SPECIAL REPORT

LOWER SNAKE RIVER FISH AND WILDLIFE COMPENSATION PLAN

Lower Snake River, Washington and Idaho

U. S. ARMY ENGINEER DISTRICT, WALLA WALLA, WASHINGTON

JUNE 1975

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SYLLABUS

The purpose of this special report is to evaluate impacts on fish and wildlife resources caused by construction of the four Lower Snake River dams, Ice Harbor, Lower Monumental, Little Goose, and Lower Granite, and to recommend measures for compensating project-incurred losses to fish and wildlife. The report is submitted in compliance with the Fish and Wildlife Coordination Act, PL 85-264, 85th Congress, 12 August 1958, which requires the head of a construction agency responsible for losses to fish and wildlife through construction of a project to compensate for those losses to the fullest extent possible.

The four lower Snake River dams, constructed by the Corps of Engineers, impact upon the natural upstream and downstream migration of anadromous fish, inundate certain spawning grounds, flood riparian habitat supporting a variety of wildlife species and convert some 140 miles of stream-type habitat and fisheries to those associated with reservoirs. Fish and wildlife species affected include salmon, steelhead, sturgeon, deer, waterfowl, pheasant, quail, and chukar partridge. Even though fish passage facilities have already been incorporated in the four dams, studies indicate that additional measures are needed to fully compensate for adverse fish and wildlife impacts and displacements attributable to the projects. The District Engineer recommends a system of fish propagation facilities for salmon, steelhead, and resident species; game bird stocking; wildlife habitat development and acquisition of appropriate estates in lands for fish hatcheries, habitat development and fisherman and hunter access. Based on current prices, the estimated cost to provide the additional compensation measures is about $46,000,000 and the additional operation and maintenance costs are estimated to be nearly $3,000,000 annually. Annual benefits are evaluated at $11,900,000; the resulting benefit-to-cost ratio is 2.0 to 1.

DEPARTMENT OF THE ARMY
WALLA WALLA DISTRICT, CORPS OF ENGINEERS
BLDG. 602, CITY-COUNTY AIRPORT
WALLA WALLA, WASHINGTON 99362

NPWEN-PL

30 May 1975

SUBJECT: Special Report - Lower Snake River Fish and Wildlife Compensation Plan, Lower Snake River, Washington and Idaho

Division Engineer, North Pacific

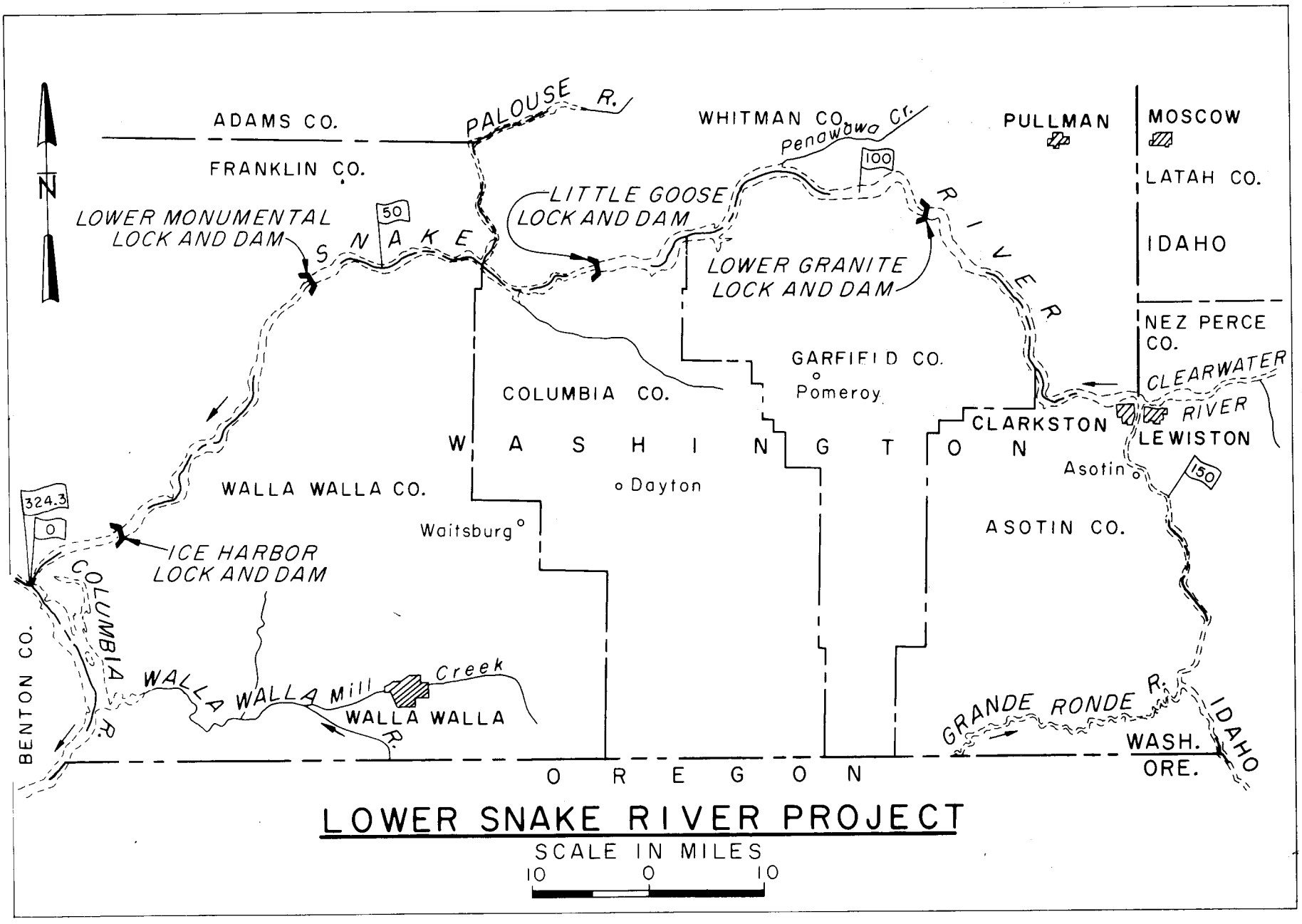
AUTHORITY

This is a special report of the Walla Walla District, U.S. Army, Corps of Engineers, on the impact of the Lower Snake River Project on fish and wildlife resources of the Project area. The Project was authorized by Public Law 14, 79th Congress, 1st Session, approved 2 March 1945, and consists of Ice Harbor, Lower Monumental, Little Goose, and Lower Granite Locks and Dams. The Project is located in Washington and Idaho as shown on Figure 1. The applicable portion of the Act reads as follows:

> "... Snake River, Oregon, Washington, and Idaho: The construction of such dams as are necessary, and open channel improvement for purposes of providing slack-water navigation and irrigation in accordance with the plan submitted in House Document 704, 75th Congress, with such modifications as do not change the requirement to provide slack-water navigation as the Secretary of War may find advisable after consultation with the Secretary of the Interior and such other agencies as may be concerned: Provided, that surplus electric energy generated at the dams authorized in this item shall be delivered to the Secretary of the Interior for disposition in accordance with existing laws relating to the disposition of power at Bonneville Dam; provided further, that nothing in this paragraph shall be construed as conferring the power of condemnation of transmission lines; ..."

Neither the Act nor the general plans presented in House Document 704, 75th Congress, made any mention of fish and wildlife measures needed to

FIGURE 1



LOWER SNAKE RIVER PROJECT

SCALE IN MILES

10 0 10

prevent or offset losses or damage to these important resources; therefore, fulfillment of the requirements of the Fish and Wildlife Coordination Act, PL 85-624, 85th Congress, enacted 12 August 1958, becomes the basic reason for submission of the compensation plan presented in this report. Sections 2(c) and 2(g) of the Fish and Wildlife Coordination Act provide necessary directive to the Corps of Engineers for funding and constructing justifiable compensation measures at the Lower Snake River Project, and Section 3(c), which requires authorization by Congress for acquisition of fish and wildlife lands, provides authority to the Corps for recommending such acquisition. This report recommends means to compensate for project-incurred losses to fish and wildlife based on a 100-year project life for each separable component.

BACKGROUND

The development of this report was initiated by a letter dated 11 April 1966 from the Walla Walla District Engineer to the Regional Director, Bureau of Sport Fisheries and Wildlife, requesting a report covering the impact of the four lower Snake River dams on the fish and wildlife resources of the area as a unit, rather than on a dam-by-dam basis. During the planning phases of the first three dams, Ice Harbor, Lower Monumental, and Little Goose, individual impact reports were received from the U.S. Fish and Wildlife Service. These reports were: (1) "A Detailed Report on the Fish and Wildlife Resources, Ice Harbor Lock and Dam Project, Snake River, Washington, May 1, 1959;" (2) "A Detailed Report on Fish and Wildlife Resources Affected by Lower Monumental Lock and Dam Project, Snake River, Washington, September 1960;" and (3) "A Detailed Report on Fish and Wildlife Resources Affected by Little Goose Lock and Dam Project, Snake River, Washington, May 7, 1963."

The initial recommendations in these reports for offsetting Project-incurred fish and wildlife losses were based on very limited engineering and biological information. Recommended fishery measures included fish passage at dams and artificial propagation facilities for salmon and steelhead trout. Recommended wildlife measures were leasing of small land and water areas scattered along the reservoirs to the Washington State Department of Game and provision of Project funds to the Department for

their management. These recommendations were not necessarily concurred with by all the wildlife agencies. Specifically, the recommendations and actions concerning them were as follows:

ICE HARBOR DAM

Recommendation. A designated area at river mile 25 be made available as a wildlife management area; fish protective facilities for upstream and downstream migrants be included in the project design.

Initial Action. The river mile 25 area was made available to the Washington State Department of Game on long-term license at no cost. To date no development or management work has been accomplished on this 260-acre unit of land because a comprehensive development plan and funding requirements satisfactory to the involved parties were never formulated. Upstream fish passage facilities were included in the project design at a total cost of $12,591,000.

Subsequent Action. In 1969 the ice and trash sluiceway at the project was modified to provide a means of bypassing a portion of the downstream migrants which entered the turbine intakes around the power units. Slotted bulkheads were installed in the intakes to the three skeleton units of the powerhouse by spring 1972 to reduce the amount of water passed over the spillway during spring freshet seasons and resultant nitrogen supersaturation levels caused by high spillway flows. Construction of three additional power units was initiated in July 1973 to provide full power production capability. This precluded further use of the slotted bulkheads at this project after the spring high-flow season of 1973 except for possible future use in an operating unit. The three additional power units are scheduled to be completed by July 1975. Spillway deflector installation, which will prevent spillway discharges from plunging into the stilling basin thereby eliminating or greatly reducing nitrogen supersaturation of the water, is scheduled for completion in 1977.

LOWER MONUMENTAL DAM

Recommendation. Permanent and temporary fish passage facilities provided in project design; five specific areas on the reservoir, including project lands and acquired lands be made available to the Washington State Department of Game for wildlife management areas.

Initial Action. Both adult and downstream migrant fish passage facilities were included in project design at a cost of $9,483,000. Project lands were made available for wildlife management in the requested units one and two comprising 700 acres. Off-project lands were not acquired at that time. The District determined that a recommendation for purchase of additional lands should be included in the comprehensive compensation report being prepared on the Lower Snake River Project. Unit three of project lands, comprising 640 acres, was made available on an interim-use basis and parts of units four and five, totaling about 300 acres, were designated fish and wildlife lands in conjunction with recreation and industrial use. To date no development or management work has been accomplished on these lands because a comprehensive development plan and funding requirements satisfactory to the involved parties were never formulated.

Subsequent Action. A prototype spillway deflector was installed in 1971 to test the effectiveness of this type of structure in preventing spillway discharges from plunging and causing a supersaturation of gasses. Preliminary evaluation indicated that nitrogen supersaturation was less in water which had passed over this deflector than over a conventional spillway bay, and that juvenile fish mortalities were negligible. On this basis five more deflectors were installed in 1974, leaving the end spillway bays unaltered. Tests conducted in spring 1974 by National Marine Fisheries Service indicated that the deflectors actually reduced the nitrogen content of highly saturated water passing over them, and that juvenile fish mortality was less when passing over the deflectors than over a conventional spillway. Slotted bulkheads were installed in

the intakes to the three skeleton units of the powerhouse by spring 1972 to reduce the amount of water passed over the spillway during spring freshet seasons and resultant nitrogen supersaturation levels caused by high spillway flows. Excessive mortality to juvenile salmonids passing through these bulkheads precluded their later use during the downstream migration period. A pilot program was begun in 1970, in cooperation with the Washington Game Department and Washington State University, to develop artificial Canada goose nesting sites. Three additional power generating units are scheduled to be installed between 1976 and 1978.

