning provided related to key uncertainties.

If an H can achieve its contribution to improving survival with more than one combination of actions, then a comparison of the relative benefits and costs of alternative combinations becomes relevant. Selection of a combination that achieves desired results for less cost than another combination that would achieve the same result increases effective use of financial resources. In contrast, selection of actions with costs disproportionate to the benefits provided suggests a less than fiscally responsible use of resources. This approach derives in part from the requirement in § 4(h)(6)(C) of the Northwest Power Act that actions in the Northwest Power Council's Program "utilize, where equally effective alternative means of achieving the same sound biological objective exist, the alternative with the minimum economic cost."

A comparison of the relative efficacy of alternative actions *across* the Hs, not just within each H, is also possible once the process has matured. In concept, if a non-hydro measure provides the same benefits as a measure in hydro at less cost, then hydro may have interest in supporting the non-hydro measure in lieu of the hydro measure. If hydro did support a non-hydro measure, it would ensure that the benefits of the non-hydro measure would more than offset the take associated with the hydro measure not taken. Again, selection of a combination that achieves desired results for less cost than another combination increases effective use of financial resources.

For these reasons, the Construct proposed by the Action Agencies advocates that all actions under consideration be contemplated with a full understanding of the full biological and economic impacts.

4.4 UNCERTAINTY RESOLUTION

4.4.1 Introduction

The Action Agencies believe that sound decisions on various aspects of listed species rebuilding and recovery depends on a better understanding of associated uncertainties. Further, the Action Agencies believe that carefully developed hypotheses and experimental designs to test these hypotheses provide real opportunity to improve understanding of essential variables and/or parameters of importance to rebuilding/recovery efforts. In fact, failure to improve understanding of these matters would prevent informed decision making or the exploration of alternative hypotheses that may be necessary to advance the state-of-the-science; effective adaptive management demands such endeavors.

The importance of addressing these uncertainties must also be considered in context of the Construct and performance standards. The relative importance of reducing various uncertainties is derived from the strategic directions that are established through the Construct and the specific performance standards that are set in the processes described above. In other words, the uncertainties of highest priority are those that are inherent or explicit in the direction or course set by the Construct and which are most sensitive relative to performance standards. Feedback from routine monitoring and evaluation also provides valuable input for planning on research uncertainties. This Construct helps ensure that uncertainty resolution is pursued within a clearly defined context, thereby providing the scientific underpinning within life stages and in aggregate across the entire life history.

NMFS' A-Fish Appendix in the Corps' *Draft Lower Snake River Juvenile Salmon Migration Feasibility Report/Environmental Impact Statement* (Corps, 1999b) (see Section 3.1) identified key uncertainties that, left unresolved, hinder decisions on hydrosystem configuration and operations. Other uncertainties that are important relative to effective implementation of actions were identified in, or formulated from, recent summaries of knowledge on the four hydro-related topic areas (i.e., juvenile fish transportation, flow and survival, dam passage, and predation) by NMFS in its draft White Papers (NMFS, 1999b, c, d, and e; also see Section 1.7.4). CRI analysis (or other forms of demographic analysis) would also provide some indication of relative priority in relation to the effect of life stage survival on population growth (see Section 1.7.3).

4.4.2 Categories of Hydrosystem Uncertainties

Two forms of information needs are important for this discussion. First, there are those critical uncertainties that, until resolved, prevent development of appropriate policies, strategies, or informed decisions on a particular action or actions. The other category of information needs relate to information that would enhance the effectiveness of actions, but is not necessarily critical to a particular decision. There are important distinctions between these two categories. It is also important to note that improved understanding on a particular issue may result in a reconsideration of the significance of that uncertainty. That is, an uncertainty could be moved from one category to the other as new information is developed. See Appendix C for more detailed discussion.

1. Critical Uncertainties – hypotheses about various forms of delayed mortality are the primary critical uncertainties in this category.
2. Uncertainties Inhibiting Effective Implementation – information needed to enable optimizing actions to achieve more effective and efficient implementation and to reduce risks between life stages or species are included in this category.

4.4.3 What's Next?

Opportunities to develop a more cohesive strategy to improve the knowledge base are afforded by recent analyses such as PATH, CRI, and EDT, and independent scientific reviews such as those performed by the National Research Council (NRC), the Independent Science Advisory Board (ISAB), and the Independent Science Group (ISG). Recent developments in tools for conducting research and analyzing information provide enhanced capabilities for observing juvenile and adult salmonid behavior and survival. Specifically, PIT tag technology, digitally-encoded radio tags, sonic tags, scientific-grade hydroacoustics, satellite imagery, remote sensing, integrated data bases, and computer models have all advanced in recent years. These improved capabilities provide opportunities to develop more accurate and precise observations of salmonid behavior, survival, and productivity, and to do so across a broader range of conditions, both temporally and spatially. They also provide much better opportunity to integrate information across life stages and environmental conditions.

Planning of research to address various uncertainties will be guided by the output from the Construct and performance standards processes. One approach to addressing these uncertainties would be to develop requests for proposals (RFPs) to solicit detailed proposals from selected and/or interested research agencies, universities, and private consultants. Proposals would be reviewed by independent scientists with one or more selected for subsequent funding. This entire process would be coordinated regionally through appropriate parties and processes, including the Northwest Power Planning Council, Columbia Basin Fish and Wildlife Authority, Corps' Anadromous Fish Evaluation Program, NMFS' Regional Forum, ISG, etc. (see Section 4.5).

4.4.4 Conclusion

Many of the uncertainties identified above have been the subject of regional discussion and included in previous biological opinions. These uncertainties are highlighted here to emphasize the urgency to address them in context of the Construct, performance standards, and pending decisions requiring improved information. The Action Agencies anticipate that existing regional forums and independent scientific reviews will foster rapid aggressive pursuit of these uncertainties in a scientifically rigorous manner.

4.5 IMPACT TO CURRENT DECISION-MAKING PROCESS

Outlined below is the process as defined by the 1995 and 1998 Biological Opinions that is used to determine funding and operational priorities on the hydrosystem. The development of performance standards is not expected to affect the functions or the composition of the teams outlined above. However, the performance standards will provide clear objectives and priorities by which to assess the efficacy and feasibility of their decisions.

The Regional Forum (see Figure 4-3) provides an intergovernmental forum for regional discussion and decision on operation and system configuration of the FCRPS.

Executive Committee: This group is the senior regional policy body known as the Executive Committee (EC). The designated representative or alternate of the NMFS chairs the meetings of the EC.

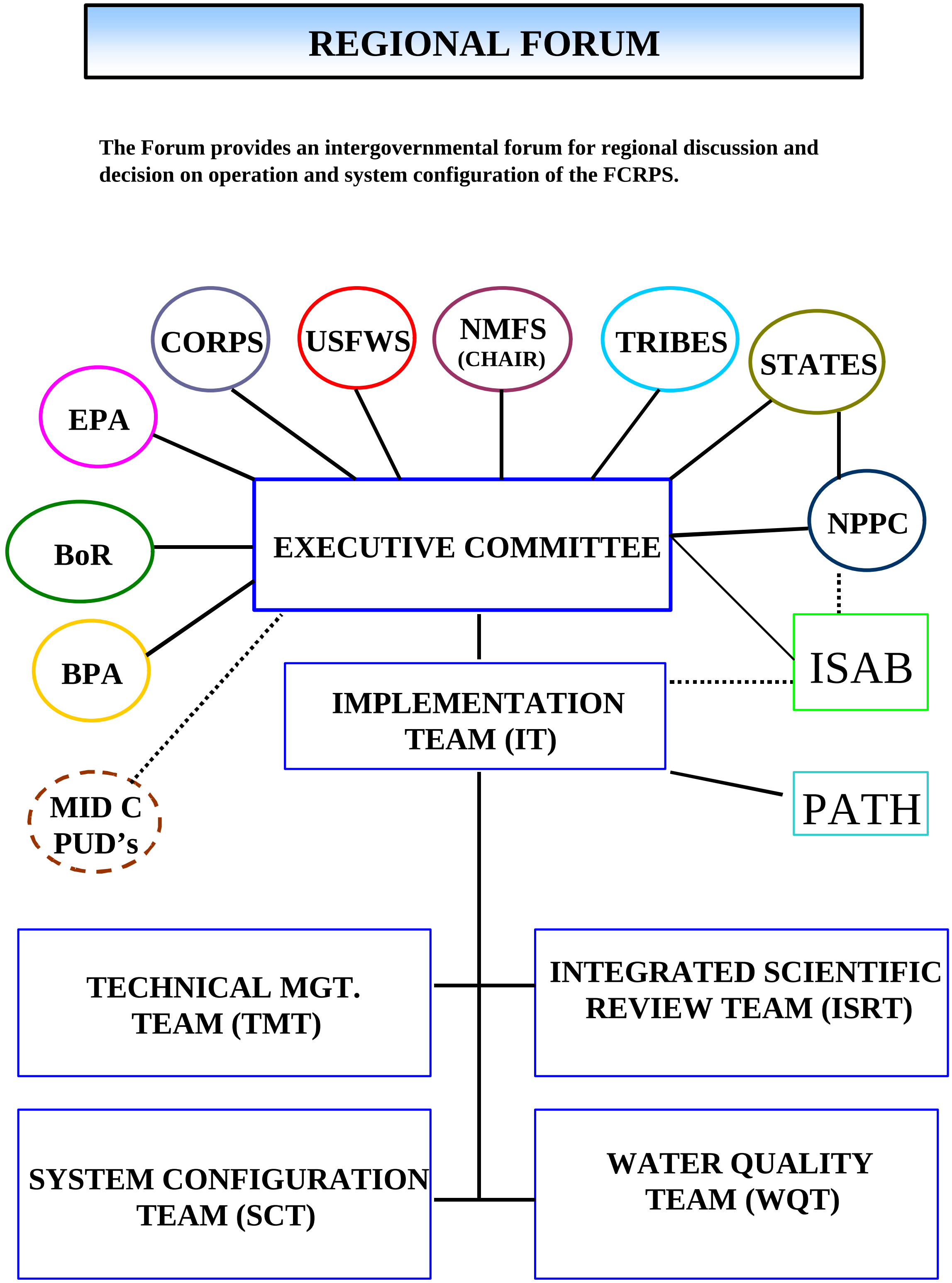
Implementation Team: The senior program managers' body is known as the Implementation Team (IT). The IT maintains on-going oversight of the Technical Management Team (TMT), SCT, Water Quality Team (WQT), PATH, and the Integrated Scientific Review Team (ISRT) activities.

System Configuration Team (SCT): This group was established to determine priorities and review progress on planning/engineering studies, and/or collection of research data under the Corps' Columbia River Fish Mitigation Project (CRFMP) funding program and related activities, and to make appropriate modifications to the measure or schedule where a measure is contingent upon completion of these studies.

Technical Management Team (TMT): This group is an inter-agency technical group responsible for making recommendations on dam and reservoir operations.

Water Quality Team (WQT): This group's mission is to provide scientific and technical recommendations and guidance on water quality issues to the Forum committees/subcommittees for decisions that may impact aquatic resources.

Figure 4-3. Regional Forum



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5. CONCLUSIONS

The primary purpose of this BA is for the Action Agencies to request reinitiation of consultation with the NMFS and USFWS and to present the operations, configurations, and processes that are intended for implementation. Unlike many BAs, this document does not present detailed descriptions of the species or the effects on these species from the described actions. As stated above, the Action Agencies believe that details of the effects of these actions have been addressed in many past documents and that NMFS and USFWS are either familiar with them, or they were authors of those documents. Also, evaluation of effects and development of actions to aid species are an ongoing process that can best be addressed through the consultation process. Additionally, the current actions have already considered the effects to the listed species and are directed at mitigating the effects within the constraints of the many factors affecting the FCRPS. Finally, the Action Agencies have identified a process by which Adaptive Management can be implemented to address specific concerns for listed species. As such, the Action Agencies believe that a summary of likely effects is sufficient for the intended purposes of this BA.

5.1 SUMMARY OF LIKELY EFFECTS

5.1.1 Anadromous Salmon, Steelhead and Trout

While many improvements have been and continue to be made in the FCRPS, some adverse effects to anadromous fish remain. The level of effect of many of the factors affecting survival of anadromous stocks during their whole life cycle remains poorly documented. But the effects relating to the hydrosystem of the Columbia River System have been analyzed in numerous documents. Even though the effects are not completely known, the FCRPS Action Agencies have relied on these documents to determine effects and, also, what current actions should be taken within this system to aid listed anadromous fish stocks. Previous Biological Opinions by the NMFS, in particular the 1995 Biological Opinion on the operation of the FCRPS (NMFS, 1995), the 1998 Supplemental Biological Opinion (NMFS, 1998), and the ongoing consultation on the Lower Columbia River chum salmon have been important in evaluating the FCRPS effects on these fish and the approach to be taken within this BA. However, since the 1998 Biological Opinion on FCRPS operations was issued, six additional anadromous salmonids have been listed and one is proposed for listing. Actions taken in response to these Biological Opinions and recent listings of more anadromous fish are included in the near-term and long-term actions covered in this BA (Sections 2.0 and 3.0).

In addition to the above noted Biological Opinions, other key sources of information have been used for the evaluation of effects. Recent evaluations in the Corps' draft *Lower Snake River Juvenile Salmon Migration FR/EIS* (see Section 3.1), and its associated Anadromous Fish Appendix developed by the NMFS, have been major sources of information for evaluating the effects of Snake River system operations on four listed fish stocks from that system.

Two major portions of the Anadromous Fish Appendix include the PATH analysis (see Section 1.7.2) and the CRI analysis (see Section 1.7.3). The PATH analysis (see Marmorek and Peters, 1998a,b; Peters et al., 1999) evaluated how implementation of four alternative actions on the lower Snake River Project (includes all four Corps dams on the lower Snake River) would affect the chance of meeting NMFS' jeopardy standards for listed Snake River fish. As part of the Anadromous Fish Appendix, NMFS developed a new analysis known as the CRI analysis. This new analysis evaluates how current and possible future operations on the Snake River may affect the risk of extinction of listed Snake River fish. In addition, it evaluated in general terms how actions outside of hydrosystem control may influence the chance of extinction. In conjunction with the analysis that was conducted for the Corps' FR/EIS, NMFS developed four white papers (see Section 1.7.4) that summarized what is known about the effects of the hydrosystem on anadromous salmonid survival. These four "White Papers" specifically addressed key items relating to the hydrosystem including: flow, travel time and survival (NMFS, 1999b), dam passage system effects on juvenile and adult salmonids (NMFS, 1999c), current fish transportation effects (NMFS, 1999d), and predation effects (NMFS, 1999e). All of these sources of information and others have influenced consideration of future recommended configurations and operations and the evaluation of how these operations affect listed, proposed, and candidate species.