LITTLE GOOSE DAM

Recommendation. Permanent and temporary fish passage facilities be provided in project design; project funds be provided to conduct a study on nongame fish control; artificial propagation facilities be provided for 1,500 adult fall Chinook salmon to compensate for loss of spawning areas; artificial propagation facilities be provided to produce 400,000 juvenile steelhead annually to compensate for lost spawning areas; five specific areas on the reservoir, including project lands and acquired lands, be made available to the Washington State Department of Game for wildlife management areas.

Initial Action. Both adult and downstream migrant fish passage facilities were included in project design at a cost of $5,900,000. On-going studies were then being conducted on nongame fish control under the Columbia River Fisheries Development Program; consequently, no project funds were made available for that purpose. It was recommended by the Corps of Engineers that the fall Chinook propagation facilities should also be accomplished through that program. Of the five wildlife management areas requested, unit two, totaling 238 acres, was designated for wildlife management in entirety. Unit one, comprising 172 acres, was on lands unavailable for wildlife because of other project needs, and portions of units three, four, and five, totaling about 325 acres, were designated wildlife management areas in conjunction with recreation and industrial uses. To date no development or management of these areas for wildlife use has occurred because a comprehensive development plan and funding requirements satisfactory to the involved parties were never formulated.

Subsequent Action. Traveling screens for diverting downstream migrant fish from the power units into the bypass system were installed in April 1973. Slotted bulkheads were installed in the intakes to the three skeleton units of the powerhouse by spring 1972. Excessive mortality to juvenile salmonids passing through these bulkheads precluded their later use during the downstream migration period. A six-year study of the efficiency of screening juvenile fish into the bypass system in the turbine intakes and of the feasibility of trapping downstream migrant salmonids and transporting them below Bonneville Dam for release was begun in 1971 by the National Marine Fisheries Service, funded by the Corps of Engineers. Preliminary results indicate that the transported juveniles have a higher survival to returning adults than those which migrate naturally to the ocean. The three additional generating units are scheduled for completion in 1978 and spillway deflector installation is scheduled for completion in 1976.

LOWER GRANITE DAM

Recommendation. During formulation of the U.S. Fish and Wildlife Service Impact Report on the project, the Walla Walla District, Corps of Engineers recommended that a report be prepared covering the effects of the four lower Snake River projects on fish and wildlife resources of the area with recommendations on measures necessary to compensate for losses caused by the four-dam project.

Action. During construction of the project, adult and downstream migrant fish passage facilities are being included at a cost of approximately $11,000,000. These facilities are planned to include traveling screens in the intakes of the three operating units and the three additional units when they are completed to divert a large portion of the downstream migrating salmonids into a bypass system for collection and transport or diversion around the powerhouse to the river below the dam. Spillway deflectors for reduction of nitrogen supersaturation have been constructed in all spillway bays.

In addition to project features, construction of Lower Granite Dam required removal of Washington Water Power Dam spillway at Lewiston, Idaho, which restored five miles of the lower Clearwater River to a free-flowing condition. During the construction phase six subimpoundments totaling about 250 surface acres which can be managed for trout or warm-water fisheries were created behind railroad and highway relocations, and seven islands were constructed for goose nesting purposes. The reservoir clearing contract was modified so that emergent vegetation between elevations 728 and 738 msl (normal pool) was left standing to provide habitat for warm-water fish. Development of the emergent lands on the Clearwater River will include features for wildlife management.

Efforts to maintain the anadromous fish resources at the Lower Snake River Project have cost approximately $52 million to date, including initial construction costs and research development. Thus, it can be seen that an effort to prevent fish and wildlife losses has already been made. In spite of this effort, it has become apparent that losses to the fish and wildlife resources are still occurring. As a result of increased knowledge of the effects of these dams on the fish and wildlife resources of the area developed between 1962 when Ice Harbor was completed and 1966 when the comprehensive report was requested, it was concluded that more extensive compensation requirements existed beyond those recommended in the initial reports.

A draft of the Bureau of Sport Fisheries and Wildlife-National Marine Fisheries Service Report covering the impact of the whole Project was received by letter of 3 February 1971 for internal review and comment. By letter of 24 March 1971 comments on this draft were submitted to the Bureau of Sport Fisheries and Wildlife for their consideration. A second draft was received by letter of 13 December 1971 and comments were returned to the Bureau on 2 March 1972. These comments were concerned mainly with the lack of data in the draft to justify the size and type of recommended compensation features. The final report, signed by the Directors of the Bureau of Sport Fisheries and Wildlife and the National

Marine Fisheries Service, entitled "A Special Report on the Lower Snake River Dams, Ice Harbor, Lower Monumental, Little Goose, Lower Granite," dated September 1972, was received by the Walla Walla District on 4 November 1972. This report was prepared through the cooperation of the above two Federal agencies and the five fish and wildlife agencies of the States of Oregon, Washington, and Idaho. The report is attached as Appendix A. Subsequent to receipt of this report, meetings were held with the technical staffs and the directors of the agencies to discuss the recommended compensation features. Additional justification data were furnished as a result of these meetings and a supplemental report on the fishery portion, prepared by the Fish Commission of Oregon, is attached as Appendix B. Supplemental data on the wildlife portion are included in the text of this report.

The Walla Walla District was instructed by the Office, Chief of Engineers that independent consultant services should be obtained to review and analyze the compensation report prepared by the fish and wildlife agencies, and that an environmental impact statement on the effects of the proposed compensation measures be prepared prior to submission of the District Engineer's report to higher authority for approval.

A preliminary draft report dated 13 April 1973 was prepared by the District Engineer and later revised in September 1973, based on additional data furnished by the agencies and on input from four public meetings held in May and July 1973. The final report of the fish and wildlife agencies and the revised draft report were furnished to the consultants for their consideration. The reports furnished by these consultants essentially concurred with the recommendations of the fish and wildlife agencies.

The data used in preparation of this final report by the Walla Walla District, Corps of Engineers have been furnished by the concerned State and Federal fish and wildlife agencies, whose efforts and cooperation in this matter have been most helpful, and from the independent reports of the Corps' fisheries consultant, Appendix C, and the wildlife consultant, Appendix D.

Independent of this report, the Walla Walla District has contracted for separate consultant services to prepare a wildlife habitat management plan to outline those areas and methods which will provide maximum replacement possible of wildlife and wildlife habitat on already owned project lands in the lower Snake River area. This report is being processed as a separate project design memorandum. The estimated proportion of total compensation to be realized on Project lands is considered in the development of plans and recommendations for off-project lands.

PROJECT IMPACTS ON ANADROMOUS AND RESIDENT FISH

PRE-PROJECT CONDITIONS

The Snake River system is one of the outstanding river systems in the United States for production of fish and supports large populations of both anadromous and resident species. Anadromous fish from the Snake River system, particularly Chinook salmon, contribute substantially to the large commercial and sport fisheries in the Columbia River and the Pacific Ocean from California to Alaska. Salmon and steelhead trout support an extensive sport fishery throughout the lower Columbia and Snake Rivers and tributaries, a limited commercial fishery below Bonneville Dam, and an Indian commercial fishery above Bonneville Dam. An excellent sport fishery for anadromous as well as resident species existed in the Project area prior to Project construction. No actual count of the numbers of anadromous fish entering the Snake River was possible until the completion of Ice Harbor Dam in 1962. Table 1 shows the McNary and Ice Harbor Dam counts since 1962 and the percentage of the Columbia River fish (McNary count) entering the Snake River (Ice Harbor count).

Principal resident game fish in the Project area are smallmouth and largemouth bass, white sturgeon, and channel catfish. Other less important species to the fishery are rainbow trout, Dolly Varden, brown bullhead, mountain whitefish, white crappie, and bluegill. Nongame fish include carp, squawfish, suckers, chiselmouth, and shiners.

TABLE 1

NUMBER AND PERCENT OF CHINOOK SALMON AND STEELHEAD TROUT
COUNTED AT MCNARY DAM PASSING ICE HARBOR DAM

Year	Spring & Summer Chinook			Fall Chinook			Steelhead		
	McNary Number	Ice Harbor Number	%	McNary Number	Ice Harbor Number	%	McNary Number	Ice Harbor Number	%
1962	108,640	64,252	59.1	44,116	30,049	68.1	163,181	115,796	71.0
1963	97,096	47,653	49.1	57,363	13,537	23.6	113,646	74,539	65.6
1964	109,341	49,000	45.1	58,593	11,097	18.9	100,742	58,860	58.4
1965	74,581	26,879	36.0	76,326	12,345	16.2	118,960	62,873	52.9
1966	148,022	60,864	41.1	75,119	15,018	20.0	145,130	65,798	45.3
1967	122,566	65,908	53.7	73,087	19,022	26.0	77,700	44,205	56.9
1968	127,731	74,304	58.2	72,757	24,377	33.5	112,522	82,383	73.2
1969	134,032	83,007	61.9	79,375	17,507	22.1	76,681	63,889	83.3
1970	107,338	67,313	62.7	61,554	10,385	16.9	69,759	53,870	77.2
1971	101,730	59,244	58.2	69,718	11,004	15.8	109,630	67,029	61.1
1972	119,514	73,196	61.2	49,307	9,436	24.4	93,820	63,593	67.7
1973	110,859	73,468	66.3	73,253	8,353	11.4	64,620	38,311	59.3
1974	65,849	29,630	45.0	62,009	2,814	04.5	26,932	12,528	46.5
Average	109,792	59,593	54.3	65,583	14,226	21.7	97,948	61,821	63.1

SIZE OF ANADROMOUS FISH RUNS

Basic to any determination of project impact is a knowledge of the pre-project population sizes. Because an actual count of anadromous fish into the Snake River was not possible prior to the completion of Ice Harbor Dam in 1962, determination of the pre-project run sizes has been estimated by the Northwest fisheries agencies. One estimate of representative run sizes was based on the maximum counts at McNary Dam from 1954 to 1967 and the maximum percentage of the McNary count passing over Ice Harbor Dam from 1962 to 1967. The fishery agencies regard this approach as reasonable in that substantial numbers of steelhead migrate upriver during noncounting periods and because higher counts of Chinook salmon occurred at McNary Dam prior to completion of Ice Harbor in 1962 than occurred after completion. Table 2 summarizes the fishery agencies' calculation of pre-project Snake River run sizes on this basis. Table 3 shows annual McNary Dam fish counts for the period 1954 through 1974.

Subsequent to receipt of the basic report of the Bureau of Sport Fisheries and Wildlife and National Marine Fisheries Service, and at the request of the Corps of Engineers for additional supporting information, the fish and game agencies developed an appendix to their basic report which discusses at length their rationale for estimating the pre-project run sizes into the Snake River. In their supplemental report, which is attached as Appendix B, the fish and wildlife agencies utilize a different approach to demonstrate that use of maximum McNary Dam counts as a basis for determining pre-project Snake River run sizes is justifiable.

First, the fishery agencies show that total dam construction in the Columbia Basin since the early 1950's has resulted in substantial reduction in total run sizes and that dam counts of some runs during this period have been artificially maintained at relatively high levels by

TABLE 2

ESTIMATED DISTRIBUTION OF SALMON AND STEELHEAD TROUT RUNS TO SNAKE RIVER SYSTEM IN PERCENT AND NUMBER *

River Segment	Fall Chinook Maximum Count McNary Dam 97,500 (1958) Distribution		Spring-Summer Chinook Maximum Count McNary Dam 222,100 (1957) Distribution		Steelhead Maximum Count McNary Dam 172,600 (1962-63) Distribution	
	Percent	No. Fish	Percent	No. Fish	Percent	No. Fish
Snake River						
Lwr. Monumental-China Gardens (main stem spawning)	26.5	17,600			4.0	4,600
Tucannon River			2.0	2,400	3.0	3,400
Clearwater River	0.5	300	0.5	600	37.5	43,200
Asotin Creek					1.5	1,700
Grande Ronde River			10.0	12,200	14.0	15,900
Snake River:						
China Gardens-High Mtn. Sheep	5.5	3,600				
Salmon River			79.5	97,200	30.5	35,200
Imnaha River	0.5	300	5.5	6,700	3.5	4,000
Snake River:						
High Mtn. Sheep-Appaloosa	1.5	1,100				
Appaloosa-Pleansant Valley	5.5	3,600				
Pleasant Valley-Hells Canyon	33.0	22,000				
Hells Canyon Dam Fish Facilities	27.0	17,800 4/	2.0	2,500	5.0	5,700
Small Tributaries:						
Imnaha River-Hells Canyon Dam	100.0	66,300 1/	0.5 / 100.0	600 / 122,200 2/	1.0 / 100.0	1,100 / 114,800 3/

1/ McNary Dam maximum count 97,500 x 68% = 66,300 (rounded to nearest 100) (68% is the highest percent of McNary counts over Ice Harbor 1962-67.)

2/ McNary Dam maximum count 222,100 x 55% = 122,200 (rounded to nearest 100) (55% is the highest percent of McNary counts over Ice Harbor 1962-67.)

3/ McNary Dam maximum count 172,600 x 66.5% = 114,800 (rounded to nearest 100) (66.5% is the highest percent of McNary counts over Ice Harbor per fish year 1962-67 adjusted to include estimates of fish migrations during months when no counts were made.)

4/ The highest count at Oxbow Dam (1958) prior to construction of Hells Canyon Dam. This includes 3,497 known mortalities downstream from the dam in October.

Note: Counting period breakdown: Fall chinook..... August 9 to October 31
Spring-summer chinook..... April 1 to August 8
Steelhead..... July 1 to June 30

* Table based on data available through 1967 and does not reflect distribution that could occur within any section or tributary in any given year.

TABLE 3

NUMBER OF CHINOOK SALMON AND STEELHEAD TROUT COUNTED AT MCNARY DAM 1954 - 1972

Year	Spring and Summer Chinook	Fall Chinook	Steelhead Trout
1954	113,079	13,476	75,059
1955	92,489	16,426	85,575
1956	103,052	11,290	42,554
1957	222,089	70,607	105,728
1958	128,564	97,528	87,890
1959	115,760	55,730	110,475
1960	129,430	47,337	96,895
1961	113,796	41,200	103,743
1962	108,640	44,116	163,181
1963	97,096	57,363	113,646
1964	109,341	58,593	100,742
1965	74,581	76,326	118,960
1966	148,022	75,119	145,130
1967	122,566	73,087	77,700
1968	127,731	72,757	112,522
1969	134,032	79,375	76,681
1970	107,338	61,554	69,759
1971	101,730	69,718	109,630
1972	119,514	49,307	93,820
1973	110,859	73,253	64,620
1974	65,849	62,009	26,932

severe reduction in fishery harvest. Summer Chinook counts have fallen drastically, even though there has been no fishery since 1964. Thus, the use of recent Snake River dam counts to determine the average annual Snake River run sizes prior to project construction would reflect depressed run sizes caused by lower Columbia River projects and produce an artificial and unreliable estimate.

The fisheries agencies then developed a case to show that if McNary and other dams constructed since 1954 had not been built, and with sound management of the runs to achieve an optimum sustained yield, average sustainable returns to the Columbia River would approximate the actual maximum returns to the river during the 1950's. From this it is demonstrated then that use of actual maximum McNary Dam counts during the time span the actual maximum return to the river occurred provides a reasonable approximation of the escapement needed past McNary to produce an annual run of optimum size.

In the development of this case the agencies utilize average return-per-spawner* rates for an 11-year period prior to completion of McNary Dam and multiply this rate by the optimum escapement values, developed in the late 1950's by actual management research, to achieve the average optimum run size. Thus, development of the optimum figures does inherently include an averaging process and a built-in damage factor for projects constructed prior to 1954. Tables 4 and 5 illustrate the development of the optimum run figures.

In their development of pre-Lower Snake River Project fish run sizes into the Snake River the fishery agencies applied maximum percentage of the individual runs past McNary Dam that entered the Snake and were counted over Ice Harbor Dam for the years 1962 through 1967. During this period a large percentage of the fish passing McNary Dam was unaccounted

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* Return-per-spawner is defined as the run size (Bonneville count plus the catch in the Columbia River below Bonneville) divided by the escapement (Bonneville count minus commercial and Indian catches above Bonneville Dam).

TABLE 4

BASIC COLUMBIA RIVER SALMON AND STEELHEAD DATA FOR ESTIMATING THE PRODUCTION RATES (RETURN PER SPAWNER) FOR THE 11 BROOD YEARS PRECEDING THE COMPLETION OF MCNARY DAM AND THE 11 BROOD YEARS AFTER THE COMPLETION OF THE DALLES DAM

Period	Parameter	Salmon			Summer Steelhead
		Spring Chinook	Summer Chinook	Sockeye	
Pre-McNary-The Dalles brood years (1942-52)	Avg excapement (1942-52)	52,400	37,900	49,100	95,600
	Avg run size (Salmon: 1946-56) (Steelhead: 1947-57)	187,300	105,100	195,900	259,600
	Return per spawner	3.57	2.77	3.99	2.72
Post-McNary-The Dalles[1/] brood years	Avg escapement (1957-67)	83,200	82,500	72,500	130,000
	Avg run size (Salmon: 1961-71) (Steelhead: 1962-72)	172,500	94,500	100,400	200,800
	Return per spawner	2.07	1.15	1.38	1.54

1/ Production in these years was also influenced in varying degrees by other dams: Brownlee (1953); Priest Rapids (1960); Oxbow (1961); Rocky Reach (1961); Ice Harbor (1962); Wanapum (1963); Wells (1967); Hells Canyon (1967); John Day (1968); Lower Monumental (1969); and Little Goose (1970). (Source: Fish and Wildlife Agencies Supplement Report Appendix B).

TABLE 5

COMPUTATION OF AVERAGE YEARLY LOSS TO COLUMBIA RIVER FISHERIES BASED ON DIFFERENCE BETWEEN OPTIMUM YIELD 1/ AND CURRENT YIELD

Period	Parameter	Salmon			
		Spring Chinook	Summer Chinook	Sockeye	Summer Steelhead
Pre-McNary-The Dalles	Average optimum run	285,600	221,600	319,200	326,400
	Optimum escapement	80,000	80,000	80,000	120,000
	Optimum sustainable yield (difference)	205,600	141,600	239,200	206,400
Current	Average run (Table 4)	172,500	94,500	100,400	200,800
	Average escapement 1968-72	115,400	74,800	68,700	129,800
	Average sustainable yield (difference)	57,100	19,700	31,700	71,000
Average yearly loss to fisheries (difference between yields)		148,500	121,900	207,500	135,400

1/ Optimum yield is average yearly harvest that could have been taken by fisheries if McNary and subsequent dams had not been constructed.

Source: Fish & Wildlife Agencies Supplemental Report (Appendix B)

for or lost before reaching the next upstream dams (Ice Harbor on the Snake River and Priest Rapids on the Columbia River). A study by the Fish Commission of Oregon in 1966, under contract to the Corps, indicated losses as high as 41 percent for spring Chinook and 45 percent for steelhead. Improved operational conditions starting in 1968 at Ice Harbor Dam greatly reduced these losses and, except for fall Chinook which will be discussed later, average percent passage at Ice Harbor of McNary counts for the years 1968 to 1973 was actually larger than the maximum values used by the fishery agencies in computing the required compensation. See Table 6.

Further credence for the use of maximum McNary count figures and maximum percents of McNary counts arriving at Ice Harbor as a basis for estimating pre-Ice Harbor run sizes is provided by the fact that this method has been accepted by all parties in Federal Power Commission proceedings pertinent to a number of projects in the middle Snake River area.

ANADROMOUS FISH SPAWNING GROUNDS

The Bureau of Sport Fisheries and Wildlife-National Marine Fisheries Service Report indicates that about 5,000 fall Chinook spawned in the Snake River below the mouth of the Clearwater River prior to project construction. Accurate counts of the actual numbers of fish spawning in this stretch of river have not been made because the water was too turbid for observation. Estimates appear to have been made, at least in part, on the basis of early surveys to catalog areas possessing necessary spawning ground requirements such as gravel availability and proper depths, water velocities, and temperatures.

STEELHEAD SPORT FISHERY

Prior to construction of the project, the lower Snake River supported the largest summer run steelhead fishery in the State of Washington. With

TABLE 6

COMPARISON OF AVERAGE AND MAXIMUM PERCENT PASSAGE
McNARY AND ICE HARBOR DAMS

	Spring & Summer Chinook	Steelhead
McNary Average Count 1968 - 1973	116,867	87,839
Ice Harbor Average Count 1968 - 1973	71,755	61,512
Actual Percent Passage over Ice Harbor 1968 - 1973	61%	70% 1/
Maximum Percent Passage at Ice Harbor (as used in FWS-NMFS Report, Appendix A)	55%	66.5%

1/ Average percent of McNary count passing Ice Harbor in years following 1967 exceeded "maximum" used by fish and game agencies.

the project, favorite rapids and pool areas have been changed to large, deep lakes and previous methods of fishing for these large trout are no longer effective except in the tailrace areas immediately below the dams. It has been estimated by the fish and wildlife agencies that about 130,000 angler-days annually would have been expended on steelhead fishing in the project area during the 100-year project life, which will be lost because of project construction.

RESIDENT SPORT FISHERY

The Washington Department of Game has conducted evaluation studies on the lower Snake River resident sport fishery since 1964. Based on these studies, the project long-term estimate for angler-day use in the four-dam area during the project life would have been 250,000 days annually for resident fish without construction of the project.

PRESENT PROJECT CONDITIONS

The major effects which construction of the four dams on the lower Snake River has had on fish include the conversion of a flowing stream into a reservoir-type habitat, the inundation of main stem spawning areas for some fall Chinook, and the addition of four substantial obstructions and sources of loss and damage to upstream and downstream migrants. The change from a stream to reservoir conditions has, of course, also substantially altered the character of the sport fisheries for anadromous and resident fish in the project area.

ANADROMOUS FISH RUN LOSSES

The Bureau of Sport Fisheries and Wildlife-National Marine Fisheries Service Report discusses a number of possible sources of loss to the anadromous fish runs at the lower Snake River dams, including losses of juveniles in turbines; losses to adults in seeking, entering, and passing

through the fishway system at each dam; losses of juveniles stunned in passing through turbines and spillways to increased predation; losses of juveniles through increased predation caused by creation of reservoirs which are more conducive to predator production; possible losses of juveniles through delay in reaching the sea as a result of having to migrate through reservoirs rather than moving to the sea in a fast-flowing stream; losses of juveniles and adults from nitrogen supersaturation; and, of course, loss of total production through the inundation and loss of spawning grounds. The fish and wildlife agencies stress the fact that compensation for nitrogen-related losses is not a part of this current program and acknowledge that other ongoing programs of the Corps are dedicated to minimizing supersaturated nitrogen as a major source of loss. The other sources of loss, except for spawning ground inundation and turbine losses, are not quantified but only discussed in general terms. Spawning ground inundation and loss is quantified in the fish and wildlife agencies report, at 5,000 fall Chinook salmon. Beyond this, the entire plan for anadromous fish propagation facilities is based on a 48-percent cumulative loss to juvenile downstream migrants passing through the turbines of the four lower Snake River dams.

Thus, of 66,300 fall Chinook, 122,200 spring and summer Chinook, and 114,800 steelhead calculated in Table 2 to have entered the Snake River prior to Project construction, some 34,400 fall Chinook, 58,700 spring and summer Chinook, and 55,100 steelhead are alleged to have been lost as a result of Lower Snake River Project construction. Table 7 summarizes these loss figures and their values.

ANADROMOUS SPORT FISHERY LOSSES

Based on creel census studies and punch card returns, the fish and wildlife agencies estimate that without the Project 130,000 average annual fisherman-days would be spent stream fishing for steelhead in the Project area during the Project life. They further estimate that the conversion of this reach of river into a series of reservoirs will completely eliminate these 130,000 average annual stream fisherman-days for steelhead.

TABLE 7

COMMERCIAL LANDINGS AND SPORT FISHING USE, WITH AND WITHOUT COMPENSATION [1/] IN COLUMBIA RIVER SYSTEM AND PACIFIC OCEAN (ANADROMOUS SPECIES) AND IN LOWER SNAKE RIVER PROJECT AREA (RESIDENT SPECIES)

Areas and Species	Commercial Fisheries									Sport Fisheries [4/]		
	With Compensation			Without Compensation			Difference					
		Landings			Landings			Landings		W/Comp.	WO/Comp.	Diff.
	Escapement	Pounds	Value	Escapement	Pounds	Value	Escapement	Pounds	Value	Ang. Days	Ang. Days	Ang. Days
Columbia R. System, Ocean												
Fall Chinook [2/]	32,700	1,668,000	$1,651,320	14,400	734,000	$ 726,660	18,300	934,000	$ 924,660	163,500	72,000	91,500
Spring and Summer Chinook [2/]	122,200	6,232,000	6,169,680	63,500	3,238,000	3,205,620	58,700	2,994,000	2,964,060	611,000	318,000	293,000
Steelhead [3/]	114,800	692,000	380,600	59,700	360,000	198,000	55,100	332,000	182,600	763,000	397,000	366,000
Totals	269,700	8,592,000	$8,201,600	137,600	4,332,000	$4,130,280	132,100	4,260,000	$4,071,320	1,537,500	787,000	750,500
L. Snake Project Area												
Resident										250,000	205,000	45,000

1/ Insofar as possible "with compensation" is intended to reflect the preproject condition.