The Action Agencies determined that operation of the FCRPS may likely adversely affect the continued existence of listed (and additional ones proposed for listing) anadromous fish ESUs of the Columbia River system. The Action Agencies recommend that the current operation (Section 2.0) plus the approach described in this BA be implemented to reduce adverse effects. Further, the Action Agencies emphasize that the procedures described in Section 4.0 should be used to determine how future configurations and operations should be modified to improve survival as needed. The Action Agencies acknowledge that the established NMFS Regional Forum and the Northwest Power Planning Council's Multi-Species Framework process and Columbia Basin forum will have active roles in the future in guiding hydrosystem operations under control of the Action Agencies. Any recommendations in the Corps' FR/EIS (Corps, 1999b) will also influence future configurations and operations within the system. The process of describing and implementing these actions by the FCRPS will be presented in the TMT's Annual Water Management Plan and the Corps' annual FPPs after completion of consultation in accordance with NMFS's recommendation and adoption in the Action Agencies Records of Decision.

5.1.2 Bull Trout

As indicated in the beginning of this BA, the effects of specific actions on bull trout within the areas influenced by the FCRPS, including the upper Snake River area, are addressed in detail in two separate BAs and are presented here by reference. The effects of the FCRPS (exclusive of the upper Snake River) under current and proposed operations have been addressed primarily in the newly developed BA on Columbia River bull trout and Kootenai River white sturgeon (Corps et al., 1999). The effects on bull trout from Action Agencies' projects in the upper Snake River (upstream of Lower Granite Reservoir) are addressed in another BA developed by the BoR (BoR, 1998). The bull trout and white sturgeon BA (Corps et al., 1999) has been reviewed by the USFWS. Based on their review, they requested additional information (Hallock, 1999). The Action Agencies are making changes where appropriate in the assessment of the effects of proposed operations. The upper Snake River BA (BoR, 1998) has also been reviewed by the USFWS and NMFS, and they issued Biological Opinions (USFWS, 1999; NMFS, 1999a) addressing species under their purview, including bull trout (see Appendix A for details on BoR projects).

Because bull trout are widely distributed, hydrosystem effects occur over a broad region of the Columbia River Basin. Bull trout are found in nearly all regions under the influence of the FCRPS (exclusive of the upper Snake River), except possibly for most regions of the four mainstem Columbia River projects (Corps et al., 1999). The distribution in the upper Snake River Basin is also large, with bull trout being present in several project areas under the influence of BoR projects (BoR, 1998).

The current configuration and operation of the FCRPS has affected this species in many ways that vary by individual project area. These have included effects on food resources in reservoirs, thermal changes in reservoirs and downstream rivers, flow fluctuation effects on rearing and feeding conditions, blockage of migration separating larger populations into smaller groups, and possibly entrainment through turbines and outlet works at some dams. Operation of the FCRPS will continue to result in some of these adverse effects to bull trout in some of the areas. These actions are discussed in detail in the two current Action Agencies' BAs (BoR, 1998; Corps et al., 1999) and partially summarized in this BA. Additionally, the USFWS and NMFS have issued Biological Opinion on effects in the upper Snake River Basin for BoR Projects (see Appendix A for details) (USFWS, 1999).

The Action Agencies, as detailed in the two BAs specifically addressing this species (Corps et al., 1999; BoR, 1998), have determined that, in some of the affected areas, FCRPS and upper Snake operations of some of the projects may likely adversely affect the Columbia River bull trout. The Action Agencies recommend that the actions described in this BA, and the other two BAs be implemented. Also, the Action Agencies recommend that the Construct presented in Section 4.0 of this BA be used to determine what future changes, if any, should be made relative to bull trout in configurations or operations of projects under FCRPS control. The Action Agencies acknowledge, as for anadromous salmonids, the Federal Caucus and Northwest Power Planning Council's Multi-Species Framework process will be active in determining what future actions will be implemented relative to the hydrosystem operations under control of the Action Agencies.

5.1.3 Kootenai River White Sturgeon

The recently developed BA for Columbia River bull trout and Kootenai River white sturgeon addresses the effects of proposed actions on Kootenai River white sturgeon (Corps et al., 1999). Much of the relevant information on effects of the FCRPS on Kootenai River white sturgeon has been presented in the original FCRPS BA (BPA et al., 1994), the USFWS' Biological Opinion that described the effects of FCRPS proposed actions (Dwyer, 1995), and the recent Action Agencies' BA (Corps et al., 1999). As noted for bull trout, this latter BA has been reviewed by the USFWS and is being modified by the Action Agencies. Factors, including peaking flows and reduced spring flows during spawning, may have contributed to adverse effects to this species in the past. For example, load following may have affected spawning behavior, success of egg hatching, or available food supply (BPA et al., 1994). Since operations were modified following the original Biological Opinion (Dwyer, 1995), spring flow enhancements and reduced ramping activities from the Libby Project may have contributed to apparent increased spawning success of this species in the Kootenai River below Libby Dam (Corps et al., 1999). However, some adverse effects may remain, including possible high TDG concentrations from spring spill as a result of exceeding current powerhouse capacity. In addition, late summer – early fall ramping may still affect production of food sources and survival in the system.

The Action Agencies have determined that currently proposed actions specifically relating to the Libby Project may likely adversely affect the Kootenai River white sturgeon. The details of this determination are presented in the recent BA that specifically addressed this species (Corps et al., 1999). As with the other listed species discussed above, in addition to the actions proposed in the noted BA, the Action Agencies emphasize that the Construct presented in Section 4.0 of this BA be considered when evaluating future changes in operations. Also, other Federal actions as noted for bull trout (e.g., All H Papers) will be considered by the Action Agencies when evaluating future changes to the hydrosystem operations under their control.

5.1.4 Other Species

The effects of the operations of the FCRPS on bald eagles, peregrine falcon, grizzly bear, and gray wolf were documented in the Action Agencies BA in 1993 (BPA et al., 1993) and BA supplement in 1994 (BPA et al., 1994). The USFWS issued a Biological Opinion in 1995 (USFWS, 1995) regarding these species. The Action Agencies are not aware of any changes in the FCRPS operations which would substantially change the effects or conclusions of those documents.

The effects on other species in Table 1-1 for the upper Snake River Basin were addressed in the recent BoR BA on operations and maintenance in the Snake River Basin above Lower Granite Reservoir (BoR, 1998). Biological Opinions have also been issued relative to all ESA species affected by the assessed BoR actions in this region (USFWS, 1999; NMFS, 1999a). The Action Agencies will consider the effects of the FCRPS operations in the rest of the project action area during consultation with the USFWS.

Currently, the Action Agencies have not made any determination of effects on proposed or candidate species.

5.2 NEXT STEPS

This BA is the first step in the ESA Section 7 consultation process and represents the Action Agencies' assessment of the effects of the proposed near-term operations, and long-term alternatives and decisions processes. Submission of this BA to NMFS and USFWS constitutes the Action Agencies' request to reinitiate formal consultation. During the consultation process, the Action Agencies, NMFS, and USFWS will discuss the proposed actions, consider available scientific data, and take into consideration relevant input on potential actions and biological information. Additional scientific analysis being conducted through CRI and EDT will be considered in the consultation. Based on those discussions, actions may be amended by the Action Agencies. The formal Section 7 consultation process will conclude with the issuance of Biological Opinions by NMFS and USFWS.

A draft Biological Opinion is anticipated for release in March 2000, with the final Biological Opinion scheduled to be released in May 2000.

For more information, call 1-509-358-7415, write to the ESA Public Comment Record c/o BPA-PL, 707 W. Main Street, Suite 500, Spokane, WA 99201, or send e-mail to esacomments@bpa.gov.

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APPENDIX A

DESCRIPTION OF BUREAU OF RECLAMATION PROJECTS IN THE COLUMBIA RIVER BASIN

Description of Bureau of Reclamation Projects in the Columbia River Basin

for the

Multi-Species Biological Assessment of the
Federal Columbia River Power System

Bureau of Reclamation
Pacific Northwest Region
December 1999

ABBREVIATIONS AND ACRONYMS

BA	Biological Assessment
BO	Biological Opinion
BPA	Bonneville Power Administration
CFR	Code of Federal Regulations
cfs	cubic feet per second
ESA	Endangered Species Act
FCRPS	Federal Columbia River Power System
kW	kilowatt
M&I	Municipal and industrial
NMFS	National Marine Fisheries Service
Reclamation	Bureau of Reclamation
Stat.	U.S. Statutes at Large
USFWS	United States Fish and Wildlife Services
USGS	United States Geological Service

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1. INTRODUCTION

This report provides descriptions for projects of the Bureau of Reclamation (Reclamation) in the Columbia River basin in the states of Washington, Oregon, Idaho and Montana. It has been appended to the Multi-Species Biological Assessment (BA) of the Federal Columbia River Power System (FCRPS). These Reclamation projects, some are single purpose irrigation and others are multipurpose, are a small component of the environmental baseline[1] in the FCRPS action area. Endangered Species Act (ESA) Section 7 consultations for Reclamation projects in the Snake River basin have been completed. Completed BA's for those projects where ESA Section 7 consultations have been completed or are in progress are referenced in this report and are incorporated by reference pursuant to 50 CFR '402.12(g).

Reclamation projects are the result of congressional actions that provide authority and funding, beginning with the 1902 Reclamation Act and continuing with numerous other acts, for Reclamation to engage in the development of water resources and the irrigation of arid lands. Early in the century, Congress expanded the role of Reclamation in water developments to include purposes in addition to irrigation and later modified operational purposes of some existing projects through additional legislation. As a result, some Reclamation projects are single purpose irrigation while others are multipurpose projects that may include flood control, hydropower generation, municipal and industrial (M&I) water supply, recreation, and fish and wildlife.[2] With respect to irrigation, some Reclamation projects involve the development of full water supplies for the irrigation of new lands, others involve only the rehabilitation of facilities privately developed, while still other projects involved various combinations of full water supplies for new lands and full or supplemental water supplies for previously irrigated lands.

There are 32 Reclamation projects operating in the basin, some of which have several divisions and some divisions have more than one unit[3] that receive irrigation water supplies through Reclamation facilities or are dependent on Reclamation programs. Reclamation projects in the Columbia River basin are summarized in table 1-1. Irrigated land areas

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[1]Environmental baseline - the past and present impacts of all Federal, State, or private actions and other human activities in an action area, the anticipated impacts of all proposed Federal projects in an action area that have already undergone formal or early ESA section 7 consultation, and the impact of State or private actions that are contemporaneous with the consultation in process. [50 CFR ' 402.02]

[2]All Reclamation projects in the Columbia River basin, with the exception of the Hungry Horse Project, provide water for irrigation. Hungry Horse Project, in northwest Montana, is primarily a hydroelectric project.

[3]Reclamation Projects may consist of more than one functional part. Official designation for the first rank is Division and for the second rank is Unit. Due to the selection process during authorization and funding, a Project as constructed may not be subdivided, consist of one or more Divisions, or consist of only a single Unit.

associated with these projects range from no irrigation for the Hungry Horse Project to about 1 million acres associated with the Minidoka Project.

Water supplies for these projects may include a single source or some combination of storage, natural flow, and ground water. Reclamation-developed water supplies may provide a full water supply, a supplemental water supply, or some combination of a full water supply to some lands and a supplemental water supply to other lands. Reclamation generally holds the water rights for storage supplies that it develops, but there are exceptions. Where Reclamation provides a supplemental water supply, irrigation entities generally retain the water rights for the primary (or first developed) water supply. However, there are exceptions where the original holder of a natural flow right has exchanged the right for storage space or natural flow rights which are held by Reclamation. Natural flows are normally used for irrigation early in the season, and, as natural flows subside, irrigation water is supplied from storage.

Reclamation projects represent most of the Federal authorized irrigation development in the Columbia River basin. Other Federal irrigation has been developed by the Bureau of Indian Affairs but the amount is minor; data on the Wapato Irrigation Project on the Yakama Indian Reservation in the Yakima River basin is included in Reclamation statistics for the Yakima Project. Total irrigated lands within Reclamation projects amounts to about 2.8 million acres (Reclamation, 1990 and 1992). This compares with a total of about 7.1 million acres of irrigated land within the United States portion of the Columbia River basin (Bonneville Power Administration (BPA) et al, 1995). Nearly 62 percent of all irrigation is private with no connection to Reclamation.

Net depletion of the Columbia River due to irrigation is about 14 million acre-feet; more than one-half of the nearly 33 million acre-feet of water diverted for irrigation returns to rivers (BPA et al, 1995). Irrigation depletions are less than 7 percent of the observed outflow of the Columbia River. Observed outflow of the Columbia River averages about 198 million acre-feet per year. Except for the Snake River basin upstream of Lower Granite Reservoir, the collective hydrological effect of irrigation diversions, and consequently Reclamation project irrigation, on the Columbia River, is small. The effect in the Snake River basin is fairly significant due to two factors: (1) about one-half of the irrigation in the Columbia River basin is within the Snake River basin while the runoff of the Snake River is small compared to the Columbia River and (2) about one-third of the natural flow upstream of Brownlee Dam is consumptively used for irrigation (Reclamation, 1997). Local hydrological effects due to irrigation are sometimes substantial.