2/ Calculations based on catch to escapement ratio of 4:1 (commercial catch 3:1 and sport catch 1:1) average weight per fish of 17 lbs.; and commercial value of $0.99 per lb. for Chinook, based on 1973 prices.

3/ Calculations based on catch to escapement ratio of 2:1 (commercial catch 0.67:1 and sport catch 1.33:1); average weight per fish of 9 lbs.; and commercial value of $0.55 per pound, based on 1973 prices.

4/ Angler-days for anadromous fish are based on catch to escapement ratios (footnotes 2 and 3) and an estimated 5 days of effort per fish (the value of an angler-day for anadromous fish is $9.00). Angler-days for resident fish are based on creel studies of Washington Department of Game and the ratio of 3 reservoir angler-days to 2 stream angler-days.

From BSF&W-NMFS Report (Appendix A) as revised by correspondence.

RESIDENT SPORT FISHERY LOSSES

Prior to dam construction the Snake River resident fish species most important to anglers were smallmouth bass, channel catfish, sturgeon, and whitefish. These species are dependent upon a live flowing stream environment. Their size, abundance, and fishing characteristics generated an intensive sport fishery in the Project area. Project completion created large reservoirs more favorable to other species. The Bureau of Sport Fisheries and Wildlife's joint report with the National Marine Fisheries Service states, "the without project resident fishery would have averaged 250,000 angler days. The average with project fishery will be 205,000 days, a loss of 45,000." Later correspondence indicated that compensating only the 45,000 angler-days lost is, in fact, insufficient. Loss of fishery quality must be compensated for. The report infers this quality aspect in stating, "the loss is actually greater than the 45,000 difference because two stream-angler days are equivalent to three reservoir-angler days in value." The resident fishery decline, therefore, amounts to 67,500 angler-days.

FISH AND WILDLIFE AGENCIES' RECOMMENDED COMPENSATION MEASURES FOR FISHERIES LOSSES

ANADROMOUS FISH RUNS

To achieve compensation for reduced anadromous fish production caused by the Lower Snake River Project, the fish and wildlife agencies have recommended fish propagation facilities. Their sizes and costs are based on loss level discussed above and on the factors shown in Table 8. These are hatchery facilities that would return 18,300 adult fall Chinook, 58,700 adult spring and summer Chinook, and 55,100 adult steelhead trout to the Snake River above the project area. The basic report of the agencies recommended a fall Chinook hatchery sized to return a run of 34,400 adults based on the maximum count at Ice Harbor Dam. This single

TABLE 8

HATCHERY REQUIREMENTS NECESSARY TO PRODUCE THE REQUIRED NUMBERS OF ADULT CHINOOK SALMON AND STEELHEAD TROUT
(Northwest Fish & Wildlife Agencies)

	Fall Chinook	Spring & Summer Chinook	Summer Steelhead
Adult Loss Level for Basing Hatchery Size	18,300[1/]	58,700	55,100
Percent Survival, Smolt to Adult	0.20	0.87	0.50
Number of Smolts	9,160,000	6,750,000	11,020,000
Smolts per Pound (Weight)	90	15	8
Pounds of Smolts[2/]	101,800	450,000	1,377,500
Percent Survival, Eggs to Smolt	80	70	65
Number of Eggs Needed	11,450,000	9,650,000	16,950,000
Eggs per Female	5,000	4,500	5,000
Number of Females Needed	2,290	2,145	3,390

1/ Reduced figure derived through negotiation between Corps and fish and wildlife agencies.
(The 66,300 and 34,400 figures are based on the highest percent of McNary count to enter Snake (some 68%). While this was an actual figure, it was twice as high as the next highest percent of McNary count to enter the Snake (33.5%). Thus, the second highest level was used as being more representative: [97,500 x 33.5%) - 5,000] x 48% + 5,000 = 18,300.)

2/ Pounds of smolts reared is the most significant item, both with respect to hatchery cost and eventual adult production. Size and numbers may be adjusted to hatchery practice.

year count was excessively high in comparison with other annual counts so the size was reduced to 18,300 adults by separate correspondence based on the second highest annual count as being more representative of the actual Snake River run.

ANADROMOUS SPORT FISHERY

To compensate for the loss of 140 miles of stream-type fishing for steelhead, the fish and wildlife agencies have recommended the acquisition of 150 linear miles of streamside lands averaging 100 feet in width along such streams as the Grande Ronde, Salmon, Clearwater, Tucannon, and Main Snake Rivers for assured fisherman access.

LOWER SNAKE RIVER RESIDENT SPORT FISHERY

Based on a revised estimated loss of 67,500 stream angler-days and a "put-and-take" trout fishery for compensation, the fish and wildlife agencies recommend trout propagation facilities capable of producing annually 233,000 trout weighing 93,000 pounds. These legal-size fish would be planted in southeastern Washington and western Idaho streams tributary or near to the Snake River, such as Asotin Creek and Touchet, Walla Walla, Tucannon, and Clearwater Rivers.

DISCUSSION

ANADROMOUS FISH RUNS

The entire matter of measuring damage levels to multiple stocks of fish in the Columbia River Basin and assigning specific increments of loss to the many individual projects in the basin is extremely complex and difficult. Actual data to accomplish this directly are limited at best and it is necessary to use the information that does exist in a reasonable manner to achieve reasonable estimates of loss. In spite of the best efforts possible, the presentation of such material may appear

incomplete and confusing to some. However, in this case it is believed that sufficient information does exist to form a reasonable basis for future detailed planning and action. This belief is further supported in the fishery consultant's report (Appendix C) which basically states that the fishery losses claimed and compensation measures recommended by the agencies are reasonable and justified.

The basic reason for this report is, of course, the concern over losses to the fisheries of the spawning stock of fish that must pass upstream and the juvenile offspring which must pass downstream through the Lower Snake River Project area. In their supplemental report, Appendix B, the fish and wildlife agencies did demonstrate that a substantial drop in the return-per-spawner rate had occurred since 1952 in the Columbia River system (see Table 4) due to the impacts of all projects. The summer Chinook run is, at present, not maintaining itself. The agencies then applied these actual average return-per-spawner rates from before and after the construction of McNary and succeeding dams to optimum escapement figures developed through management experience to demonstrate annual losses to the fisheries. From all dam construction in the Columbia Basin since 1952 this annual loss is estimated to be about 270,400 spring and summer Chinook and 135,400 steelhead. When one considers the substantial numbers of spring and summer Chinook and summer steelhead that are produced in the Snake River system, it is reasonable to assume that the Lower Snake River Project plays a prominent role in the reduction of these runs.

The actual loss to the fishery in recent years is of particular concern. In order to provide adequate escapement levels to spawning areas, large inter-dam losses of adult fish have been countered by severely curtailing the commercial fisheries. This has been accomplished both by reducing the number of fishing days allowed and by permitting fishing only after a predetermined number of adults had been counted over Bonneville Dam. The sport fishery in the upper Snake River has also been

reduced because of these lower runs. In fact, because of the low steelhead run into the Snake River in fall 1974, no sport fishery was permitted on these fish in the States of Washington, Oregon, and Idaho.

Figure 2 illustrates the decline in number of fishing days since 1945. Figure 3 shows the decline in the actual commercial landings of spring and summer Chinook, sockeye, and summer steelhead for the same pre- and post-McNary years considered in Tables 4 and 5. It is clear that the landings of these species in the river have been reduced to less than half their former levels.

In addition to compensating for increasing losses of fish between dams, additional escapement has been allowed to compensate for pre-spawning mortalities occurring to fish after they have passed the uppermost dam. In the last four or five years many of these mortalities may have resulted from nitrogen gas bubble disease. However, pre-spawning mortality was observed during 1972 when nitrogen levels were relatively low because of river flow regulation by the Corps. Observations of fish on and below their spawning grounds indicated that delayed mortalities resulted from a high incidence of physical injury to fish passing dams. This pre-spawning mortality is illustrated by the declining number of spawning nests (redds) per 100 fish counted over the uppermost dam (see Figure 4).*

Published data on the commercial catch and escapement of spring and summer Chinook over Bonneville Dam, which constitutes the total run, are shown in Figure 5. As can be seen by these data, the catch, escapement, and total run maintained high levels in the early 1950's with the peak occurring in 1955. This high yield was due largely to screening of irrigation ditches, laddering of stream obstructions, and scientific management of the fisheries. Since 1955, the escapement above the commercial fishery has been kept relatively high by severely restricting the commercial catch and reduction of the sport fishery in the upper Snake River. In spite of this, the total run has declined. The period of this

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* Redd counts supplied by the Idaho Department of Fish and Game.

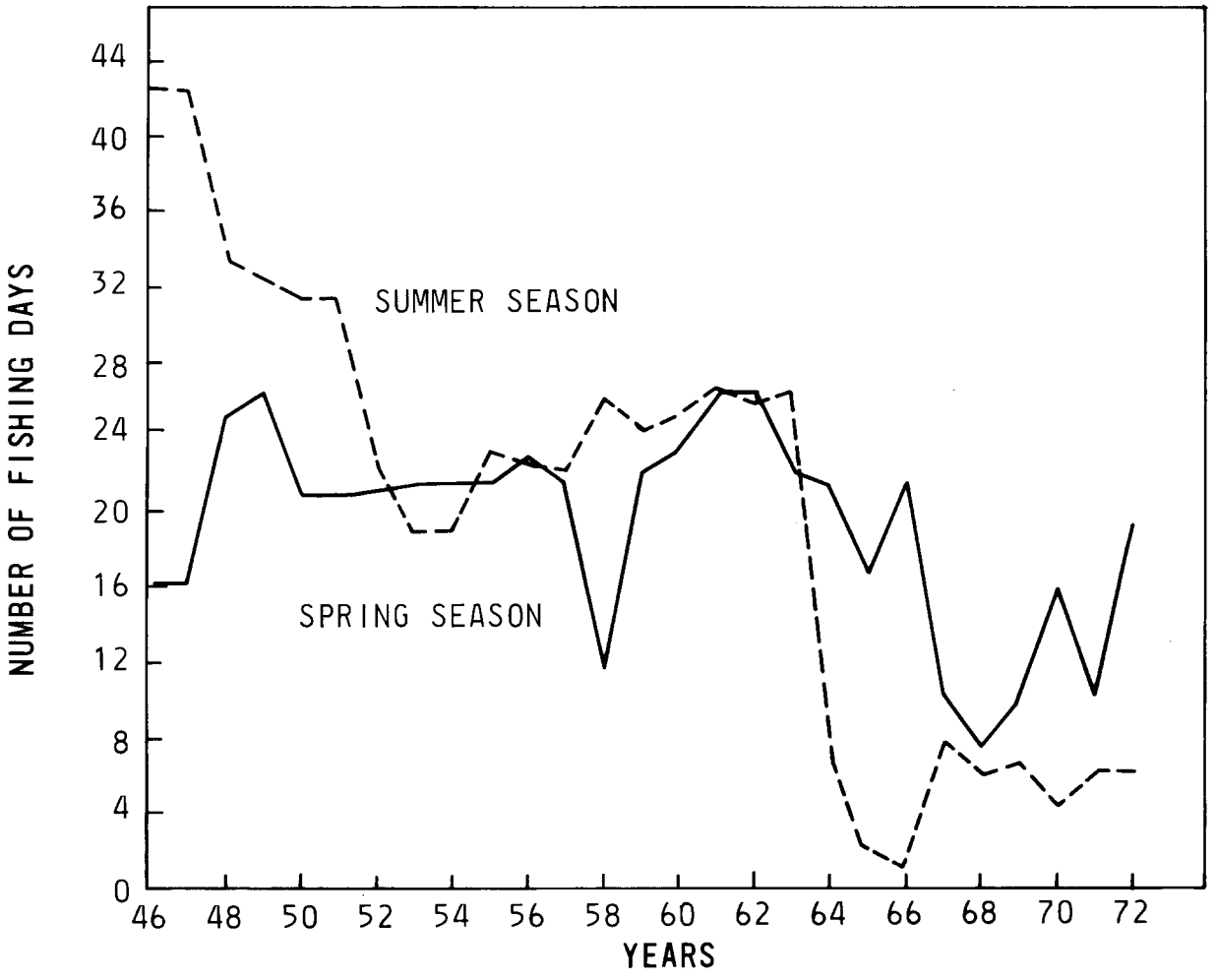


FIGURE 2. COLUMBIA RIVER COMMERCIAL FISHING SEASONS FOR SALMON BELOW BONNEVILLE DAM, 1946-72.

FIGURE 2

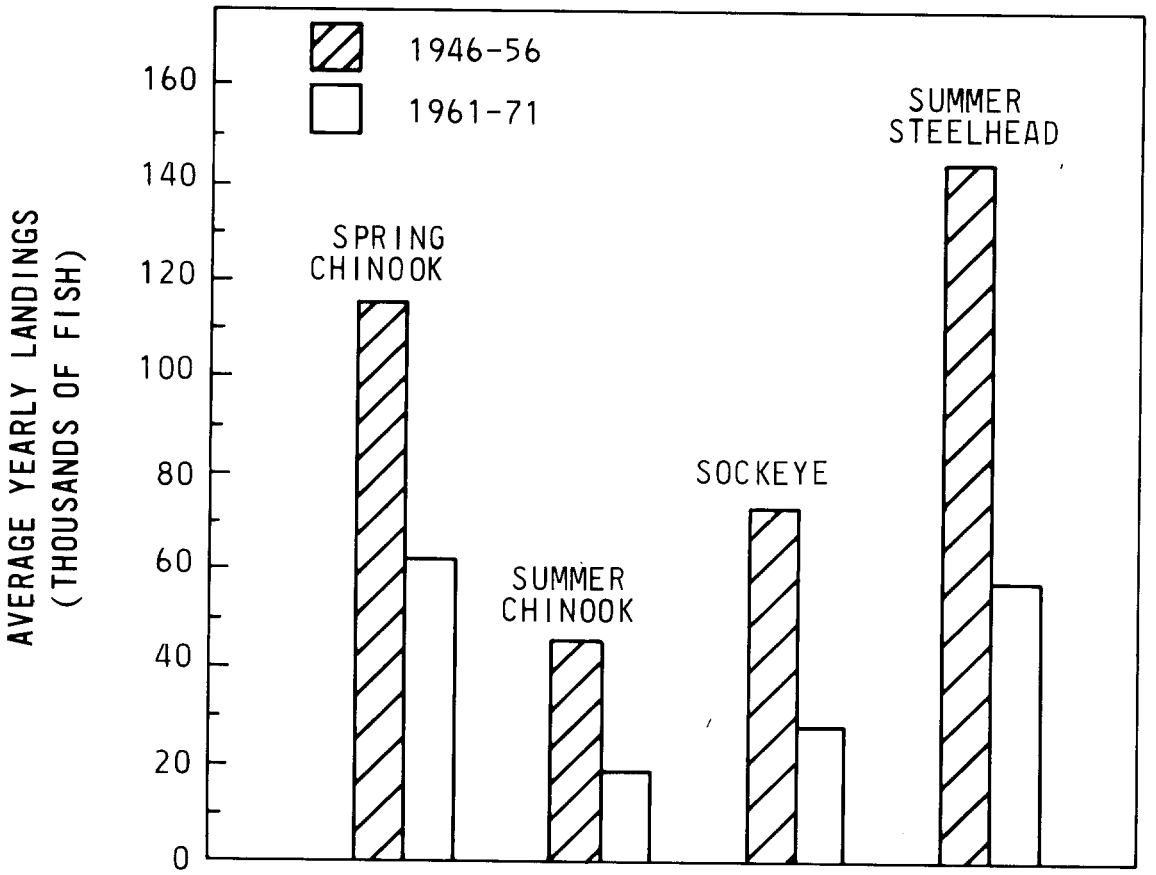


FIGURE 3. A COMPARISON OF AVERAGE ANNUAL COMMERCIAL LANDINGS IN THE LOWER COLUMBIA RIVER FOR THE YEARS 1946-56 AND 1961-71 OF SPRING CHINOOK, SUMMER CHINOOK, SOCKEYE, AND SUMMER STEELHEAD.

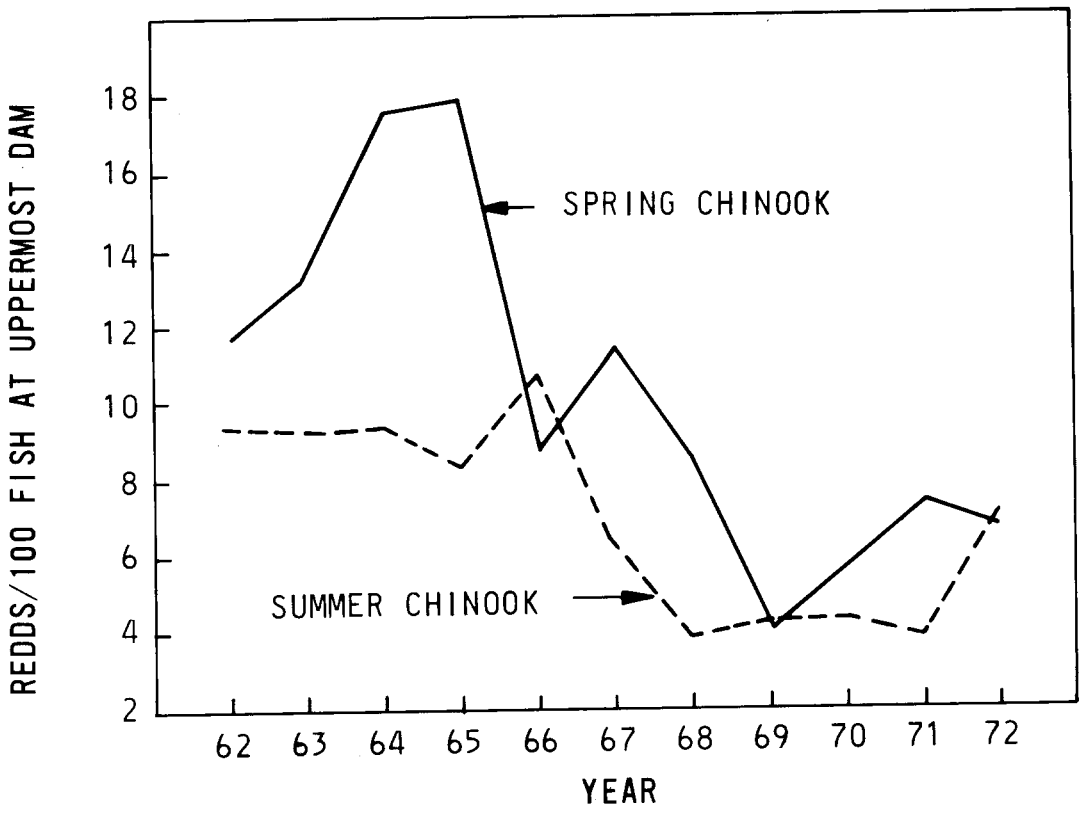


FIGURE 4. NUMBER OF REDDS IN STANDARD SPAWNING GROUND SURVEY UNITS IN IDAHO PER 100 FISH COUNTED OVER UPPERMOST DAM FOR SPRING AND SUMMER CHINOOK, 1962-72 1/

1/ REDD COUNT DATA SUPPLIED BY IDAHO DEPARTMENT OF FISH AND GAME.

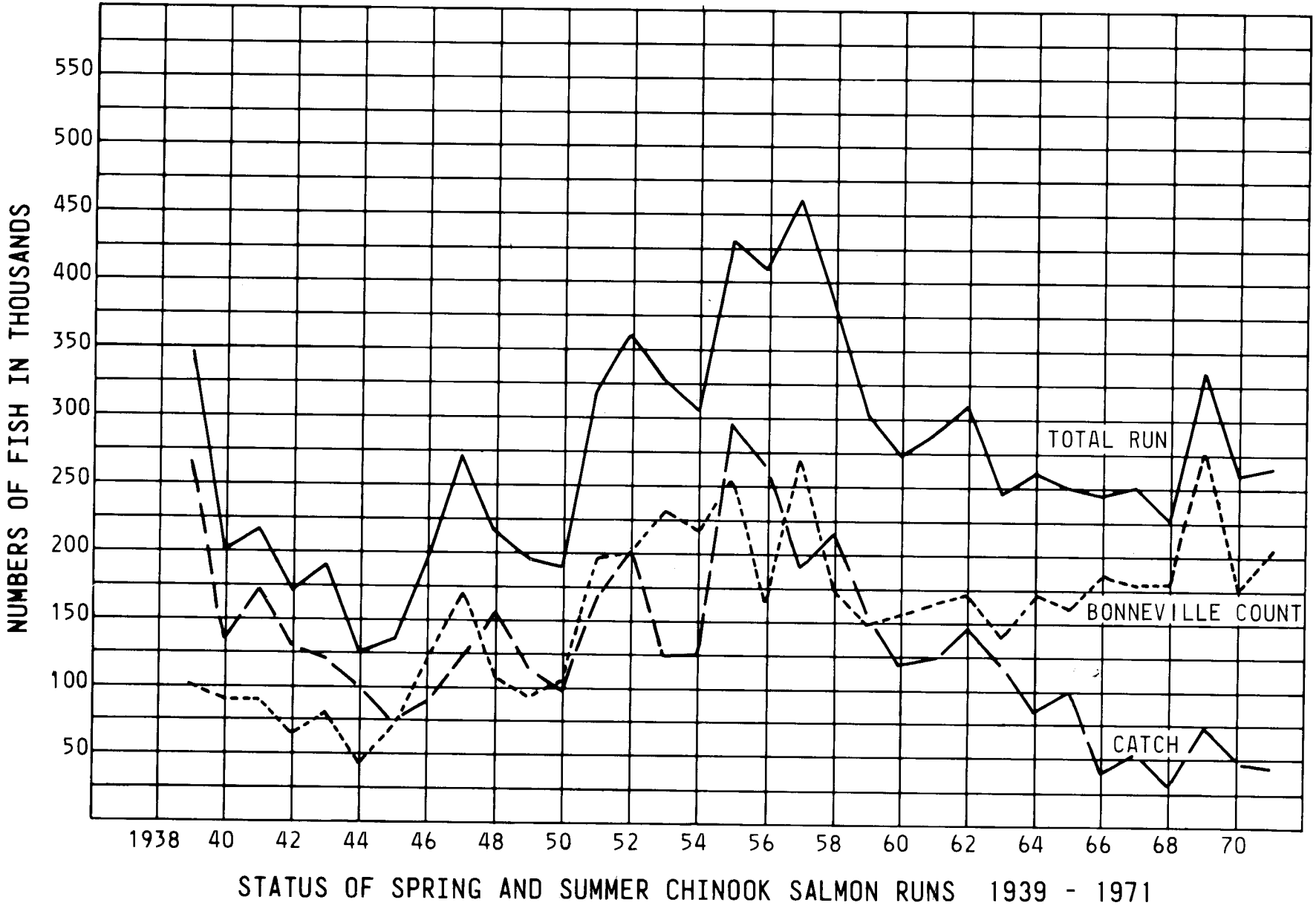
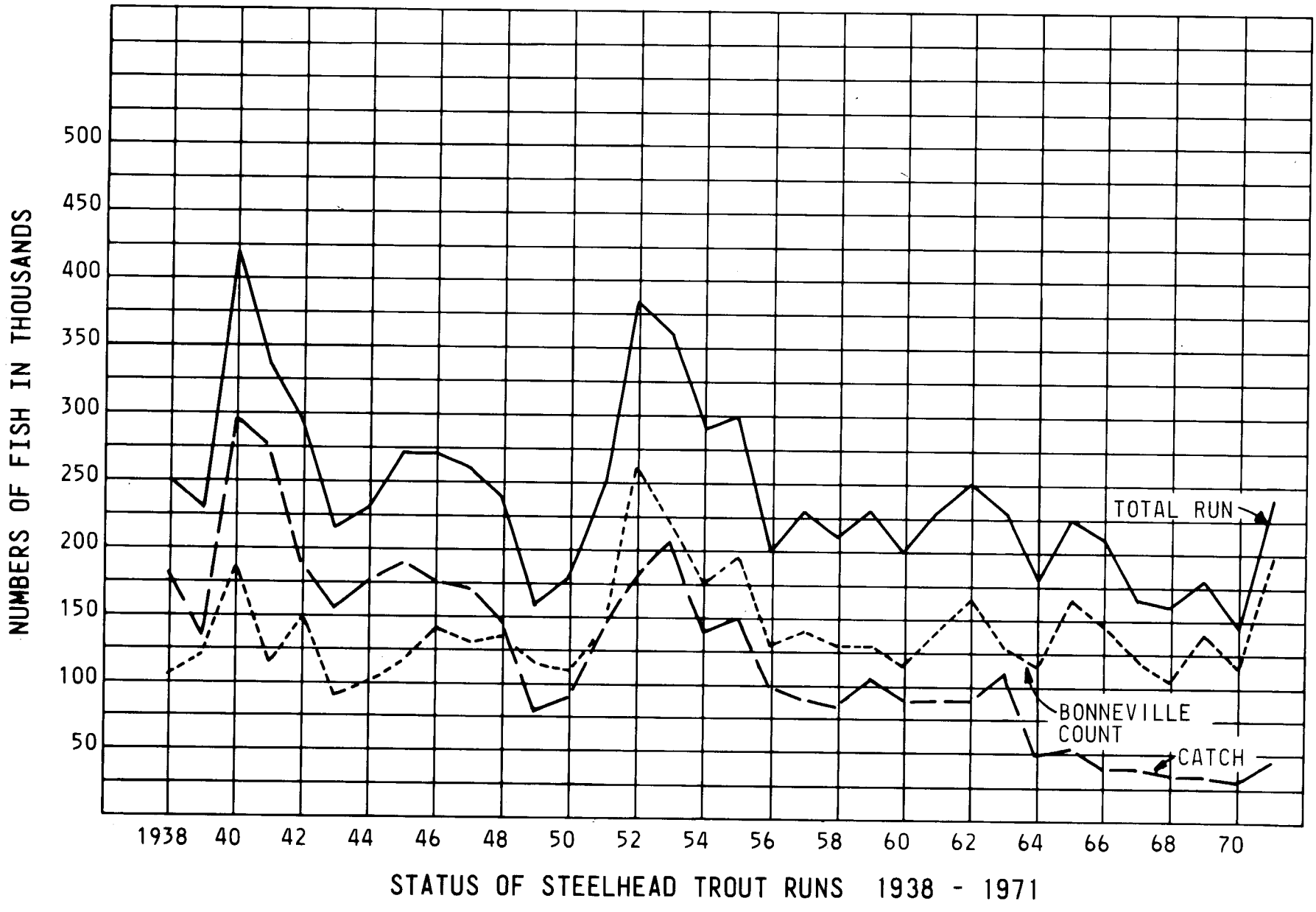