Table 1-1. Reclamation Projects in Operation in the Columbia River Basin		
Project	**Location**	**Subbasin or Stream**
Upper Columbia River (Upstream of Snake River Confluence)		
Hungry Horse	Western Montana, north of Flathead Lake	South Fork Flat Head River
Bitter Root	Western Montana, south of Missoula	Bitterroot River
Missoula Valley	Western Montana, north of Missoula	Clark Fork River
Frenchtown	Western Montana, north of Missoula	Clark Fork River
Dalton Gardens	North Idaho, north of Coeur d'Alene	Spokane (Hayden Lake)
Avondale	North Idaho, north of Coeur d'Alene	Spokane (ground water)
Rathdrum Prairie	North Idaho, northwest of Coeur d'Alene	Spokane (ground water)
Spokane Valley	Eastern Washington, east of Spokane	Spokane (ground water)
Columbia Basin	Central Washington	Columbia River
Chief Joseph Dam	North-central Washington, from Canadian border to Wenatchee	Okanogan and Columbia Rivers
Okanogan	North-central Washington, near Okanogan	Okanogan River
Yakima	Central Washington, near Yakima	Yakima River
Lower Columbia (Downstream of the Snake River Confluence)		
Umatilla	Northeast Oregon	Umatilla and Columbia Rivers
Arnold	Central Oregon, south of Bend	Deschutes River
Crescent Lake Dam	Central Oregon west of Bend	Deschutes River
Crooked River	Central Oregon, north of Bend	Crooked River
Deschutes	Central Oregon, north of Bend	Deschutes River
Wapinitia	North-central Oregon, south of The Dalles	Deschutes River
The Dalles	North-central Oregon, near The Dalles	Columbia River
Tualatin	Northwest Oregon, west of Portland	Tualatin River (Willamette River)
Snake River		
Minidoka	Southern Idaho and western Wyoming from Twin Falls Idaho to Jackson Lake, Wyoming	Snake River
Palisades	Eastern Idaho, on Wyoming border	Snake River
Michaud Flats	Southern Idaho, near Pocatello	Snake River
Little Wood River	South-central, Idaho north of Twin Falls	Little Wood River
Boise	Southwest Idaho, near Boise	Boise and Payette Rivers
Mann Creek	Southwest Idaho, northwest of Boise	Weiser River
Owyhee	Eastern Oregon and southwest Idaho, near Ontario Oregon	Owyhee and Snake Rivers
Vale	Eastern Oregon, west of Ontario	Malheur River
Burnt River	Eastern Oregon, south of Baker City	Burnt River
Baker	Eastern Oregon, near Baker City	Powder River
Lewiston Orchards	West-central Idaho, near Lewiston	Clearwater River

These hydrological effects are included in the FCRPS hydrogeneration/flow models utilized by river planners and operators. These models are also used to help assess the impacts of the FCRPS on the 13 stocks of ESA listed salmon, steelhead, and bull trout. Consequently, the flow impacts of these projects are factored into all Reclamation consultations involving flows of the lower Snake and Columbia Rivers.

2. OTHER RECLAMATION CONSULTATIONS

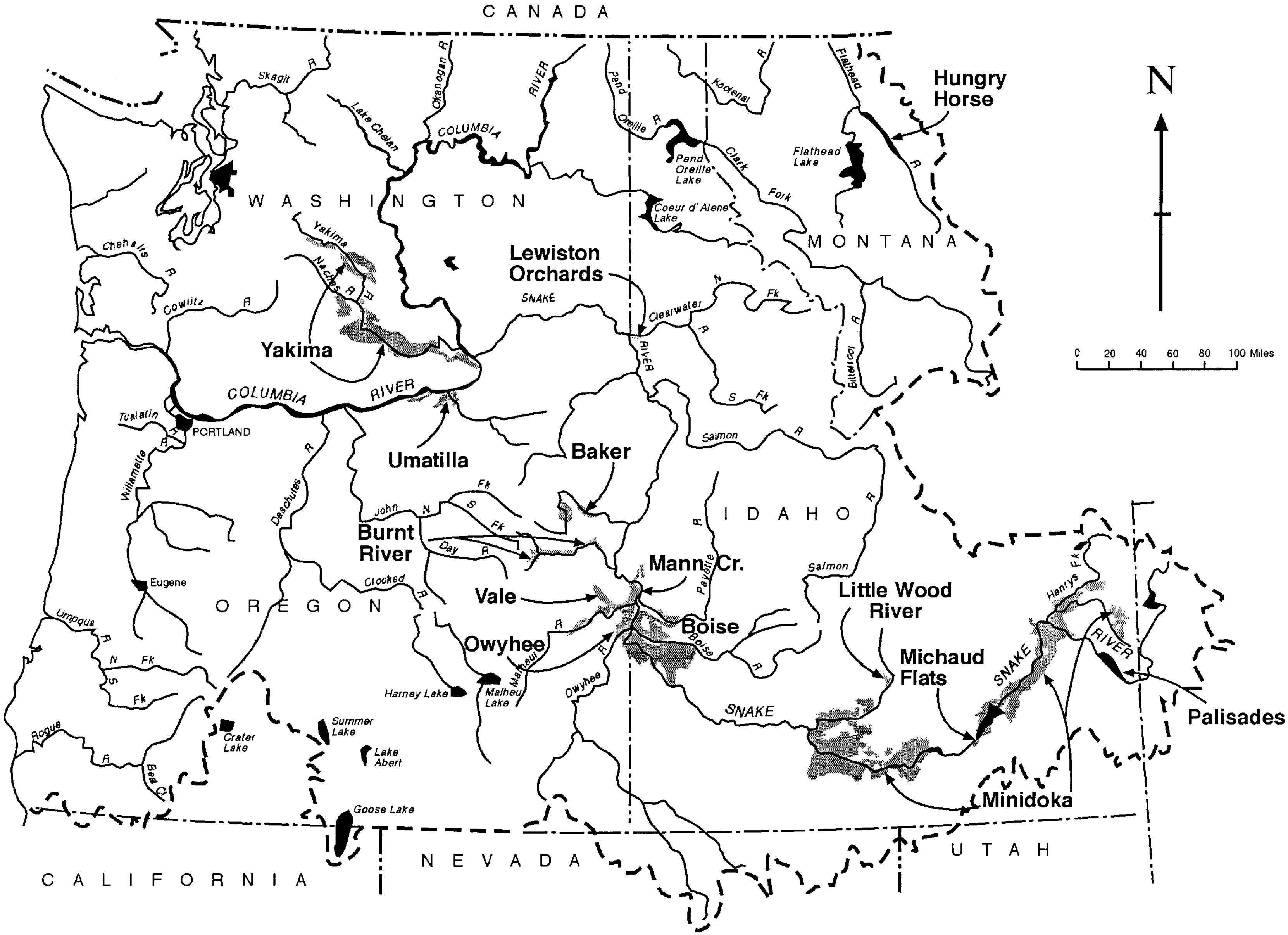
ESA section 7 consultations have been completed or are currently underway on Reclamation project operations in four areas. Except for the Lewiston Orchards Project, consultation has been completed for all Reclamation projects located in the Snake River basin upstream of Lower Granite Reservoir. The 11 Reclamation projects in this basin are located in western Wyoming, Idaho, and eastern Oregon. Consultation on operations of the Hungry Horse Project, located in northwest Montana, is underway and is included in the December 1999 multi-species ESA consultation on operation of the FCRPS for year 2000 and beyond. Consultation has been initiated recently on the Yakima Project in Washington (Yakima River basin) and the Umatilla Project in Oregon (Umatilla River basin) (see Individual ESA Section 7 Consultations on Reclamation Projects Completed or in ProgressBJanuary 2000 map). Project operation descriptions for these areas are contained in the respective BA=s written by Reclamation (Reclamation, 1998; 1999a, and 1999b).

Reclamation initiated these separate consultations because these projects may affect listed species in a manner not specifically described in the 1995 FCRPS consultation effort. Specifically, operation of the Yakima, Umatilla, and Hungry Horse Projects may affect listed salmonids or other listed species in close proximity to these projects and in a manner discrete and distinct from downstream flow-related impacts. With respect to the upper Snake River projects, Reclamation initiated a separate consultation in 1998, primarily to address perceived deficiencies in the level of consultation on the upper Snake River projects through the 1995 FCRPS consultation. These BA's, and therefore the descriptions, of Yakima, Umatilla, upper Snake River, and Hungry Horse Projects, are incorporated into this document by reference pursuant to 50 CFR '402.12(g) in recognition of the integration of Reclamation operations with the FCRPS.

Consultation actions for these four areas are summarized below.

2.1 UPPER SNAKE RIVER BASIN

Reclamation transmitted a final BA to the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) in April 1998 covering the operations and maintenance of 29 dams and reservoirs located throughout the Snake River basin upstream of Lower Granite Reservoir. This consultation covered water storage and diversion facilities associated with the Minidoka, Palisades, Michaud Flats, Little Wood River, Boise, Mann Creek and Lewiston Orchards Projects in Idaho, and the Owyhee, Vale, Burnt River,



Individual ESA Section 7 Consultations on Reclamation Projects Completed or in Progress - January 2000.

and Baker Projects in Oregon. Reclamation evaluated project operational effects on 21 ESA listed, proposed and candidate plant and animal species and concluded that three species were likely to be adversely affected. Final Biological Opinions (BO' s), completed by the USFWS in October 1999 and by NMFS in December 1999, concurred for the most part with Reclamation's conclusions on effects. The BO's contained Incidental Take statements with reasonable and prudent measures for the Utah valvata snail, bull trout, Ute ladies' tresses (a plant), and four stocks of listed Snake River salmon and steelhead. Due to additional pertinent information that was found after the BA was transmitted by Reclamation, NMFS will provide a separate BO in early 2000 on the operational effects of the Lewiston Orchards Project on Snake River steelhead.

As a result of the consultation on its upper Snake River projects, Reclamation is now taking several actions. These include (1) implementing field studies and operational procedures to protect the Utah valvata snail in the middle Snake River, (2) conducting reservoir water quality and minimum pool studies, fish entrainment evaluations, in addition to fishery investigations intended to conserve bull trout populations in Reclamation reservoirs, (3) participating in field surveys to better define the distribution and habitat of Ute ladies' tresses in Idaho, and (4) continuing the acquisition of the Snake River basin water to provide flow augmentation for listed Colombia River basin salmon and steelhead stocks. These protective measures will continue in place until such time as operations may be changed stemming from the consultation on the FCRPS operations for 2000 and beyond.

2.2 YAKIMA PROJECT

Reclamation prepared a draft BA on the effects of the routine operation and maintenance of the Yakima Project on nine ESA listed species of plants and animals, and the draft BA was sent to USFWS and NMFS for review and comment. Current project operations will continue until completion and implementation of the basin interim comprehensive operation plan (Section 1210, Title XII, Public Law 103-434). 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. An extensive description of irrigation project operations is included in the BA. Reclamation concluded in the draft BA that present project operations could adversely affect bull trout and steelhead. A BO is expected in mid-year 2000.

2.3 UMATILLA PROJECT

Reclamation reinitiated ESA consultation with NMFS on the Umatilla Project in northeastern Oregon, and Reclamation is drafting an updated BA on operations. A BO from NMFS in expected in the mid-year 2000. Consultation includes the Columbia River water exchange with Hermiston, Stanfield and West Extension Irrigation Districts plus Westland Irrigation District water operations. Over the past decade, substantial changes have been implemented through construction and operation of a water exchange program to improve instream flows for salmon and steelhead runs. Fish passage improvements have been constructed at all project diversion facilities.

Umatilla River salmon runs extirpated in the early 1900's are being restored under current operations. Several salmonid species, two of which (steelhead and bull trout) are listed under the ESA, now inhabit the Umatilla River. The Confederated Tribes of the Umatilla Indian Reservation and the Oregon Department of Fish and Wildlife are sharing management of anadromous fish resources in the Umatilla River basin.

2.4 HUNGRY HORSE PROJECT

ESA consultation on the Hungry Horse Project is included in the consultation on operations of the FCRPS for 2000 and beyond. Hungry Horse Dam and Reservoir are located on the South Fork of the Flathead River in northwestern Montana. Authorized purposes of the Hungry Horse Project are primarily flood control and power generation, but also includes other beneficial uses; storage has not been allocated for an irrigation water supply. In 1995, a selective withdrawal system was retrofitted on the dam to help regulate downstream water temperatures to mimic pre-dam conditions. Hungry Horse operations also include releases to meet year round minimum flow targets of 3,500 cubic feet per second (cfs) in the main stem Flathead River. Additionally, up to 20-feet of reservoir draft in the summer has been required since the 1995 FCRPS Biological Opinion to augment Columbia River flows for salmon. Key species in the current ESA consultation include many of the listed Columbia River basin anadromous fish stocks plus bull trout.

3. OVERVIEW OF IRRIGATED ACREAGE AND WATER WITHDRAWALS IN THE UNITED STATES PORTION OF THE COLUMBIA RIVER BASIN

3.1 IRRIGATED ACREAGE

As a perspective, the Columbia River drains about 219,000 square miles in the United States and another 39,500 square miles in Canada. Average annual outflow observed at the mouth is 198 million acre-feet with the current level of development. Total irrigated acreage in the Columbia River basin in 1990 was about 7.3 million acres of which about 7.1 million acres were in the United States (BPA et al, 1995). Of the total in the United States about 3.3 million acres are located in Idaho, 1.9 million are in Washington, 1.3 million are in Oregon, and the remainder is scattered in other states. Irrigated lands within Reclamation projects (lands that receive Reclamation water or use Reclamation constructed systems for water transport) in the Columbia River basin amount to nearly 2.9 million acres on average cropping using Reclamation data for 1990 to 1992 (Reclamation, 1990 and 1992) and contract acreages for Montana and some Washington State projects (Personal Communication, 1999). Table 3.1 shows irrigated acreage by state.