NUMBERS OF FISH IN THOUSANDS
550
500
450
400
350
300
250
200
150
100
50
1938
40
42
44
46
48
50
52
54
56
58
60
62
64
66
68
70
TOTAL RUN
BONNEVILLE COUNT
CATCH
STATUS OF SPRING AND SUMMER CHINOOK SALMON RUNS 1939 - 1971

FIGURE 5

decline has coincided with the period of major dam construction on the Snake and Columbia Rivers.

As with the spring and summer Chinook runs, the escapement of steelhead over Bonneville Dam has remained relatively constant but the commercial fishery on this species has been drastically reduced (see Figure 6). Historically, steelhead supported a sizeable commercial fishery in the Columbia River. Because of the declining runs and efforts of sport fishing groups, steelhead are now essentially a sport fish with only a limited commercial fishery below Bonneville Dam and an Indian commercial fishery above Bonneville Dam. According to estimates by the agencies, the sport fishery for steelhead has increased during this time with the estimated 52,000 angler-days annually occurring in the Lower Snake River Project area before construction, projected to an estimated 130,000 angler-days annually during the 100-year project life, without the project. Total catches of steelhead in the Columbia River system by both sport and commercial fishermen are down substantially compared to earlier years.

What should be most clear from the foregoing material is the magnitude of the fish losses in the Columbia River due to dams constructed in the last 20 years, and the inordinate hardship on the resource and the fisheries if reasonable compensatory procedures are delayed further. Losses due to Snake River projects have been increasing since the completion of Ice Harbor Dam in 1962, and serious losses related to main-stem Columbia River dams jumped sharply in the late 1950's and have continued year after year since that time. It could be argued that some of these losses result from environmental changes in tributary streams. However, during the period studied here, extensive screening of water diversions, other stream improvements, and increased hatchery production of spring Chinook and steelhead have countered most of the adverse effects occurring in these tributaries during this period. None of these latter activities are related to compensation for fishery losses at main-stem Corps projects.


NUMBERS OF FISH IN THOUSANDS
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TOTAL RUN
BONNEVILLE COUNT
CATCH
STATUS OF STEELHEAD TROUT RUNS 1938 - 1971

FIGURE 6

Pro-rating total losses to individual projects on the basis of precise, factual information is not possible as necessary detailed data just do not exist. Fish counts by themselves are unreliable as they are an artifact of downriver fisheries management decisions and passage conditions at other dams. Substantial losses of adult fish between dams have been quantified for some projects; however, this does not appear to be a major source of loss in the lower Snake River. If damage to adult fish occurs at the lower Snake River dams, then the actual loss occurs between the uppermost dam and the spawning grounds and is not directly discernible in the lower Snake dam fish counts. As Figure 4 illustrates, however, there has been a substantial drop in the numbers of redds (spawning nests) produced by spring and summer Chinook in the Snake River watershed per 100 fish counted above the uppermost dam since Ice Harbor was completed in 1962. Lower Monumental was completed in 1969, Little Goose in 1970, and Lower Granite in 1975*. John Day Dam on the lower Columbia River was completed in 1968.

Nitrogen supersaturation at lower Snake dams may well contribute to the adult loss indicated above, but is unquantifiable at this time. Nitrogen supersaturation has been related to high quantified losses to juvenile salmonids at lower Snake dams; however, nitrogen losses are not claimed for compensation as a part of this plan. Another program to minimize or eliminate supersaturated nitrogen at lower Snake dams in progress by the Corps should ultimately eliminate most of the loss from this source.

The increased loss of juvenile salmonids to predation because reservoirs are more conducive to predator production is a generally accepted premise; however, this source of loss has not been quantified in the Columbia Basin to date. While this is probably a valid source of loss assessable to the Lower Snake River Project, it is not treated as such in this report.

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* Pool raising date.

Possible loss of juvenile salmonids due to delay in reaching the sea due to the necessity of negotiating long slack-water areas created by impoundments rather than being moved quickly through the former stream environment by the spring freshet has been theorized but not demonstrated to date. Presumably the delay associated with increased exposure to impoundment and the possibility of arriving in the estuary at an inopportune time so far as food availability, predator exposure, and osmotic regulatory capability are concerned could result in increased losses. A portion of any such loss would be assessable to the Lower Snake River Project, but has not been treated as such in this report.

The entire anadromous fish loss attributable to the Lower Snake River Project in the report is based on the inundation of spawning grounds for 5,000 fall Chinook in the lower Snake by the Lower Snake River Project and the 48-percent loss of juvenile downstream migrant salmonids that would pass through the turbines of the four lower Snake River dams. Thus, the only possible source of confusion or error concerning appropriate allocation of total Columbia Basin dam losses to the Lower Snake River Project lies in the selection of a reasonable estimate of pre-project Columbia River fish run sizes at McNary and the selection of reasonable proportions of those runs that might be expected to enter the Snake River.

The 5,000 fall Chinook said to have spawned in the lower Snake is a fish and wildlife agency estimate based on limited evidence. Surveys some years ago revealed that extensive gravel areas were available and that depth, velocity, and water quality conditions were adequate for salmon spawning. Because of turbid water conditions, however, no quantitative, visual evidence of fall Chinook spawning in this area has been possible. Personal communication from one former fishery agency employee indicated that he had seen several redds on one flight in the mid-1950's and was sure there was some spawning in the area. However, since the completion of Lower Monumental and Little Goose dams, there is evidence that at least 5,000 fall Chinook spawned there even as recently as 1969. In 1969, of the 17,500 fall Chinook passing Ice Harbor Dam, only 7,600 were counted over Lower Monumental Dam. From 1970 through

1973 the average difference between Ice Harbor and Little Goose Dams has been 5,300 adult fall Chinook. Since we have already noted that no dam-related loss is attributable to passage in this area, it is reasonable to conclude that this difference represents fish formerly spawning in this area.

The basis for the 48-percent mortality to juvenile downstream migrants through the turbines is quite sound. Repetitive experiments involving the measurement of loss to juvenile fish in Kaplan turbines under head and other conditions similar to those at the lower Snake River dams have clearly demonstrated that a 15-percent loss rate at each of the four projects is a reasonable estimate. This 15-percent loss rate at each project includes direct turbine loss and some predation loss of fish stunned in the turbine. A progressive 15-percent loss rate to a group of downstream migrants at each of four projects, of course, results in a cumulative loss rate of 48-percent.

The Bureau of Sport Fisheries and Wildlife-National Marine Fisheries Service Report (Appendix A) recognizes the ongoing investigations by the National Marine Fisheries Service under the Corps of Engineers financing to reduce the loss of juvenile downstream migrants through development of a feasible penstock screening and bypass system to minimize the numbers of juvenile fish that would otherwise pass through the turbines. Such a system could be installed at each dam or operated at an individual project in conjunction with trapping and hauling equipment to transport these fish around several dams. To date the work has shown that up to 80 percent of the available juvenile fish can be deflected into the by-pass-collection system and that improved survivals to adult returns can result from fish so trapped and hauled around seven dams. Recent experimental and development work has greatly reduced levels of impingement, descaling, and other fish damage to a point where screening, trapping, and hauling appears to be a viable method for reducing fish mortalities. Subsequent evaluations which will take into account the reduced mortalities attributable to the screening and bypass system or hauling operations will be balanced against increased mortalities due to effects on downstream migrants of expanded powerhouse construction and increased power peaking operations.

Recognizing that dam counts have their shortcomings as indicators of run size, particularly for periods of time prior to Project construction, one is, nevertheless, faced with the necessity of using them for lack of any alternative source of information. In this report the McNary counts and percent of fish counted past McNary that were subsequently counted at Ice Harbor are dominant factors in the calculation of damage level and size and cost of compensating propagation facilities for the Lower Snake River Project.

In reference to the McNary counts, the fish and wildlife agencies (see Table 1) used the 1958 fall Chinook count of 97,500, the 1957 spring and summer Chinook count of 222,100, and the 1962-63 steelhead year count of 172,600. Reference to Table 3 showing all of the McNary counts illustrates that these counts are not only the maximum counts, but that they are substantially higher than the next highest count. It is believed that those counts occurring in 1957 were the result of The Dalles Dam inundating Celilo Falls, eliminating the Indian fishery there and permitting much larger numbers of fish to move upstream. The 172,600-figure used for steelhead by the fish and wildlife agencies cannot be found in the official public documentation of annual fish counts. Reported figures for the same year are 164,864. If one added 4.5-percent to this count for winter passage when counting does not normally occur, then the 172,600-figure could be achieved. The 4.5-percent winter passage rate is reasonable as demonstrated by other actual winter counts.

A point for supporting the use of the high McNary count is the fact that these same figures have been agreed to as a basis for compensation of fisheries losses by owners and proponents of several hydroelectric projects in the middle Snake River area during various Federal Power Commission proceedings. Also, the Federal Power Commission has ordered the Idaho Power Company to compensate losses from their middle Snake River dams on the basis of the same maximum figures. Further, a theoretical case by the fish and wildlife agencies to illustrate the optimum sustained yield of the Columbia River runs under conditions existing prior to 1952 demonstrated that optimum production would

approximate maximum runs occurring since 1938. Information has been presented to show that the generally low runs prior to 1952 were due to improper fisheries management and regulation and to hundreds of unscreened diversions in the basin that trapped and led thousands of juvenile downstream migrant salmonids to their death in the agricultural expanses of eastern Oregon, Washington, and Idaho. These shortcomings have since been largely corrected. It must also be remembered that a number of sources of losses at the lower Snake dams have been identified but few of them can be quantified. This in itself tends to justify the use of maximum numbers where some quantification is possible in the development of an artificial case for pre-project run sizes. It is also the opinion of the consultant that the use of maximum numbers is justified in computing compensation measures.