Table 3-1. Columbia River Basin Irrigated Acreage in 1990 by State

State	Acreage		
	Reclamation[1]	Other	Total[2]
Idaho	1,423,000	1,909,200	3,332,200
Montana	22,500	411,200	433,700
Nevada	0	70,400	70,400
Oregon	334,500	982,100	1,316,600
Utah	0	5,600	5,600
Washington	1,084,000	794,900	1,878,900
Wyoming	0	94,100	94,100
Total in United States	2,864,000	4,267,500	7,131,500

[1]1990 and 1992 Summary Statistic Water, Land and Related Data, Bureau of Reclamation and more recent data on contract acreage for some Washington State projects
[2]Columbia River System Operation Review, Final Environmental Statement, Appendix F, November 1995, BPA

Reclamation irrigated acreage by Reclamation project and by three general subbasinsBupper Columbia River (upstream of the Snake River confluence), lower Columbia River (downstream of the Snake River confluence), and the Snake RiverBhave been compiled using Reclamation data (Reclamation, 1990 and1992; Personal Communication, 1999). Acreages for the Bitter Root, Frenchtown, Dalton Gardens, Avondale Rathdrum Prairie, Spokane Valley, Columbia Basin, and Okanogan Projects are based on contract acreage, not average cropping acreage. The amount of land irrigated in any single year can vary depending on water supply and the general economy. Annual variation in irrigated acreage for Reclamation projects is more than 10 percent and in some cases may approach 20 percent. As a result, data on Reclamation irrigation is intended to be only a general guide.

Table 3-2 summarizes Reclamation irrigation and total irrigation in the three subbasins; total irrigation was summed from U.S. Geological Service (USGS) data on hydrological units for 1990. About 2,015,000 acres are irrigated in the upper Columbia River basin and of this amount about 1,115,700 acres are in Reclamation Projects. About 95 percent of this Reclamation irrigation is within the Columbia Basin and Yakima Projects. In the lower Columbia River basin, about 1,063,000 acres are irrigated and this includes about 157,000 acres in Reclamation projects. In the Snake River Basin about 3,794,000 acres are irrigated with about 1,591,000 acres in Reclamation projects. The Minidoka-Palisades Projects account for about two-thirds of Reclamation irrigation in the Snake River Basin.

3.2 WATER WITHDRAWALS FOR IRRIGATION

Irrigation accounts for nearly all water withdrawals from surface waters in the Columbia River basin. About 32.6 million acre-feet are diverted from streams and pumped from ground water for irrigation (BPA et al, 1995). Of this total, about 13.7 million acre-feet are lost from the system and the remainder, 18.9 million acre-feet, returns 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. Diversions dependent entirely on natural flow rights, will likely be less during drought years as the streamflow falls. An additional caution in comparing Reclamation and total irrigation diversion data presented in this section is that the methods of collecting data and/or estimating diversions for Reclamation projects and for total irrigation diversions are not the same. Reclamation data is based on actual diversions, while USGS data is generally an estimate based on irrigated acres, climate, crops needs, and expected conveyance and other losses. As a result, irrigation diversions should be viewed only as a general guide.

Based on 1990 USGS data and Reclamation data for 1990 and 1992, Reclamation irrigation diversions amount to about 45 percent of total diversions for the Columbia River basin. Reclamation diversions account for the following: nearly 77 percent of all irrigation diversions in the upper Columbia River basin, about 28 percent of diversion in the lower Columbia River basin, and about 45 percent of diversions in the Snake River basin. Irrigation diversions in the three subbasins and for individual Reclamation projects are summarized in table 3-3.

Information on return flows for the three subbasins and individual Reclamation projects was not compiled for this report. 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 indicates that the amount of return flow versus total diversion is highly variable and depends on many factors including type of application, application rate, and efficiency of the carriage system. Reclamation (1997) indicates that slightly less than 40 percent of surface diversions upstream of Brownlee Dam (Snake River basin) are consumptively used.

Table 3-2. Columbia River Basin Irrigated Acreage by Subbasin			
Reclamation Projects		Other (Acres)	Total (Acres)
Project[1]	Acres		
Upper Columbia River (Upstream of Snake River Confluence)			
Hungry Horse	0		
Bitter Root	16,700		
Missoula Valley	800		
Frenchtown	5,000		
Dalton Gardens	1000		
Avondale	1100		
Rathdrum Prairie	7,100		
Spokane Valley	7,500		
Columbia Basin	671,500		
Chief Joseph Dam	20,000		
Okanogan	5,000		
Yakima[2]	380,000		
Reach Total	1,115,700	899,300	2,015,000
Lower Columbia (Downstream of the Snake River Confluence)			
Umatilla	24,800		
Arnold	1,900		
Crescent Lake Dam	8,100		
Crooked River	14,000		
Deschutes	85,000		
Wapinitia	2,000		
The Dalles	5,500		
Tualatin	15,800		
Reach Total	157,100	905,900	1,063,000
Snake River			
Minidoka-Palisades	1,062,100		
Michaud Flats	10,400		
Little Wood River	7,900		
Boise	325,500		
Mann Creek	4,900		
Owyhee	102,700		
Vale	30,000		
Burnt River	20,000		
Baker	24,700		
Lewiston Orchards	3,000		
Reach Total	1,591,200	2,202,800	3,794,000
Basin Total	2,864,000	4,008,000	6,872,000
[1]Bold-italics indicate projects where consultation has been initiated or completed[2]Includes Wapato Irrigation Project			

Table 3-3. Columbia River Basin Irrigation Diversions by Subbasin[1]			
Reclamation Projects		Other (Acre-Feet)	Total (Acre-Feet)
Project[2]	Acre-Feet		
Upper Columbia River (Upstream of Snake River Confluence)			
Hungry Horse	0		
Bitter Root	80,000		
Missoula Valley	3,000		
Frenchtown	29,000		
Dalton Gardens	2,000		
Avondale	1,000		
Rathdrum Prairie	10,000		
Spokane Valley	16,000		
Columbia Basin	2,700,000		
Chief Joseph Dam	69,000		
Okanogan	14,000		
Yakima[3]	2,000,000		
Reach Total	4,924,000	2,496,000	7,420,000
Lower Columbia (Downstream of the Snake River Confluence)			
Umatilla	161,000		
Arnold	30,000		
Crescent Lake Dam	36,000		
Crooked River	50,000		
Deschutes	500,000		
Wapinitia	5,000		
The Dalles	11,000		
Tualatin	41,000		
Reach Total	834,000	2,120,000	2,954,000
Snake River			
Minidoka-Palisades	6,500,000		
Michaud Flats	26,000		
Little Wood River	60,000		
Boise	1,808,000		
Mann Creek	8,000		
Owyhee	530,000		
Vale	70,000		
Burnt River	50,000		
Baker	78,000		
Lewiston Orchards	6,000		
Reach Total	9,136,000	13,346,000	22,482,000
Basin Total	14,894,000	17,962,000	32, 856,000

[1]Reclamation diversions are based on 1990-1992 data and total diversions are based on 1990 USGS data[2]Bold-italics indicates projects were consultation has been initiated or completed3Includes Wapato Irrigation Project

4. PROJECT DESCRIPTIONS

Information for this section has been obtained from a variety of sources including the Reclamation Project Data (Reclamation, 1999c), which includes additional information on the history and development of the projects, Reclamation 1990 and 1992 Summary Statistics Water, Land and Related Data (Reclamation, 1990 & 1992) and more recent data on contract acreage for some projects (Personal Communication, 1999). Project descriptions in this chapter are organized by three subbasins from upstream to downstream and within each subbasin from upstream to downstream. Cummulative impacts due to irrigation operations of the projects described in this section are part of the FCRPS flow record through Bonneville Dam used in all of Reclamation's ESA consultations.

4.1 UPPER COLUMBIA RIVER (UPSTREAM OF SNAKE RIVER CONFLUENCE)

4.1.1 Bitter Root Project

4.1.1.1 Overview

The Bitter Root Project is located mostly south of Stevensville, Montana, on the east side of the Bitterroot River along the western edge of Montana. Formed in 1920 and experiencing difficulties by 1930, the Bitter Root Irrigation District asked Congress for help in rehabilitating facilities and retiring indebtedness. Reclamation began rehabilitating the project in 1930.

About 16,700 irrigable acres are in the project, but only 15,380 are irrigated to produce grain, hay, and pasture.

4.1.1.2 Authorization

Congress authorized rehabilitation of the irrigation system in Public Law 71-506 dated July 3, 1930. Additional Congressional actions included Public Law 74-327 dated August 26, 1935, and Public Law 81-561 dated May 6, 1949, related to contractual matters. Further rehabilitation of facilities was made pursuant to Public Law 81-335 dated October 7, 1949 and Public Law 80-790 dated June 26, 1948. The purpose of the project is irrigation.

4.1.1.3 Facilities and Water Supply

Project facilities include Como Dam and Lake Como, Rock Creek Diversion Dam, and a canal distribution system. Como Dam, privately constructed in 1910, was rehabilitated by Reclamation in 1954; additional modifications under Reclamation's safety of dams program were made between 1992 and 1994. The dam, located on Rock Creek about 12 miles south of Hamilton, Montana, is an earthfill structure about 70 feet high and 2,550 feet long. Lake Como, the impoundment, has a capacity of 36,900 feet (35,100 acre-feet active capacity) and a surface area of 1,010 acres at full pool.

Rock Creek Diversion Dam, located about 1 mile downstream from Como Dam, is about 10.5 feet high and diverts up to 325 cfs of water to the irrigation distribution system.

The water supply for the Bitter Root Project is Rock Creek and Lost Horse Creek, tributaries of the Bitterroot River.

4.1.1.4 Operation and Maintenance

The Bitter Root Irrigation District operates and maintains the facilities and owns Como Dam and Lake Como. Operation of facilities is limited generally to the irrigation season that begins about May 15 and ends about September 15. About 80,000 acre-feet are annually diverted for irrigation. Recent Safety of Dams work resulted in an agreement with the State of Montana to provide 3,000 acre-feet of new space for instream flow maintenance.

4.1.2 Missoula Valley Project

4.1.2.1 Overview

The Missoula Valley Project consists of only one unit, Big Flat Unit, located about 7 miles west of Missoula, Montana along the Clark Fork River. Reclamation began investigations in 1939 at the request of local interests, began construction in 1945, and completed construction of the project in 1949.

Within the project are about 800 irrigable acres but only 150 acres are currently irrigated to produce hay, grain, and pasture. The northern part of the project is being subdivided for rural homesites.

4.1.2.2 Authorization

The President authorized the Missoula Valley Project on May 10, 1944 under the authority of Public Law 76-398 dated August 11, 1939. Authorized project purpose is irrigation.

4.1.2.3 Facilities and Water Supply

Major project features are the Big Flat Canal and headworks that divert water from the Bitterroot River about 5 miles southwest of Missoula, Montana. Big Flat Canal has a capacity of 40 cfs and conveys water to a short length of laterals. Water supply for the project is the Bitterroot River.

4.1.2.4 Operation and Maintenance

Project facilities are operated and maintained by the Big Flat Irrigation District. Operation of facilities is limited generally to the irrigation season that begins about April 1 and ends about mid-October. About 3,000 acre-feet are annually diverted for irrigation.

4.1.3 Frenchtown Project

4.1.3.1 Overview

The Frenchtown Project is located along the Clark Fork River west of Missoula, Montana. Lands in the area were settled in 1860 by French-Canadian immigrants. Reclamation studied the area as early as 1919 but did not proceed further until local farmers, in 1936, asked Reclamation for assistance in developing irrigation. Reclamation began construction in 1936 and completed construction in 1937.

Within the Frenchtown Project are about 5,000 contract acres of which only 3,800 acres are irrigated to produce hay, grain, and pasture. Few farms are operated full-time.

4.1.3.2 Authorization

The Frenchtown Project was authorized by the President on September 21, 1935 under authority of the Act of June 25, 1910 and the Act of December 5, 1924 (36 Stat. 836 and 43 Stat.702). Authorized purpose is irrigation.

4.1.3.3 Facilities and Water Supply

Major facilities include the Frenchtown Canal diversion, which consists of a intake chanel and dike with a canal headworks and a sluice gate on a side channel of the Clark Fork River near Missoula, Montana, and a gravity flow main canal and distribution system. The Frenchtown diversion structure, constructed in 1937, is about 16 feet high and 489 feet long. The main canal has a capacity of 170 cfs.

Water supply for the Frenchtown Project is the Clark Fork River.

4.1.3.4 Operation and Maintenance

Facilities are operated and maintained by the Frenchtown Irrigation District. Operation of facilities is limited generally to the irrigation season that begins about mid-April and ends about October 1. About 29,000 acre-feet are annually diverted for irrigation.

4.1.4 Dalton Gardens Project

4.1.4.1 Overview

The Dalton Gardens Project consists of rehabilitation of a private development that provided irrigation water to lands located about 2 miles north of Coeur d'Alene, Idaho. Dalton Gardens developed as one of several privately developed irrigation ventures in the area that used Hayden Lake as an irrigation water supply. In 1953, the irrigation district that was operating the facilities, originally constructed in 1905, submitted a plan to Congress for reconstruction. Reclamation completed rehabilitation in 1955 and additional pipe rehabilitation was completed in 1964.

Within the Dalton Gardens Project are about 990 contract acres but only 700 acres are irrigated to produce primarily pasture and hay. Most farm units are operated on a part-time basis.

4.1.4.2 Authorization

Congress authorized the project through the Public Law 83-172 dated July 31, 1953 and authorized emergency pipe rehabilitation in Public Law 87-289 dated September 22, 1961. The project purpose is irrigation.

4.1.4.3 Facilities and Water Supply

Facilities consist of a pumping plant on Hayden Lake, a steel tank equalizing reservoir, and a pressure pipe distribution system. The pumping plant consists of two units with a capacity of 6.7 cfs each. Water supply is Hayden Lake, which has an annual inflow of about 45,000 acre-feet.

4.1.4.4 Operation and Maintenance

The Dalton Garden Irrigation District operates and maintains project facilities. Operation of facilities is limited to the irrigation season that begins about May 15 and ends about September 15. About 2,000 acre-feet are pumped annually to irrigate lands.

4.1.5 Avondale Project

4.1.5.1 Overview

The Avondale Project consists of the rehabilitation of private facilities that provide water to irrigate lands east of Hayden Lake, about 6 miles north of Coeur d'Alene, Idaho. Private development began in 1906. Frequent failure of the 50-year-old irrigation system resulted in an appeal during the 1953 irrigation season for reconstruction assistance. Rehabilitation by Reclamation began in 1954, was completed in 1955, and further pipe rehabilitation was begun in 1962 and completed in 1964.