Another important factor in establishing the Lower Snake River pre-project run size is the percent of fish passing McNary Dam that subsequently passed into the Snake (Ice Harbor count). The figures originally used by the fish and wildlife agencies (see Table 2) are 68 percent for fall Chinook, 55 percent for spring and summer Chinook, and 66.5 percent for steelhead. At the time these figures were selected, they too were apparently maximums. However, since 1968 average percent figures have exceeded these maximums for spring and summer Chinook and steelhead. Comparison of the percent figures used for spring and summer Chinook and steelhead with the annual percent figures for all years in Table 1 indicates that the selected figures are reasonable. The maximum percent figure of 68 percent for fall Chinook, however, appeared to be excessive and through negotiation with the fish and wildlife agencies agreement was reached to use the second highest percent figure from Table 1, 33.5 percent.

The remaining factor substantially influencing the size and cost of the propagation facilities is the percent of planted fish that return to the hatchery or its vicinity. The fish and wildlife agencies have used 0.20 percent for the fall Chinook hatchery, 0.87 percent for the spring

and summer Chinook hatchery, and 0.50 percent for steelhead. On the basis of experience to date, these figures appear reasonable for detailed planning purposes.

It has not been the purpose of the preceding discussion to minimize the difficult task of establishing a reasonable basis for compensation or to discount the methods utilized in this instance. Rather, this discussion intends only to point out the strengths and weaknesses of the methods used and to list the supporting facts and rationale as dispassionately as possible. These strengths and weaknesses are further discussed in the consultant's report (Appendix C) and while the consultant disagrees with certain of the computation methods, there is complete agreement on the basic premise that a serious loss to the fishery has and is still occurring. Even using different computation methods the extent of loss demonstrated is almost equal. The consultant's report emphasizes that no present method can give a precise figure because of the many uncontrollable variables involved. Fully recognizing that the sizes of the compensation propagation facilities for anadromous fish affected by the Lower Snake River Project have been developed by rather imprecise means, it is believed that the basic information furnished by the fish and wildlife agencies and discussed above is generally reasonable and accurate enough at this time to use as a basis for approval or authorization of the compensation program.

Following approval or authorization and initial funding, detailed planning of the propagation facilities would encompass review of all information including any pertinent new data, the success of the screening program in protecting fish, adult returns from the transportation program, steelhead propagation at Dworshak hatchery, adverse effects of expanded powerhouses and increased peaking operations, and any other information that would have a bearing on the size and cost of the facilities ultimately constructed.

There is a matter of urgency in proceeding with this plan. Anadromous fish produced in the area affected by the Project contribute substantially to both the sport, commercial, and Indian fisheries in

Oregon, Washington, and Idaho and an ocean sport and commercial fishery from California to Alaska. With adequate compensation for existing and continuing dam-caused losses, in conjunction with existing and future fishery management programs, this important resource can be maintained to the benefit of present and future generations. The process of obtaining reasonable compensation for Lower Snake River Project will require some period of time even if plans for hatchery construction are initiated immediately.

Because of the Columbia and Snake River dams, fishermen have already lost an accumulation of tens of millions of pounds of prime salmon and steelhead. The present compensation program is not addressed to these past losses but rather is aimed at reducing such losses in the future. Because of the fact that summer Chinook and wild spring Chinook runs are not supporting themselves now and the 1974 steelhead count into the Snake River indicates that run is also in jeopardy, further delay of the compensatory process could have a serious impact on the viability of the fish runs and the fisheries.

ANADROMOUS SPORT FISHERY

The fish and wildlife agencies have stated that the Lower Snake River Project will eliminate 140 miles of stream-type fishing for anadromous fish, causing the annual average loss of 130,000 fisherman-days during the Project life. They are recommending the acquisition of 150 linear miles of assured streambank access for fishermen on other unimpounded streams in the area. The 130,000 fisherman-days figure is developed by making estimates of the current fishing intensity through creel census and punch card analysis and by applying population growth and fishing popularity factors. In recent years (1965-1969) summer steelhead catches in the lower Snake River have ranged between 10,800 and 14,500 fish and have accorded some 52,000 man-days of stream fishing pleasure annually. From year to year during this period of time, the lower Snake River has consistently ranked first or second among the top ten summer-steelhead-producing streams in the State of Washington. With the dams, tailrace fishing in the Project area for anadromous fish is popular and productive now and will probably increase if the runs can

be maintained. Thus, we cannot agree with the fishery agencies that all anadromous sport fishing in the Project area will be eliminated but there is no doubt that an extensive stream-type fishery has been lost. The 130,000 average annual fisherman-day figure does appear to be reasonable as a basis for detailed planning.

RESIDENT SPORT FISHERY

The estimated loss of 67,500 stream angler days for resident fish has been derived from creel census, population growth and fishing popularity data. This loss would be compensated by producing and planting 93,000 pounds of trout in southeastern Washington and western Idaho streams tributary or near to the Snake. The 93,000 pounds have been derived in the following manner on the basis of management experience in this area.

67,500 angler days x 2.52 trout/day = 170,000 trout harvested

$$170{,}000 \text{ trout harvest} \times \frac{1000}{0.729} \text{ (harvest rate)} = 233{,}000 \text{ trout planted}$$

233,000 trout planted ÷ 2.5 fish/pound = 93,000 pounds

The figures furnished by the fish and wildlife agencies for resident fish loss compensation appear to be reasonable as a basis for detailed planning.

ALTERNATIVES TO THE PROPOSED ACTION

The compensation plan presented in this report contains features which are considered to hold the greatest potential for restoring fish and wildlife losses caused by construction of the four lower Snake River dams. The recommended actions contained in the fish and wildlife agencies' report were selected by the seven agencies involved: U.S. Fish and Wildlife Service, National Marine Fisheries Service, Washington Department of Fisheries, Washington Department of Game, Fish Commission of Oregon, Oregon Game Commission, and Idaho Department of Fish and Game, from a number of alternative actions based on their experience with these alternatives under various field and research conditions. During the preparation of that

report, 1966 to 1972, a thorough analysis of these various means was made. The final actions recommended in this report are the result of considerable coordination between the Walla Walla District Corps of Engineers and the fish and wildlife agencies, results of later research, reports from independent consultants who reviewed the data, and comments from the general public.

Representative alternative actions considered in formulation of the final recommendations are:

No Action - This does not meet the requirements of the Fish and Wildlife Coordination Act, and losses caused by project construction would still remain.

Removal of Dams - This is not feasible because of the money already spent for construction and the relinquishment of benefits derived from the projects.

Spawning Channels in Lieu of Hatcheries - This type of facility has exhibited limited success. They are not nearly as efficient as hatcheries from the production standpoint and would require considerably more land to produce an equal number of fish.

Locating Hatcheries Nearer the Mouth of the Columbia River - This would be a more efficient operation from the standpoint of obtaining adult spawning stock and reducing project-caused losses to both adult and juvenile fish. It would not, however, replace the loss in the upper river area where it occurred, nor would the fish be available to the sport, commercial, or Indian fishery from which they had been lost.

Subimpoundment for Reservoir Fishery - Creation and development of subimpoundments could replace some of the resident trout and warm-water sport fishery losses. Areas for development are very limited, however, and could not replace the loss of an extensive steelhead sport fishery. The rate of success for steelhead fishing in the reservoirs is very low. In order to replace this lost fishing opportunity, it is necessary to acquire guaranteed access to nearby steelhead fishing streams.

PLAN OF DEVELOPMENT

GENERAL

Based on the fish and wildlife agencies' estimates of loss caused by the Lower Snake River Project and recommendations for compensation, the following Plan of Development is proposed as a basis for general approval or authorization and funding and the expeditious prosecution of detailed planning for design and construction.

From data furnished by the fishery agencies, subsequent to receipt of their final report, size and location of the hatchery facilities is of major importance. This point is strongly emphasized also in the consultant's report. The integrity of individual stocks of fish native to a particular watershed should be preserved as much as possible. Much effort was wasted in the early days of fishery management by indiscriminate transfer of fish, in some cases, to the detriment of the fishery. Because of the incompatability of some transplanted fishes with the environment, there are many instances in which both the transplanted fish and the native stocks have suffered near extinction. For this reason the fishery agencies have suggested the construction of several smaller hatcheries rather than a lesser number of large "super hatcheries".

As can be seen from the following descriptions of the required hatchery facilities, the cost-per-pound of production varies considerably from $61 per pound for fall Chinook to $25 per pound for spring and summer Chinook and $15 per pound for steelhead trout. The exact hatchery locations have not been determined as yet so the cost of the facilities was based on single-species production for estimating purposes. The per-pound production cost for fall Chinook is considerably higher than for the other species because the young are reared for a short time only and released at a much smaller size. The more expensive hatchery components, such as buildings, incubators, water supply, and adult holding ponds are still required regardless of the size of fish released. In the actual siting of the hatcheries it may be possible to raise more than one species of fish at a given

facility thereby obtaining dual use of certain components and obtaining a reduction in the per-pound cost of production. This aspect will be considered during the siting and design stages for hatchery construction

ANADROMOUS FISH RUNS

Fall Chinook - To compensate for the loss of spawning grounds for an estimated 5,000 fish, and a 48-percent loss to juvenile downstream migrants passing through the turbines of the four lower Snake dams and other unquantifiable losses due to the Lower Snake River Project, it is proposed that propagation facilities be constructed to accommodate approximately 2,290 female adult fish and a like number of males, 11,450,000 eggs and 9,160,000 juveniles, totalling 101,800 pounds at release time, which is estimated to return 18,300 adults. A hatchery of this capacity would require approximately 40 acres of land and is estimated to cost $6,200,000 for construction and $450,000 annually for operation and maintenance. These costs include any necessary trapping and holding facilities. Since this race of fish normally spawned in the lower Snake River and in smaller streams tributary to it, this hatchery should be constructed as near to the Project area as possible, but downstream from the Project to minimize mortalities caused in passage through the four-dam complex. Although fall Chinook runs in the lower Columbia River are in relatively good condition and do not appear to be in danger of being completely lost, the particular run endemic to the lower Snake River area has suffered a serious and gradual reduction in recent years.

An economic analysis has been prepared on a 100-year project life as a basis for benefit-cost comparison.

Item	100-Year Life
Initial Construction Cost	$6,200,000
Annual Costs	
Interest and Amortization, 5-7/8 percent	$ 365,495
Operation and Maintenance	450,000
Total	$ 815,459
Annual Benefits	
Commercial Fishery Value	
934,000 lbs. @ $0.99 per lb.	$ 924,660
Sport Fishery Value	
91,500 angler days @ $9.00 per day	823,500
Total	$1,748,160
Benefit-Cost Ratio	2.14:1

The proposed fall Chinook propagation facilities appear to be well justified.

Spring and Summer Chinook - Spring and summer Chinook spawn in the major tributaries of the Snake River, primarily the Salmon River. To compensate for a 48-percent loss to the spring and summer Chinook juvenile downstream migrants passing through the turbines of the four lower Snake dams and other unquantifiable losses due to the Lower Snake River Project, it is proposed that propagation facilities be constructed to accommodate approximately 2,145 female adult fish and a like number of males, 9,650,000 eggs and 6,750,000 juveniles totalling 450,000 pounds at release time which is estimated to return 58,700 adults above the Project area. Land requirements would be approximately 80 acres, and costs are estimated at $11,500,000 for construction and $900,000 for annual operation and maintenance. These facilities would include any trapping and holding facilities required. These propagation facilities will be constructed as multiple units and will be located upstream of the Lower Snake River Project to provide for the sport fisheries in eastern Oregon, Washington, and Idaho as well as downriver commercial fisheries. Of all the Lower Snake River Project propagation facilities, these would have the highest priority for an early start on the basis

that the summer Chinook are not maintaining their numbers now, even though there is virtually no fishery on these stocks. Were it not for the Rapid River hatchery of Idaho Power Company providing approximately one-third of the Snake River spring Chinook escapement in recent years, those stocks would be in similar trouble.

Because of the extremely low run of summer Chinook in 1974, a two-year emergency program was approved and funded by the Corps of Engineers to preserve a nucleus of this race of fish until adequate compensation features can be constructed. This program allowed for 400 female and 200 male summer Chinook to be trapped by Idaho Fish and Game Department and their progeny to be reared in Department hatcheries. Continuation of the program will depend upon its success in producing a sufficient number of juvenile migrants, the size of the runs in the ensuing years, and a rapid approval of this compensation plan.

An economic analysis has been prepared on a 100-year project life as a basis for benefit-cost comparison.

Item	100-Year Life
Initial Construction Cost	$11,500,000
Annual Costs	
Interest and Amortization, 5-7/8 percent	$ 677,867
Operation and Maintenance	900,000
Total	$ 1,577,867
Annual Benefits	
Commercial Fishery Value 2,994,000 lbs. @ $0.99 per lb.	$ 2,964,060
Sport Fishery Value 293,000 angler days @ $9.00 per day	2,637,000
Total	$ 5,601,060
Benefit-Cost Ratio	3.55:1

The proposed spring and summer Chinook propagation facilities appear to be well justified.