Originally developed as a private irrigation project for fruit production, current facilities and crop patterns are quite different. The original tracts consisting of 5-10 acres have been, for the most part, subdivided many times with only a few consolidations of more than 10 acres in an ownership. Most of the tracts are now used as suburban homes or part-time farms in pasture or hay. Contract acreage for the Avondale Project amounts to about 1,100 acres, but only 240 acres are irrigated under 1,300 user accounts.

4.1.5.2 Authorization

Congress authorized the Avondale Project through Public Law 83-172 dated July 31, 1953. This appropriation act authorized the emergency rehabilitation of the Avondale Project. Further emergency rehabilitation of the pipe system was authorized by Congress through Public Law 87-289 dated September 22, 1961. Project purpose is irrigation.

4.1.5.3 Facilities and Water Supply

Reclamation's rehabilitation of facilities consisted of reconstruction of a pumping plant on Hayden Lake, construction of an elevated equalizing tank, and construction of a water main and distribution system for sprinkler irrigation. The Avondale Irrigation District retains the Hayden Lake pumping plant for emergency use, but has independently replaced the Hayden Lake water supply with ground water pumped from four wells. These four wells have a total capacity of 13.1 cfs and range in depth from 280 feet to 405 feet.

4.1.5.4 Operation and Maintenance

The Avondale Irrigation District operates and maintains the facilities of the Avondale Project. During the irrigation season, about May 15 to September 15, water is pumped to supply irrigation demand. Average annual water use is about 1,000 acre-feet.

4.1.6 Rathdrum Prairie Project

4.1.6.1 Overview

The Rathdrum Prairie Project was developed in Northern Idaho and Eastern Washington as three unitsBPost Falls, Hayden Lake, and East Greenacres UnitsBfrom three separately operated private irrigation developments that began operating about 1910. At present, the project consists of only the Hayden Lake and East Greenacres Units; the Post Falls Unit was dissolved in 1995 with disposal of all of the associated facilities. The remaining two units have a total of about 7,100 contract acres, but only 4,000 acres are irrigated. Major crops in the units include grain, hay, pasture and seed (grass and potatoes); however, many farm units are operated part time or as rural homesites.

The Hayden Lake Unit is about 6 miles north of Coeur d'Alene, Idaho near Hayden Lake. Emergency repair of the main supply line was accomplished in 1948-1949, major rehabilitation of the system was completed in 1958, and emergency pipe rehabilitation was completed in 1963. A total of 1,600 irrigable acres are within the unit.

The East Green Acres Unit is about 10 miles west of Coeur d'Alene. Construction on the unit began in 1972 and was completed in 1976. The distribution system was constructed to supply irrigation water to about 5,300 acres and domestic water to residents within the unit. In 1995, there were more than 770 domestic turnouts. Development of the ground-water supply and modification of the outlet works of Twin Lakes by Reclamation resulted in enhanced recreation and improved fish and wildlife habitat at the lakes; Twin Lakes was the water supply before development of the ground-water system.

4.1.6.2 Authorization

Units of the Rathdrum Prairie Project were authorized separately. The Post Falls Unit was authorized by the President on January 29, 1944 under the water Conservation and Utilization Act of August 11, 1939 (535 Stat. 1418). Congress authorized replacement of the wooden discharge line through Public Law 93-97 dated August 16, 1973. Authorized purpose of the unit was irrigation; however, the unit was dissolved on August 11, 1995 with the assent of the Reclamation.

The Hayden Lake Unit was authorized by the Secretary of the Interior on June 9, 1947 under the 1939 Reclamation Project Act (53 Stat. 1187). Emergency rehabilitation was authorized by Congress through the Interior Department Appropriation Act of 1948 (61 Stat. 473). Congress authorized further rehabilitation through Public Law 84-641 dated July 2, 1956.

Emergency pipe rehabilitation was authorized by Congress under Public Law 87-289 dated September 22, 1961.

Authorized purpose of the unit is irrigation.

The East Greenacres Unit was authorized by Congress through Public Law 91-286, dated June 23, 1970. Purposes of the East Greenacres Unit include irrigation, M&I water supply, conservation of fish and wildlife, and enhancement of recreation.

4.1.6.3 Facilities and Water Supply

Water is now supplied to the Hayden Lake Unit from three large wells with a total pumping capacity of 7,800 gallons per minute. The first well was developed in 1983. After the Hayden Lake Irrigation District developed the last two wells in 1990, the pumping plant on Hayden Lake (20-cfs capacity) was placed on standby. Distribution facilities include a 10,000-cubic-foot, elevated storage tank and a pipe distribution system.

Water supply for the East Greenacres Unit is 14 wells developed in three complexes. There are 7 wells of 20-inch-diameter and 7 wells of 16-inch-diameter; pump capacities vary from 0.47 to 8.2 cfs. Distribution facilities include a pressure pipe system with a 43,000-cubic-foot underground concrete reregulating reservoir. The distribution system was constructed with 248 metered domestic turnouts of 1 inch diameter and 357 irrigation turnouts of 1 to 6 inches in diameter. By 1995, there were more than 770 domestic turnouts.

4.1.6.4 Operation and Maintenance

The Hayden Lake Irrigation District operates and maintains the facilities of the Hayden Lake Unit. During the irrigation season, May 15 to about September 15, water is pumped to supply irrigation demand.

The East Greenacres Irrigation District operates and maintains the facilities of the East Greenacres Unit. Operation is year-round since facilities supply domestic water.

Total annual water usage of the Rathdrum Prairie Project is about 10,000 acre-feet.

4.1.7 Spokane Valley Project

4.1.7.1 Overview

The Spokane Valley Project lies to the east of the city of Spokane, extending eastward to and past the Washington/Idaho border. Irrigation in the area dates from about 1905. Deterioration of irrigation systems and new residential subdivisions prompted a request of

Reclamation to provide aid. Reclamation's investigation led to a report in 1956 that was used as a basis for authorizing a Federal project.

The Spokane Valley Project includes about 7,500 contract acres but only about 4,000 acres are irrigated to produce hay, pasture, grain, and vegetables. In addition to irrigation water supply, the project provides a domestic, municipal, and industrial water supply to the area.

4.1.7.2 Authorization

Congress authorized the Spokane Valley Project in Public Law 86-276 dated September 16, 1959, and amended the authorization in Public Law 87-630 dated September 5, 1962. Authorized purposes are irrigation and domestic, municipal, and industrial water supply.

4.1.7.3 Facilities and Water Supply

Major facilities of the project include 34 wells, 11 elevated steel tanks used as equalizing reservoirs, and a piped distribution system.

The wells, which range from 16 to 22 inches in diameter and from 90 to 150 feet deep, are located at 11 sites in clusters of 3 or 4 wells. Pump capacities range from 2.6 to 7.4 cfs.

4.1.7.4 Operation and Maintenance

The Consolidated Irrigation District Number 19 operates and maintains the facilities. Year-round operation of the project pumps about 16,000 acre-feet annually.

4.1.8 Columbia Basin Project

4.1.8.1 Overview

The Columbia Basin Project is a multipurpose development in central Washington. Interest in an irrigation development began before 1920 but the major problem was how to supply water to lands that were high above the channel of the Columbia River. Investigations by the U.S. Army Corps of Engineers and by Reclamation in 1932 recommended the project essentially as now built. Three irrigation districts were formed by1940 as a prerequisite to construction of irrigation works.

Grand Coulee Dam, started in 1933, was completed in 1941. The primary effort during World War II was installation of hydroelectric generating units to supply electric power for the war effort. After the war, construction centered on the Pumping Plant and primary irrigation facilities. First irrigation water to about 5,400 acres of the Columbia Basin project was in 1948 from the Pasco Pumping Plant on the Columbia River near Pasco Washington.

This was followed by pumping to about 1,200 acres in 1950 from the Burbank Pumping Plant on the Snake River south of Pasco. In the spring of 1952 first irrigation water was delivered via the Grand Coulee pumping plant to about 66,000 acres.

As originally envisioned, irrigation water would be supplied to about 1.1 million 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.

Average net generation of the Grand Coulee Powerplants from 1994 to 1998 was about 22.6 billion kilowatts (kW) which is a large share of the power requirements of the Pacific Northwest. Energy produced by just the Third Powerplant is sufficient to meet the needs of the cities of Portland, Oregon and Seattle, Washington.

Flood control space is maintained in Lake Franklin D Roosevelt to control the Columbia River at the Dalles to no more than 450,000 cfs.

4.1.8.2 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 dated August 30, 1935, and was reauthorized by Congress 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 dated June 14, 1966 and Public Law 89-561, dated September 7, 1966.

Project purposes include flood control, navigation, generation of electricity, storage and delivery of water for irrigation, and other beneficial uses including fish and wildlife.

4.1.8.3 Facilities and Water Supply

Facilities of the Columbia Basin Project include a well-developed carriage system of canals, dams, reservoirs, drains, wasteways, laterals, and other structures. Only the major facilities are indicated in this description. Major facilities are Grand Coulee Dam and its impoundment, Lake Franklin D Roosevelt, the powerplant complex, the pump-generating plant, Banks Lake, and Potholes Reservoir.

Grand Coulee Dam, the largest concrete structure ever constructed, is 550 feet high and 5,673 feet long located across the Columbia River in central Washington. The dam was constructed from 1933 to 1941 and was modified in 1967-75 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. Lake Franklin D Roosevelt has a total storage capacity of 9.4 million acre-feet (5.2 million acre-feet active) and extends more than 150 miles upstream to the Canadian border.

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 125,000-kilowatt capacity plus 3 units of 10,000-kW capacity for a total capacity of 2,280,000 kW. Construction on the right and left powerplants began with the dam but the last of the 18 main units were not installed until 1951. Rewinding of the eighteen main units to the present capacity was initiated in 1964 and completed in 1980. The Third Powerplant contains three units of 600,000-kW capacity and three units of 805,000-kW capacity for a total capacity of 4,215,000 kW. Construction on the Third Powerplant began in 1967 and the last of the six units was installed in 1980.

The pump-generating plant on the left bank was designed to accommodate 12 pumping units to pump water from Lake Franklin D Roosevelt to Banks Lake for irrigation delivery. Six pumps, each with a capacity of 1,600 cfs, were installed by 1951, two pump-generating units with a pumping capacity of 1,605 cfs each and a generating capacity of 50,000 kW were installed in 1973, and four pump-generating units with a pumping capacity of 1,700-cfs each and a generating capacity of 53,500 kW 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.

Banks Lake, located in an old ice-age channel called the Grand Coulee, is an equalizing 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 and feeds water to the Main Canal and provides water to operate the pump-generator units in generation mode.

4.1.8.4 Operation and Maintenance

Reclamation operates and maintains all of the major facilities including Grand Coulee Dam, Powerplants, Pumping Plant, and Banks Lake. Reclamation also operates the following irrigation facilities: Dry Falls Dam; Main Canal through the bifurcation works including Pinto Dam, and Billy Clapp Lake, O'Sullivan Dam, Potholes Reservoir, and Potholes Canal headworks.

The Quincy-Columbia Basin Irrigation District, East Columbia Basin Irrigation District, and South Columbia Basin Irrigation District operate and maintain all of the basic irrigation facilities within their geographic areas.

The irrigation season extends from about mid-March to November 1. About 2.7 million acre-feet are diverted annually for irrigation.

4.1.9 Chief Joseph Dam Project

4.1.9.1 Overview

The Chief Joseph Dam Project occupies lands along the Columbia and Okanogan Rivers in north-central Washington. There are four divisions and a total of seven units currently in operation; however, additional units (not discussed here) have been authorized for construction but deferred. 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 1800's 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 1940's and in the 1950's. Although the project includes about 31,500 irrigable acres, about 20,000 acres are irrigated in any year. Primary crops produced on project lands include apples, pears, cherries, and alfalfa hay.

The Chelan Division bordering the north shore at the lower end of Lake Chelan consists of a single unitBManson UnitBwhich has about 6,300 irrigable acres.

The Foster Creek Division consists of lands near the confluence of the Okanogan River with the Columbia River and includes the Bridgeport Bar and Brewster Flat Units. Irrigable acreage is about 500 acres for the Bridgeport Bar Unit and about 2,400 acres for the Brewster Flat Unit.

The Greater Wenatchee Division consists of three separated areas along the Columbia River between Wells Dam and Rock Island Dam and includes the Brays Landing, East, and Howard Flat Units. Included in the division are about 1,700 irrigable acres in the Brays Landing Unit, 4,500 irrigable acres in the East Unit, and 900 irrigable acres in the Howard Flat Unit.

The Okanogan-Similkameen Division as now constituted consists of only the Whitestone Coulee Unit that includes about 3,000 irrigable acres in the Spectacle Lake area, west of the Okanogan River between Oroville and Tonasket, Washington. Until recently, the division also included the Oroville-Tonasket Unit that 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 to all Reclamation constructed facilities to the district and relieved the district of all contractual obligations. The unit is effectively dissolved, no longer a part of a Federal reclamation project.

4.1.9.2 Authorization

All of the Divisions and Units of the Chief Joseph Dam Project were authorized by Congress. Authorizing legislation is summarized below:

Chelan Division, Manson Unit	Public Law 89-557 dated September 7, 1966
Foster Creek Division, all units	Public Law 83-540 dated July 27, 1954.
Greater Wenatchee Division, all units,	Public Law 85-393 dated May 5, 1958
Okanogan -Similkameen Division	
Oroville Tonasket Unit	Public Law 87-762 dated October 9, 1962
Oroville Tonasket Unit Extension	Public Law 94-423 dated September 28, 1976
Whitestone Coulee Unit	Public Law 88-599 dated September 18, 1964

Authorized purposes are:

Chelan Division	Irrigation, conservation and development of fish and wildlife, and enhancement of recreation
Foster Creek Division	Irrigation
Greater Wenatchee Division	Irrigation
Okanogan-Similkameen Division	
Oroville-Tonasket Unit	Irrigation and enhancement of fish
Whitestone Coulee Unit	Irrigation, conservation and development of fish and wildlife, and improvement of public recreation

4.1.9.3 Facilities and Water Supply

Chelan Division

Manson Unit facilities consist of a pumping plant on Lake Chelan, relift and booster pumping plants, regulating tanks, Antilon Reservoir, and a pressure pipe distribution system. Lake Chelan Pumping Plant has eight units with a total capacity of 106.7 cfs.

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, booster and relift pumping plants, two steel reservoirs, and a closed pipe distribution system. Anadromous fish screens have been recently upgraded and meet NMFS criteria.

Bridgeport Bar Unit facilities include a pumping plant with two 4.45-cfs pumps on the Columbia River, an equalizing reservoir, and a pipe distribution system. Anadromous fish screens at the pumping plant meet NMFS criteria.

Greater Wenatchee Division

East Unit facilities include a pumping plant consisting of four units with a total capacity of 76 cfs on the left bank of the Columbia River, a booster and relift pumping plants, and a closed pipe pressure delivery system. Anadromous fish screens have been recently upgraded and meet NMFS criteria.

Brays Landing Unit facilities include a well pumping plant near the Columbia River, a regulating reservoir, four small pumping plants and reservoirs, and a closed pipe pressure 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 consist of a well pumping plant near the Columbia River, booster and relift pumping plants, and a closed pipe distribution system. The pumping plant, located north of the city of Chelan, has three units with a total capacity of 16.7 cfs.

Okanogan-Similkameen Division

Whitestone Coulee Unit facilities include Toats Creek Diversion Dam, an open carriage system and distribution system, Spectacle Lake (6,250 acre-feet), and three pumping plants on Spectacle Lake. Water supply for the Whitestone Coulee Unit is Toats Creek.

4.1.9.4 Operation and Maintenance

Facilities of the units are independently operated and maintained by the operating entities shown in Table 4-1.

Table 4-1. Operating Entities of the Chief Joseph Dam Project	
DivisionBUnit	**Operating Entity**
ChelanBManson Unit	Lake Chelan Reclamation District
Foster CreekB Brewster Flat Unit	Brewster Flat Irrigation District
Foster CreekBBridgeport Bar Unit	Bridgeport Bar Irrigation District
Greater WenatcheeBBrays Landing, East, and Howard Flat Units	Greater Wenatchee Irrigation District
Okanogan-SimilkameenBWhitestone Coulee Unit	Whitestone Reclamation District

Operation of facilities is limited generally to the irrigation season that begins from about mid-April to mid-May and ends from mid-September to October 1. Average annual diversions are: Manson UnitB19,000 acre-feet, Brewster Flat UnitB8,700 acre-feet, Bridgeport Bar UnitB1,400 acre-feet, Greater Wenatchee Division (Brays Landing Unit, East Unit, and Howard Flat Unit)B29,000 acre-feet, and Whitestone Coulee UnitB10,900 acre-feet.

4.1.10 Okanogan Project

4.1.10.1 Overview

The Okanogan Project, located along the west bank of the Okanogan River near Okanogan, 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, hay, and forage crops are produced.

4.1.10.2 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. Project purpose is irrigation.

4.1.10.3 Facilities and Water Supply

Project facilities include Conconully Dam and Reservoir, Salmon Lake Dam and Conconully Lake, Shell Rock Point Pumping Plant, diversion dams, 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. Total capacity of the impoundment, Conconully Reservoir, 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. Due to safety concerns, an operating restriction limiting the reservoir surface elevation to 2314 feet effectively reduces the active capacity to 7,400 acre-feet until structural modifications are made.

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 fish screens 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 Anadromous fish screen replacement is scheduled for the summer of 2001.

Water supply for the Okanogan Project is Salmon Creek, a tributary of the Okanogan River, and the Okanogan River.

4.1.10.4 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 mid-May and ends about mid-September. Annual diversion of water is about 14,000 acre-feet.

4.2 LOWER COLUMBIA RIVER (DOWNSTREAM OF THE SNAKE RIVER CONFLUENCE)

4.2.1 Arnold Project

The status of the Arnold Project as a Reclamation project is uncertain. Arnold Irrigation District has repaid the debt to the United States and the rather unique contract with the district indicates that once the debt is repaid all facilities are to return to the ownership of the district. With this interpretation, the Arnold Project could be considered to revert to a private status with no connection to Reclamation. Arnold Project is described in this section as though it remains a Reclamation project.

4.2.1.1 Overview

Arnold Project, located southeast of Bend, Oregon, is one of several Reclamation projects in the Deschutes River basin. Private irrigation development began before the turn of the century and several smaller irrigation companies combined into what is now called the Arnold Irrigation District. A supplemental water supply for the Arnold Project was included in the reconstruction of Crane Prairie Reservoir, a part of the Deschutes Project. Reclamation replaced the old Arnold Flume and headworks in 1949, repaired the diversion dam in 1952, and replaced the Suttong Flume and the O'Donnell Flume and siphon in 1962. Arnold Project includes about 4,300 acres or irrigable land but only about 1,900 acres are irrigated to produce grain, alfalfa, grass hay, and pasture.

4.2.1.2 Authorization

Supplemental water from Crane Prairie Reservoir for the Arnold Irrigation District was authorized by the President on November 1, 1937 under the authority of the Act of June 25, 1910 (36 Stat. 836) and the Act of December 5, 1924 (43 Stat. 702). Rehabilitation of the Arnold Project distribution works was authorized by Congress through Public Law 80-247 dated July 25, 1947. The authorized purpose is irrigation.

4.2.1.3 Facilities and Water Supply

Major facilities of the Arnold Project include Arnold Diversion Dam on the Deschutes River, Arnold Flume and Canal, Suttong Flume, O'donnell Flume and Siphon, and a distribution system. Arnold Canal has a capacity of 120 cfs. Reclamation has determined that the diversion is not a Reclamation facility and has not included it in Reclamation's regional program to update fish screens.

Water for the project is obtained by diversion of natural flows from the Deschutes River and water stored in Crane Prairie Reservoir.

4.2.1.4 Operation and Maintenance

The Arnold Irrigation District operates and maintains the facilities of the Arnold Project. Average annual diversion of water at Arnold Diversion Dam during the irrigation season, April 1 to October 31, is about 30,000 acre-feet.

4.2.2 Crescent Lake Dam Project

4.2.2.1 Overview

The Crescent Lake Dam Project is composed of the lands of the Tumalo Irrigation District on the west side of the Deschutes River near Bend, Oregon. Private irrigation began before 1900 and was organized into an improvement district just after the turn of the century. Outlet facilities constructed at Crescent Lake (a natural lake) were badly deteriorated by 1946, prompting a request of assistance from Reclamation. Reclamation reconstructed Crescent Lake Dam in 1956 and rehabilitated the water delivery system during 1974 to 1977. The project includes about 8,100 irrigable acres and furnishes a full irrigation supply to about 8,100 acres that produce grain, alfalfa, grass hay, and pasture.

4.2.2.2 Authorization

Emergency rehabilitation of Crescent Lake Dam was authorized by Congress through Public Law 83-465 dated July 1, 1954. Rehabilitation of the canal and lateral system was authorized by Congress through the Public Works Appropriation Act of 1971 (84 Stat.890) pursuant to Public Law 81-335 dated October 7, 1949. Authorized purpose of the project is irrigation.

4.2.2.3 Facilities and Water Supply

Major facilities include Crescent Lake Dam on the Crescent Creek, three diversion dams on the Deschutes River and Tumalo Creek, canals, and a lateral distribution system. Crescent Lake Dam is an earthfill structure with a height of 40 feet and a length of 450 feet. The dam provides controlled storage of 86,900 acre-feet above the natural lake. Tumalo Irrigation District is upgrading the system with replacement of old carriage system components and consolidating diversion points. Resident fish screens at Crescent Lake Dam are considered acceptable.

Water for the project operations is obtained by diversion from the Deschutes River and from Tumalo, Little Crater, Crater, and Three Springs Creeks.

4.2.2.4 Operation and Maintenance

The Tumalo Irrigation District operates the facilities of the Crescent Lake Dam Project. Average annual diversion of water to project lands during the irrigation season, April 1 to October 31, is about 36,000 acre-feet.

4.2.3 Crooked River Project

4.2.3.1 Overview

The Crooked River Project is located near Prineville Oregon in the Crooked River basin. Private irrigation began in the late 1800's. 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 the Ochoco Project was constructed by private interests in cooperation with the State of Oregon. Reclamation conducted a basinwide survey in the 1940's and secured the Prineville damsite (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 are about 20,000 irrigable acres of which about 14,000 acres are irrigated to produce grain, hay, potatoes, and mint on farm units that 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.

4.2.3.2 Authorization

Reconstruction of Ochoco Dam was authorized by Congress 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.

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.

4.2.3.3 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, Lytel Creek Diversion Dam and Wasteway, two major pumping plants, nine small pumping plants, Ochoco Main Canal, and a distribution system of canals. Work to update the resident fish screens on the Crooked River diversion is scheduled for the fall of 2000.

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.

4.2.3.4 Operation and Maintenance

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 14,000 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 on November 15 through February 15 with space decreased in a straight line to zero on March 31. The flood control objectives is control flows downstream of Arthur R. Bowman Dam to no more than 3,000 cfs. A minimum target release of 75 cfs from Arthur R Bowman Dam is maintained to the extent possible for fish but the release may drop lower under drought conditions. A storage reallocation study is underway to determine potential uses of the uncontracted storage component of the reservoir. Reauthorization and reallocation of storage space in Prineville Reservoir are anticipated.

4.2.4 Deschutes Project

4.2.4.1 Overview

The Deschutes Project, near Madras, Oregon, consists of the North Unit. Private irrigation in the area began in the late 1800's, 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 85,000 acres are irrigated to produce grain, hay, pasture, mint, potatoes, and seeds.

4.2.4.2 Authorization

The Deschutes Project was authorized by the President on November 1, 1937 pursuant to the Act of June 25, 1910 (36 Stat. 836) and the Act of December 5, 1924 (43 Stat. 702). Construction of Haystack Dam was authorized by the Congress in Public Law 83-573 dated August 10, 1954. Irrigation is the authorized purpose of the Deschutes Project.

4.2.4.3 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 main stem 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 main stem 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. Safety of Dams construction on Wickiup Dam to address seismic and other stability concerns is scheduled to be completed in the year 2001.

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. Initial capacity is 1,000 cfs. Fish screens at the diversion are scheduled to be updated to meet current criteria in the fall of 2001.

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.

4.2.4.4 Operation and Maintenance

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 for the North Unit. Diversions include irrigation storage releases from Wickiup and Crane Prairie Reservoirs.

4.2.5 Wapinitia Project

4.2.5.1 Overview

The Wapinitia Project, at the junction of the White and Deschutes River near the town of Maupin in north-central Oregon, consists of a single DivisionBJuniper 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.

4.2.5.2 Authorization

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

4.2.5.3 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. Safety concerns related to seepage at the face of the dam resulted in a 1997 operation restriction that limits the lake elevation to 3505 feet (a 9-foot restriction amounting to 7,000 acre-feet). Safety of Dams activities have been completed and the restriction is expected to be lifted before spring 2000.

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

4.2.5.4 Operation and Maintenance

Facilities of the Wapinitia Project are operated and maintained by the Juniper Flat District Improvement Company. 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.

4.2.6 The Dalles Project

4.2.6.1 Overview

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. Due to a favorable location, the area became an important transportation hub in the early 1900's. 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 5,500 acres which produce fruit, primarily sweet cherries.

4.2.6.2 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 84-984 dated August 6, 1956 (Small Reclamation Projects Act). Authorized purpose of the project is irrigation.

4.2.6.3 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, an elevated steel tank, several smaller reregulating tanks, and a pipe distribution system.

Mill Creek Pumping Plant, on the Columbia River about 4 miles downstream from The Dalles Dam, consisted of 5 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.

Water supply for The Dalles Project is the Columbia River.

4.2.6.4 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.

4.2.7 Tualatin Project

4.2.7.1 Overview

The Tualatin Project is located along the Tualatin River in northwest Oregon just west of Portland. 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 a report in 1956 and another in 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.

4.2.7.2 Authorization

Congress authorized the Tualatin Project in Public Law 89-596 dated September 20, 1966.

Project purposes include irrigation, M&I water supply, flood control, recreation, fish and wildlife, and water quality.

4.2.7.3 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 38.7 cfs. The pumping plant and associated distribution system provide water to about 1,900 acres. Fish screens at the pumping plant are scheduled to be replaced with screens that meet NMFS fish protective criteria in the fall of 1999.

Spring Hill Pumping Plant, on the Tualatin River about 9 miles downstream from Scoggins Dam, is a combined irrigation and M&I pumping plant. There are 9 pumps with a total capacity of 148.2 cfs for pumping irrigation water and 3 pumps with a total capacity of 32.2 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. Fish screens at the Spring Hill Pumping Plant are scheduled to be replaced with screens that meet NMFS fish protective criteria between fall 2000 and fall 2002.

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.

4.2.7.4 Operation and Maintenance

Scoggins Dam and all of the irrigation facilities of the project are operated and maintained by the Tualatin Valley Irrigation District. The three M&I pumps of the Spring Hill Pumping Plant are owned and operated by the city of Hillsboro. Recreation facilities at Henry Hagg Lake are operated and maintained by Washington County.

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 41,000 acre-feet. Minimum flows of 10 cfs year-round and 20 cfs during October and November are maintained for fishery purposed 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.

5. LITERATURE CITED AND REFERENCES

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6. ATTACHMENT A B RELEVANT LEGISLATION

Table A-1. Project Authorizations and Other Relevant Legislation		
Project	**Authorization**	**Comment**
Arnold	President, November 1, 1937 (under Act of June 25, 1910 (36 Stat. 836) and Act of December 5, 1924 (43 Stat. 702)	Supplemental water from Crane Prairie Reservoir
	Congress, Public Law 80-247, July 25, 1947	Rehabilitation of distribution works
Avondale	Congress, Public Law 83-172 , July 31, 1953	Project authorization, emergency rehabilitation
	Congress, Public Law 87-289 September 22, 1961	Emergency rehabilitation of pipe system
Bitter Root	Congress, Public Law 71-506, July 3, 1930	Project authorization, rehabilitation
	Congress, Public Law 74-327, August 26, 1935	Contract changes
	Congress, Public Law 81-561, May 6, 1949	Repealed earlier contract and approved new contract
	Congress, Public Law 80-790, June 26, 1948 Congress, Public Law 81-335, October 7, 1949	Rehabilitation work
Chief Joseph Dam	Congress, Public Law 83-540, July 27, 1954	Foster Creek Division
	Congress, Public Law 85-393, May 5, 1958	Greater Wenatchee Division
	Congress, Public Law, 87-762, October 9, 1962	Okanogan-Similkameen Division, Oroville-Tonasket Unit
	Congress, Public Law 88-559, September 18, 1964	Okanogan-Similkameen Division, Whitestone Coulee Unit
	Congress, Public Law 89-557, September 7, 1966	Chelan Division
	Congress, Public Law 94-423, September 18, 1976	Oroville-Tonasket Unit Extension
	Congress, Public Law 105-9, April 14, 1997	Oroville-Tonasket Unit and Extension dissolved

Table A-1. Project Authorizations and Other Relevant Legislation		
Project	**Authorization**	**Comment**
Columbia Basin	Congress, National Industrial Recovery Act, June 16, 1933	Grand Coulee Dam
	Congress, Public Law 74-409, August 30, 1935	Project authorization
	Congress, Public Law 78-8,	Project reauthorization to bring under the Reclamation Project Act of 1939
	Secretary, January 5, 1949	Units 7,8,&9 of Right Powerplant
	Congress, Public Law 89-448, June 14, 1996 Congress, Public Law 89-561, September 7, 1966	Third Powerplant
Crescent Lake Dam	Congress, Public Law 83-465, July 1, 1954.	Project authorization, emergency rehabilitation of Crescent Lake Dam
	Congress, (84 Stat. 890), October 7, 1949 (pursuant to Public Law 81-335 dated October 7, 1949).	Rehabilitation of canal and lateral system.
Crooked River	Congress, Public Law 80-841, June 28 1948 Congress, Public Law 81-350, October 12, 1949	Reconstruction of Ochoco Dam
	Congress, Public Law 84-992, August 6, 1956	Project authorization (incorporated Ochoco Dam and authorized Arthur R. Bowman Dam (Prineville Reservoir)
	Congress, Public Law 86-271, September 14, 1959	Extra capacity in canal and pumping plants
	Congress, Public Law 88-598, September 18, 1964	Crooked River Extension
	Congress, Public Laws 81-335 and 81-451, October 7, 1949	Rehabilitation of drains and lateral system of Extension in 1982
Dalton Gardens	Congress, Public Law 83-172, July 31, 1953	Project authorization
	Congress, Public Law 87-289, September 22,1961	Emergency pipe rehabilitation

Table A-1. Project Authorizations and Other Relevant Legislation		
Project	**Authorization**	**Comment**
Deschutes	President, November 1, 1937, (under Act of June 25, 1910 (36 Stat. 836) and Act of December 5 1924 (43 Stat. 702))	Project authorization, includes Wickiup Dam
	Congress, Public Law 83-573, August 10, 1954	Haystack Dam
Frenchtown	President, September 21, 1935 (under 36 Stat. 836 and 43 Stat.702)	Project authorization
Missoula Valley	President, May 10, 1944 (under Public Law 76-398 dated August 11, 1939)	Project authorization
Okanogan	Secretary of the Interior, December 2, 1905 (under the 1902 Reclamation Act)	Project authorization
	Congress, Public Law 95-18, April 7, 1997	Shell Rock Point Pumping Plant
Rathdrum Prairie		
Post Falls Unit	President, January 29, 1944 (under the Water Conservation And Utilization Act of 1939 (535 Stat.1418)	Project authorization
	Congress, Public Law 93-97, August 16, 1973	Replacement of wooden discharge line
	Reclamation, August 11,1995	Unit dissolved
Hayden Lake Unit	Secretary, June 9, 1947 (under the Reclamation Project Act of 1939 (53 Stat. 1187))	Project authorization
	Congress, Interior Appropriation Act of 1948 (61 Stat, 473)	Emergency rehabilitation
	Congress, Public Law 84-641, July 2, 1956	Rehabilitation
	Congress, Public Law 87-289, September 22, 1961	Emergency pipe rehabilitation
East Greenacres Unit	Congress, Public Law 91-286, June 23, 1970	Project authorization
Spokane Valley	Congress, Public Law 86-276, September 16, 1959, and Public Law 87-	Project authorization and amendment

Table A-1. Project Authorizations and Other Relevant Legislation		
Project	**Authorization**	**Comment**
	630, September 1962	
The Dalles	Congress, Public Law 86-745, September 13, 1960	Project authorization
	Congress, Public Law 84-984, August 6, 1956	Rehabilitation of facilities in 1999
Tualatin Project	Congress, Public Law 89-596, September 20, 1966	Project authorization including Scoggins Dam (Henry Hagg Lake)
Wapinitia	Congress, Public Law 84-559, June 4, 1956	Project authorization including Wasco Dam (Clear Lake)

Citations:
Earlier acts are cited by the Statutes at Large number, later acts which have a public law number are cited by that number
Dates of authorization are the actual signing date by the Secretary or President where done under an authority provided by Congress
Dates of public laws are the date of the law, not the signing date by the president.

APPENDIX B

PERFORMANCE STANDARD METHODOLOGY

APPENDIX B

Performance Standard Methodology

How do you select performance standards?

We propose that performance standards should meet the following criteria:

1. The performance standard is directly measurable or quantifiable. Performance standards meeting this criterion may be easier to interpret and track, thereby reducing the uncertainty associated with action effectiveness.

2. The performance standard can be temporally or spatially isolated in order to more clearly relate effects to a specific action. This criterion is the counterpart to #2 and may be very important if the action taken is to be evaluated experimentally in order to determine cause and effect.

4. Tools and/or standardized protocols are currently available for acquiring or estimating a performance standard. It is advisable to use existing proven technology and approaches. New tool development would require additional expenditures of both time and money. Also, the end result could be that the performance standard is not readily measurable.

5. The performance standard is readily applicable to wild stocks. Since the primary focus of any Regional recovery plan is wild stock recovery, this criterion is fundamental. Unfortunately some stocks are at such depressed levels that using them as candidates in monitoring and evaluation programs is not an option. In those cases hatchery stocks may act as surrogates.

6. The performance standard is instructive. In other words, the performance standard helps us identify cause and effect mechanisms and provide a clearer understanding of how the ecosystem responds to management actions. It is also recognized that the natural variability inherent in each performance standard may also be a key factor in determining its usefulness. Performance standard's that exhibit great variability may not be particularly good indicators of program success over the short term. However, they may be essential for documenting long term progress. An example of such a performance standard would be adult run size back to the Columbia River or some sub-basin. A further consideration regarding variability involves measurement error. Performance standards that are characterized by inherently large measurement error may be poor candidates.

What steps are potentially necessary to establish a realistic set of performance standards as part of an approach to recovery of T&E species in the Columbia River Basin?

Step 1. Establish Basin-wide Recovery Goals

Clear goals and objectives for fishery recovery must be defined and agreed to by the region. Performance standards can then be developed that are linked to this “definition of success.” Currently, regional goals are obscure and provide insufficient basis for substantive regional agreement.

Step 2. Change Goals to Performance Standards

Quantified performance standards would be derived from regional objectives and goals. For example, qualitative goals would be transformed into biologically or ecologically meaningful standards that could be measured; both fish habitat and specific fish population standards could be established, thereby linking biotic and abiotic attributes.

Step 3. Develop Fish Population and Habitat Performance measurements

Measurements of fish population or habitat attributes in relation to their respective standards serves as the basis for assessing progress. Performance measures would be site-specific (e.g., for each subbasin) to account for differences in size, geology, climate, fish populations, and degree of degradation.

Step 4. Identify and Define Basin-Wide Strategies and Treatments

Comprehensive, basin-wide approaches would be developed in cases where the ability to implement site-specific actions (e.g., within a subbasin) is constrained or where site-specific actions may require broader coordination. That is, actions associated with a particular life stage or H would be integrated across life stages and/or H’s in those cases where actions may be outside of the control of an individual subbasin, implementation of actions may require participation of multiple subbasins, or the effect of the actions transcends the authority of a subbasin.

Step 5. Science Advisory Board

A Scientific Advisory Board would provide guidance on the development performance standards, feasibility and anticipated effects of actions on habitat attributes and fish performance, adequacy of subbasin plans, implementing adequate monitoring and evaluation, and guidance on changes through the adaptive management process.

Step 6. Develop Subbasin Treatment Manual

A manual of treatments for each of the major strategies will be developed as part of the overall recovery plan for the Columbia River. This manual would serve as standard operating procedure, to be updated annually based on new information, to ensure standardization and continuity across subbasins. It would include description of actions and anticipated effects, associated risks and uncertainties, required monitoring and evaluation, and cost of implementation.

Step 7. Develop a Monitoring and Evaluation Program

A monitoring and evaluation (M&E) program will be developed to track key performance standards identified under the recovery plan. Three forms of monitoring could be included to assess: *implementation* (was the action implemented as designed and are mid-course corrections needed), *effectiveness* (did the action have the anticipated effect on the habitat; may include active and/or passive monitoring), and *validation* (did the habitat change have the anticipated effect on the salmonid population).

Step 8. Province Analysis Report

This report would be comprised of Subbasin Analysis Reports that describe subbasin goals and responsibilities in context of basin-wide strategies and treatments, performance measures, and monitoring and evaluation plans. Each subbasin would select the preferred suite of strategies given the environmental, biological, policy, and legal constraints of each subbasin.

Step 9. Development of Subbasin Action Plans

Subbasin managers would develop an action plan to achieve identified objectives.

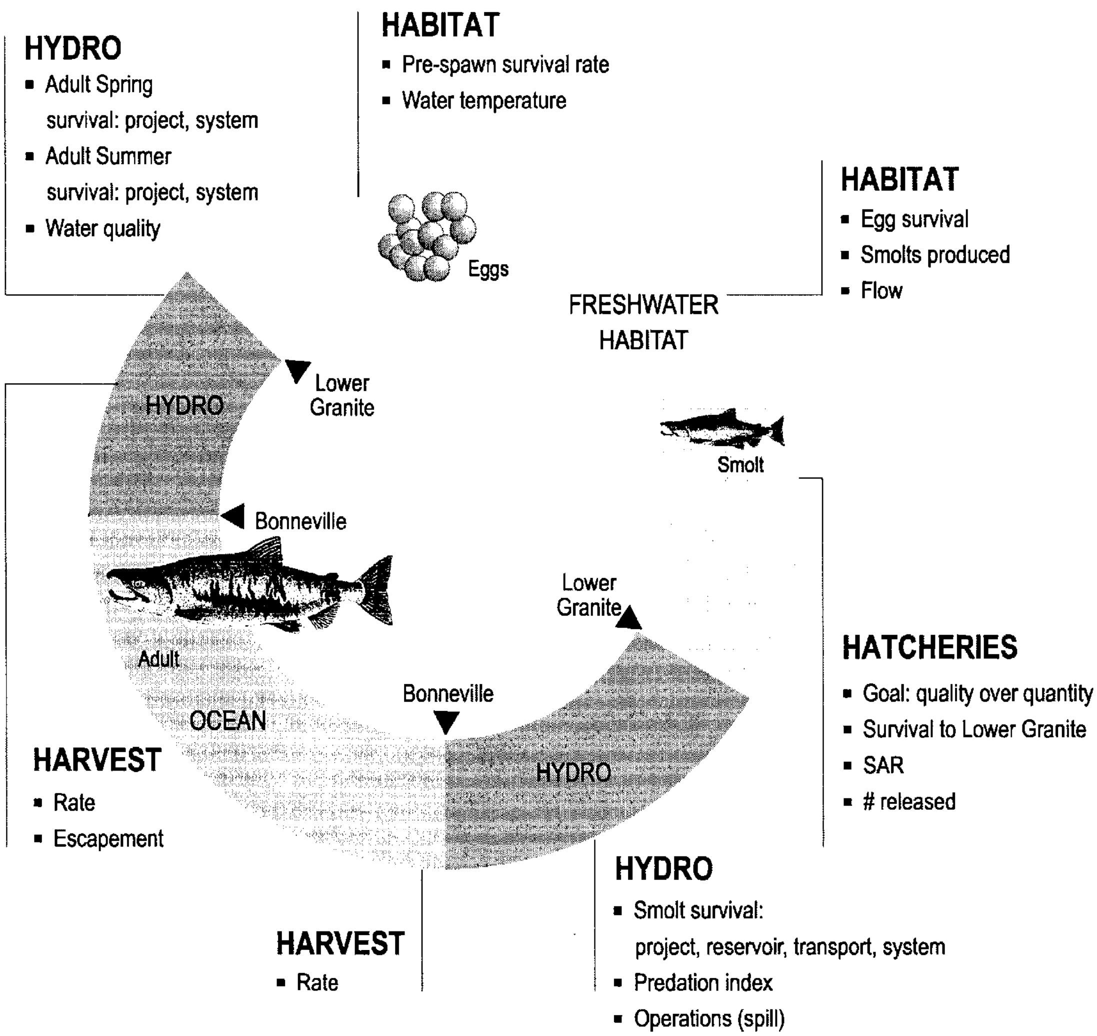
The Action Plan is in reality a business plan which describes the management team, their objectives, the product they will produce, how they will operate, how they will measure success, deal with risk, and allocate costs. On a regional level, this would create a *creative tension* between subbasins in regards to performance and cost efficiency. This would facilitate increased accountability and encourage innovation. Successful programs could be rewarded with increased funding, performance bonuses, and more autonomy.

Step 10. Scientific Advisory Board Review of Subbasin Action Plans

The Subbasin action plans would be reviewed by the Scientific Advisory Board for scientific merit. Funding would be based on the adequacy of each Action Plan's inherent assumptions, selected strategies and treatments, performance standards, implementation schedule, M&E program, and consistency with recovery program goals.

Performance Measures

Snake River Stock



APPENDIX C

UNCERTAINTY RESOLUTION

APPENDIX C

Uncertainty Resolution

1. Critical Uncertainties

The most important critical uncertainty relative to the hydrosystem is the question of delayed mortality. Questions of delayed mortality are critical for two reasons. First, if the hypothesis of substantial delayed mortality is correct, then more traditional evaluations of passage or passage survival may be insufficient for determining the contributions of actions intended to increase survival and probability of rebuilding and recovery of salmon and steelhead. Second, delayed mortality is, by definition, a result of the effects of various factors that are not manifested until later in the fish's life. It is highly complex and includes impacts that compromise the fish's fitness or survivability but which are not manifested until sometime after that impact was incurred. As such, it is difficult to isolate the effects of any of the H's from other factors that may contribute to post-hydro mortality. And yet isolation of factors contributing to delayed mortality is imperative if an accurate characterization of delayed mortality is to be developed. Further, corrective measures to reduce any delayed mortality that exists is difficult without understanding the causal mechanisms. Evaluations of delayed mortality require relatively comprehensive reconstruction of the fish's life history, including the period prior to their arrival in the hydrosystem. In other words, these evaluations must be integrated across life-history stages.

Three possible forms of delayed mortality are of interest: (A) delayed mortality of transported juvenile migrants; (B) delayed mortality of in-river juvenile migrants; and (C) delayed mortality and/or passage effects on adults. These issues are critical because decisions on major hydrosystem configurations and/or operations are dependent on the magnitude of, and contributing factors to, delayed mortality. For example, if delayed mortality is significant and solely associated with the hydrosystem, then corrective measures within hydro can be identified to reduce it. On the other hand, if delayed mortality is not significant regardless of its cause, then addressing it would be a lower priority. Finally, if delayed mortality is significant but is associated with a condition that effected the fish prior to its arrival to the hydrosystem, then non-hydro actions would be the appropriate corrective action.

<u>A. Delayed Transportation Mortality</u>

Today, approximately one-half of the juvenile salmon and steelhead coming out of the Snake River Basin are transported in trucks and barges to below Bonneville Dam. This is a way to circumvent direct mortality during passage at the hydro projects. Before these fish return to spawn, they may suffer additional mortality that exceeds what would have occurred if they were not barged. This potential mortality is termed differential delayed transportation mortality (measured by the “D-value”). This delayed mortality may also be a result of transportation of juvenile fish that were diseased or in poor condition when they arrived at the hydrosystem. Therefore, the D-value and partitioning any factors contributing to it are important.

The magnitude of delayed mortality of transported fish would help determine the most appropriate role of transportation as a tool to improve survival. It would also enhance analysis of the effect of dam breaching compared to the current system configuration, and provide a more informed basis for decisions on dam breaching. Efforts to reduce delayed mortality also depend on improved understanding of discrete factors that contribute to that delayed mortality, whether they originate within or outside the hydrosystem. Finally, the priority of measures to reduce delayed mortality, whether it be dam breaching or improvements to the transport system, should be based on the significance of the effect of the delayed mortality.

Ongoing studies of transportation could be continued to build a time-series of estimates of “D”. Currently, estimates of “D” are being developed for each year transported and inriver fish are marked and released. Estimates of survival from the Lower Granite or Little Goose tailrace to below Bonneville Dam are multiplied by the ratio of SARs of returning adults from transported to inriver fish, which provides an estimate of “D”. Repeating the experiment over the next five to 10 years would accommodate environmental variability and provide an assessment of the importance of “D” in hydrosystem decisions.

B. Delayed Effects of Passage on Juvenile Survival (1998 BO ITS 1.g, i, k)

Another major uncertainty involves what has been termed “extra mortality.” Historically, a much larger percentage of the fish that left the Snake River as juveniles returned to spawn compared with today. Even after accounting for direct losses attributed to passage through the hydrosystem, additional losses must occur to account for the low observed SARs. This unexplained mortality that occurs outside the migration corridor is termed extra mortality. Extra mortality may manifest itself at either the juvenile or adult stage.

Many hypotheses have been proposed to explain extra mortality. These include: the hydrosystem itself may weaken fish and disrupt their natural rhythms; hatcheries may interfere with the fitness and survival of wild fish; habitat degradation may reduce stock vigor; genetic effects may reduce stock viability; and degraded ocean conditions may decrease the survival of smolts to adults and may reduce the viability of the adults that return to spawn above the Snake River dams. The impact of dam breaching compared to keeping the dams intact depends on which of these alternative sources of extra mortality is true. New PIT-tag technology, the emergence of large-scale geographic databases, studies of ocean survival and fish fitness, and experiments with hatcheries provide opportunities for science to address uncertainty about extra mortality over a period of 10 to 20 years.

The effect of multiple detection/bypass on juvenile fish survival and adult productivity is unclear. Juveniles can pass through multiple bypasses on their migration route. Information on adult return rates suggests an inverse relationship between the rate of returns and the number of bypasses a juvenile encounters. Some have also suggested that fish that migrate in-river and are undetected at dams return at higher rates than those that were transported. While apparent differences in SARs exist between transported and undetected in-river migrants, no significant differences have been observed. Information is limited, however, and further investigation and analysis is necessary to reduce this uncertainty. Future decisions on the role of mechanical bypass depend on a better understanding of this issue.

Passage of juvenile migrants through multiple bypasses is one common hypothesis regarding extra mortality. To address the potential effect that passing through existing juvenile bypass systems may have on the survival of smolts, fish with known migration histories can be held for extended periods to observe the longer term effects of the hydropower system and explore possible mechanisms for any differential delayed mortality observed between treatment groups. Treatment groups could include fish the pass through no bypass systems, through one bypass system, and through multiple bypass systems. PIT tag diversion systems at a lower dam could be programmed to divert PIT-tagged fish. These “test” fish could be held in state-of-the-art holding systems and monitored for survival. Test fish would be monitored for physiological and disease profiles prior to entering the seawater holding system and at the end of the study. Mortalities would be necropsied for cause of death. This extended rearing protocol would enable test fish with known bypass passage histories to be followed into the future, beyond the hydrosystem, and their condition and survival evaluated through a time period similar to that of smolts that reach and rear in the early ocean environment. Test fish from all treatments would be held together, and only after death would the passage history of the individual be determined. The cause of death and the animal’s physiological and disease state at the time of death would be correlated to their passage history.

C. Delayed Effects of Passage on Adult Survival and Productivity (1995 BO CR 2; 1998 BO ITS 2.a)

Estimates of unaccounted losses of adult migrants prior to arrival to spawning grounds are of concern. Many factors could potentially contribute to pre-spawning mortality or reduced reproductive success. Partitioning of unaccounted losses of adults throughout the migration corridor is necessary to determine any corrective measures that may be appropriate relative to hydrosystem operations or configurations. Consideration of factors such as fish condition upon arrival to the river (i.e., conditions associated with ocean rearing conditions), fallback, cumulative delays and/or stress, energy expenditure, water quality, tributary turnoff, mainstem spawning, harvest, and other factors (e.g., “head burns” and reproductive potential) are important considerations to answer questions associated with adult passage.

The potential impacts of migration delays on adult reproductive success from passage through the hydropower system can now be evaluated using known-source PIT-tagged fish. Adults of known origin, based on PIT tags, could be marked with radio-telemetry tags at Bonneville Dam, weighed, and measured for lipid content. These individuals could again be sampled at Lower Granite Dam for weight and lipid content, and at their hatchery for weight, lipid content, and reproductive success (survival to the hatchery, fecundity, egg size, egg weight, and hatching rate). Relating their reproductive success to their migrational history (based on the radio-telemetry), weight loss, and lipid loss allows for the use of non-lethal methods to begin to quantify and correlate migrational behavior (delay, fallback, etc.) with reproductive success.

Depletion of energy reserves could be associated with poor ocean conditions, passage delays, fallback, cumulative passage stresses, warm water, and other factors. Bioenergetics modeling is a powerful tool by which various “stressors” during migration could be quantified in terms of energy expenditures and the relation to energy reserves needed to successfully spawn. By correlating energy expenditure with various passage impediments, information would then be available to focus actions intended to improve passage of adults.

2. Uncertainties Inhibiting Effective Implementation

Other uncertainties are important to enable effective and efficient implementation of actions intended to improve fish survival. These uncertainties are generally captured in the categories of: (A) Esturarine and Early Ocean Survival; (B) Optimizing Passage Conditions at Dams ; and (C) Improving Mainstem Habitat.

A. Estuarine and Early Ocean Survival (1995 BO RPA 13.b, c, d, e)

Changes in marine survival of salmonids can have huge impacts on the overall productivity of populations, potentially including delayed effects that are not manifested until their return to freshwater. Recent and dramatic declines in ocean survival have been observed for populations extending up the West Coast from Oregon north to British Columbia and Alaska. Partitioning of survival by life stage is necessary to adequately account for the effectiveness of actions in terms of returning adults. This, in turn, contributes to the opportunities for more effective management strategies in the freshwater environment. An improved understanding of marine survival is also key to evaluating delayed transportation mortality and extra mortality.

The Columbia River estuary is a complex, diverse, and important transition habitat for salmon in their migrations to and from seawater. Attributes of the estuary that appear important to the ecology of the estuary and its influence on salmon include flow rate through the estuary and plume, the timing of the flow, and turbidity. These are factors that the FCRPS has potentially altered, with unknown effects on salmonid survival. In addition, the ecosystem changes attributable to the FCRPS must be considered in concert with the known large scale declines in marine survival of salmon in Oregon and south-central British Columbia coastal waters.

Ongoing studies by NMFS that link the freshwater environment to the early ocean environment are important to understanding the relationship between the two. For example, data on the timing of release of barged or inriver fish at Bonneville Dam and their subsequent detection in PIT-trawl sampling at Jones Beach (RKm 75) allows for time-of-ocean-entry to be estimated. Studies of the near-ocean physical and chemical environment, and the biological community assemblages in these environments provide important information on the productivity and trophic Construct of the plume and near-ocean. Mating the timing of ocean entry with the conditions the fish experience at the time of entry are important to furthering our understanding of what may be one of the factors influencing early ocean survival. Based on adult returns from fish PIT tagged for the 1995 transportation study, we know that SARs can increase as much as seven fold within a week. Interpretation of this information could suggest that timing of and conditions at ocean entry may be factors highly influential to SARs. It may also indicate that survival of these fish is dependent on their movement immediately following estuary entry. For example, preliminary data indicates that juvenile salmon moving quickly to Northern B.C. and S.E. Alaskan waters have as much as a 10 fold increase in survival as those remaining in southern B.C. or U.S. waters. It is probable that a combination of these factors together determine the SARs. Research on these factors could lead to a better understanding of the possible role FCRPS operations (including transportation timing) may have on the survival of smolts once downstream of the hydrosystem. Studies to better understand the role of the estuary on the condition and fitness of smolts for ocean entry are being discussed and new research in cooperation with Canada will help us understand the population specific factors associated with estuary entry, near shore survival and how these factors influence SARs. Information of this nature would also be helpful to understand the effects of FCRPS operations on the ecology of the estuary and potential impacts on salmonid survival through this transition area. Potential anthropogenic effects from pollutants, channel maintenance, channel dredging, use of dredge disposal islands by bird colonies, and possible changes in estuarine currents and salt water intrusion are important and little understood areas of future research. The estuary ecosystem was once based on marsh productivity and infauna, but is now dominated by re-processing of fluvial micro-detritus by the ETM (estuary turbidity maximum). The role of many of these anthropogenic activities are not FCRPS related. However, the food-web processes and the dependence of salmonid productivity and preparedness for ocean entry and survival are areas that need to be better understood, within the context of managing the FCRPS to improve salmonid survival and the recovery of listed stocks.

B. Optimizing Passage Conditions at Dams (1998 BO ITS 1.k)

Juvenile fish passage survival has been increased dramatically over the past two decades. Additional opportunities to further enhance passage survival still exist through both operational and structural changes, but the increment of any improvement is small compared to the past. Yet, there is continued focus on further actions to improve juvenile passage. While there are various strategies employed to pass juvenile migrants at dams (e.g., spill, screens, surface bypass, transportation), understanding of how these various strategies interact and the incremental effect of passage improvements on juvenile fish survival is limited. Further, there are potential selective pressures of these strategies on different life history stages, stocks, and species that are not well understood. The results of any selective pressures are differential effects, ranging from positive to negative. Improved understanding in this area is needed to guide actions that may benefit one species or life stage while being detrimental to others, adversely effect genetic diversity, and to develop adequate multi-species protection strategies.

Optimization of passage provides the means to balance potential conflicts that actions can present to different species or at various life history stages. The treatment of passage at dams in context of system survival is necessary to ensure that individual actions are complementary to overall survival. By definition, optimization of survival at dams includes consideration of effects of actions at dams on system survival. This would also include issues surrounding juvenile fish transportation. Ultimately, optimization of passage strategies is necessary to make best use of available resources for the benefit of fishery resources (prioritization of actions based on anticipated improvements in fish survival and cost-effectiveness).

Key uncertainties to be addressed include:

- Routes of juvenile fish passage (1998 BO ITS 1.k)
- Fish survival by route and total project, across range of operations (1995 BO RPA 13.f; 1998 BO ITS 1.k)
- Effect of incremental changes in spill on proportion of fish passing via spill (1998 BO ITS 1.j, k)
- Effect of incremental changes in spill on adult passage (1995 BO CR 1, 2; 1998 BO 1.j, k)
- Transportation of spring migrants at McNary Dam concept (1995 BO RPA 11, 15; 1998 BO ITS 1.m)
- Juvenile migrant behavior in relation to hydraulic environment and in-river Constructs to enhance development of surface bypass concept (1995 BO RPA 11)

C. Improving Mainstem Habitat

Historically, the hydrosystem has been viewed as a migration corridor, with primary focus on flows, river velocities, and predation. However, other important biological and ecological attributes might be enhanced through operational and/or structural measures that would contribute to the survival of both resident and anadromous species. Two specific examples where mainstem habitat improvements could contribute substantially to survival and productivity include juvenile fall chinook that use the migration corridor during their first year for rearing and fall chinook and chum spawning as occurs downstream of Bonneville Dam. Improvement to mainstem habitat is a field that has been largely unexplored; primary opportunities may include instream Constructs, increased predator management, and strategic flow manipulations.