Steelhead Trout - Steelhead trout also utilize the Project area as a migratory route to the upper Snake River and tributaries to spawn. To compensate for a 48-percent loss to the steelhead juvenile downstream migrants passing through the turbines of the four lower Snake River dams and other unquantifiable losses due to the Lower Snake River Project, it is proposed that propagation facilities be constructed to accommodate approximately 3,390 female adult fish and a like number of males, 16,950,000 eggs and 11,020,000 juveniles totalling 1,377,500 pounds at release time, estimated to return 55,100 adults above the Project area.

Land requirements would be approximately 80 acres. Construction cost is estimated at $20,500,000 with annual operation and maintenance costs of $1,500,000 and would include any necessary trapping and holding facilities. These facilities should be constructed upstream of the Lower Snake River Project to provide for the sport fisheries of eastern Oregon, Washington, and Idaho as well as the downriver fisheries.

The greater portion of monetary benefits from construction of the steelhead propagation facilities is derived from the sport fishery value of the fish produced. In order to provide full compensation of losses to the sport fishery, acquisition of streambank access, as discussed in the following section, is an integral part of the compensation plan. Since both are necessary and dependent upon each other, an economic analysis of the total steelhead compensation plan appears in the Anadromous Sport Fishery section.

ANADROMOUS SPORT FISHERY

A substantial stream-type sport fishery for anadromous fish, particularly steelhead trout, was developing in the Project area prior to and during project construction. With completion of Lower Granite Dam approximately 150 miles of stream-type area once available to the fishery will be essentially eliminated. All available data to date indicate that the catch per unit of effort is extremely low in a reservoir when compared with a stream. A fishery will exist in the tailrace

area of each dam, but this will not compensate for the total area which was lost. It has been estimated that the sport fishery for steelhead would have developed to an average of 130,000 angler-days annually during project life without the Project. To compensate for this loss of stream-type fishing it is proposed that 750 acres of land in small parcels be acquired either in fee title or some lesser estate at strategic points along streams in the lower and middle Snake River area which are known to have a high steelhead fishery use to provide assured access to these streams. Consideration will be given also to acquisition of areas on the main stem of the Snake River. All acquisition would be from willing sellers only; no lands would be condemned. Depending on location, development of these areas would include parking areas, trash cans, and primitive toilet facilities. The Corps of Engineers estimate for acquisition is $750,000 based on the total acquisition approximating 750 acres, with an initial development cost of $300,000 and annual operation and maintenance costs of $10,000.

In the interest of acquisition of these lands, compatible with an efficient fishery management program, an agreement should be reached with the Washington State Game Department and Idaho Department of Fish and Game whereby these funds would be furnished to the Departments for acquisition of lands as they were available within a 10-year period after authorization of the Compensation Plan. Consideration should be given to first acquiring lands near the affected Project area to the fullest extent possible and then to lands not adjacent to the Project area compatible to a statewide fishery management program. Fair cost of these lands would be determined by independent appraisal. Apportionment of the acquisition would be 700 acres by the Washington Department of Game and 50 acres by the Idaho Department of Fish and Game. As these lands are acquired, initial development funds would be provided to the procuring agency by the Corps of Engineers. Title to these lands would be vested with the Departments of the states in which they are located who would then assume the responsibility for performing the operation and maintenance and budgeting the necessary funds for that purpose.

An economic analysis of the steelhead propagation facilities and streambank acquisition has been prepared on a 100-year project life as a basis for benefit-cost comparison.

Item	100-Year Life
Initial Cost	
Steelhead Hatchery	$20,500,000
Fisherman Access Lands and Development	1,050,000
Total	$21,550,000
Annual Costs	
Interest and Amortization, 5-7/8 percent	$ 1,270,265
Operation and Maintenance	1,510,000
Total	$ 2,780,265
Annual Benefits	
Commercial Fishery Value	
332,000 lbs @ $0.55 per pound	$ 182,600
Sport Fishery Value	
Outside Project Area - 236,000 angler-days @ $9.00 per day	$ 2,124,000
Acquired Access lands - 130,000 angler-days @ $9.00 per day	$ 1,170,000
Total	$ 3,476,600
Benefit-Cost Ratio	1.25:1

It appears that the steelhead trout compensation proposal is well justified.

RESIDENT SPORT FISHERY

Prior to Project construction, a high quality stream fishery existed in the Project area for bass, sturgeon, and channel catfish and for rainbow and brown trout, Dolly Varden, bullheads, whitefish, crappie, and bluegills. With the impoundments, this fishery has been adversely affected. Fluctuations of the reservoir levels have reduced the spawning and rearing success of bass and other warm-water species. Sturgeon production is adversely affected. A popular fishery for bass and other warm-water species has developed in recent years and will continue to increase with the Project as more people are attracted to water-oriented sports, even though fishing success is expected to decline.

According to evaluation studies conducted by the fishery agencies on the resident fishery in the Project area, it has been estimated that

the average man-day use during project life would have been 250,000 stream fishing angler-days without the Project. With the Project, with the fishery restricted primarily to warm-water species, this use is expected to be 205,000 reservoir angler-days, a loss of 45,000 reservoir angler-days, or 67,500 stream angler-days. The fishery agencies state that this loss could be offset by supplemental stocking of 93,000 pounds of catchable-size rainbow trout annually in streams in the area, such as Asotin Creek, Grande Ronde, Tucannon, Touchet, Walla Walla, and Clearwater Rivers.

It is believed, however, that since this loss was incurred primarily on warm-water species in the Project area, every practical effort should be made to replace that loss in the affected area before providing a substitute fishery off-project. Means to accomplish this replacement which should be investigated would include the improvement of spawning and rearing habitat for warm-water species, development of subimpoundments for warm-water fish or trout and rehabilitation of tributary streams. To compensate for the loss to the resident fishery it is proposed that the Corps of Engineers be authorized to expend funds equal to the cost of design, construction, and operation and maintenance of a trout hatchery capable of producing 93,000 pounds of rainbow trout annually. The cost of such a hatchery is estimated at $3,000,000 for construction and $100,000 for annual operation and maintenance. Land requirements would be approximately 10 acres. The determination of the method of replacing the lost fishery will be based on more detailed future studies conducted by the Corps of Engineers with the assistance of Washington Department of Game. Construction and initial development of the hatchery or alternate measures would be funded by the Corps of Engineers.

An economic analysis for the trout hatchery has been prepared on a 100-year project life as a basis for benefit-cost comparison.

Item	100-Year Life
Initial Construction Cost	$3,000,000
Annual Costs	
Interest and Amortization, 5-7/8 percent	$ 165,800
Operation and Maintenance	100,000
Total	$ 265,800
Annual Benefits	
Sport Fishery Value	
67,500 angler days @ $9.00 per day	$ 607,500
Benefit-Cost Ratio	2.29:1

The proposed sport fishery program appears justified.

The recreation-day values of $9.00 per angler-day for sport fishing used in computing the foregoing benefit-cost ratio are based on the Water Resource Council's "Establishment of Principles and Standards for Planning," dated September 1973. The National Marine Fisheries Service has prepared a processed report entitled "Partial Net Economic Values for Salmon and Steelhead for the Columbia River System", by Merritt E. Tuttle, et al., January 1975, which provides justification for use of a value of $28.00 per angler-day for anadromous fish in the Columbia River system. These data were developed on the basis of "Economic Evaluation of the 1967 Sport Salmon Fisheries of Washington," by Matthews and Brown, consistent with techniques described in "Principles and Standards". If this $28.00 per day value were used, then the Benefit-Cost ratios for the anadromous fish hatcheries would be: 4.28:1 for fall Chinook, 7.1:1 for spring and summer Chinook, and 3.77:1 for steelhead.

The separate features of the fishery plan of development and their associated costs are summarized in Table 9.

A summary of the cost analyses for both fishery and wildlife features is shown in Table 15. All costs and benefits are based on 1974 prices.

It must be understood that these economic analyses are not normal project benefit-cost studies. The compensation actions recommended herein are required to replace project-caused losses and return the resource to a level which existed prior to project construction and therefore are not benefits to the total project. The benefit-cost ratios discussed here only evaluate the efficiency of moneys recommended for these compensation actions in relation to the value of the resource which is to be replaced.

ALLOCATION OF COSTS

The compensation measures described are for the four Lower Snake River projects as they now exist with three power units installed. These projects are very nearly the same height and have similar basic operating features. The pools vary somewhat in length, shoreline, and total capacity. Because of the similarity of the individual projects and because they were authorized as a single project, it is appropriate to allocate the costs equally among the four existing projects.

In allocating the costs between the navigation and power purposes, it has been determined that the loss of anadromous fish is caused primarily by the power turbines. This would make the compensation cost for hatcheries to replace the anadromous fish a separable power cost. Losses to resident fishery and stream-type anadromous sport fishery would apply to a power or navigation project and, therefore, the costs would be joint-use.

The cost allocation for Ice Harbor is final and has been approved by the Federal Power Commission. Cost allocations for the other projects are tentative and are subject to revision before final approval is obtained. The distribution of costs using these allocations is shown on the following page.

LOWER SNAKE RIVER FISH COMPENSATION
ALLOCATION OF COSTS

	Project Construction Cost ($1,000)	Annual Operation & Maint. ($1,000)
Ice Harbor Dam		
Joint Use - (Navigation	308	12
(Power	1,130	43
Specific - Power	9,125	683
Subtotal	10,563	738
Lower Monumental Dam		
Joint Use - (Navigation	208	7
(Power	1,229	48
Specific - Power	9,125	682
Subtotal	10,562	737
Little Goose Dam		
Joint Use - (Navigation	374	11
(Power	1,064	44
Specific - Power	9,125	683
Subtotal	10,563	738
Lower Granite Dam		
Joint Use - (Navigation	43	2
(Power	1,394	53
Specific - Power	9,125	682
Subtotal	10,562	737
GRAND TOTAL	42,250	2,950

TABLE 9

SUMMARY OF FACILITIES AND COSTS OF FISHERY COMPENSATION FACILITIES
LOWER SNAKE RIVER PROJECT

Facility	Land Requirement	Cost	
		Construction	Annual O&M
Fall Chinook Hatchery 101,800 pounds smolt production	40 acres	$ 6,200,000	$ 450,000
Spring and Summer Chinook Hatcheries 450,000 pounds smolt production	80 acres	$11,500,000	$ 900,000
Steelhead Trout Hatcheries 1,377,500 pounds smolt production	80 acres	$20,500,000	$ 1,500,000
Rainbow Trout Hatchery 93,000 pound capacity	10 acres	$ 3,000,000	$ 100,000
Streambank Lands for Fisherman Access and Development	750 acres	$ 1,050,000	$ 10,000 1/
TOTAL FEDERAL COST	960 acres	$42,250,000	$ 2,950,000

NOTE: a. Hatchery costs are based on actual recent experience at Dworshak, Spring Creek and Bonneville Hatcheries.

b. Land costs are based on knowledge of local land costs achieved by recent experience.

c. Hatchery costs include necessary trapping facilities.

d. Hatchery costs include necessary land @ $1,000 per acre.

1/ Performance of and budgeting for operation and maintenance will be a state responsibility.

PROJECT IMPACTS ON WILDLIFE

PRE-PROJECT CONDITIONS

The Snake River Canyon within the area of influence of the Ice Harbor, Lower Monumental, Little Goose, and Lower Granite Dams varies from 100 feet in depth near its confluence to 2,000 feet near Lewiston, Idaho. The canyon is bounded by terraced bluffs, and the canyon walls consist of basalt outcroppings interspersed with steep, sparsely-soiled slopes and draws. The canyon floor is formed by basalt outcroppings, gravel flats, bars, and islands. Upland soils are of loessal origin while bottom-land soils are of alluvial origin, primarily silt and sand in content.

The rich alluvial soils of the bottom lands supported a variety of trees, shrubs, grasses, forbs, and cultivated crops which provided essential food and cover for wildlife. Willow, alders, hackberries, and an understory of teasel, poison oak, sumac, wild rose, cocklebur, wheatgrass, and wild rye comprised the natural streambank cover. Dryer areas supported sagebrush and rabbitbrush interspersed with grasses. Other plants included Russian thistle, lupine, Jim Hill mustard, downy chess, and sanddock. Crops on agricultural lands consisted primarily of grain, forage, and orchards. A summary of river acreage, inundated acreage, acreage of high brush and trees under pre-project conditions, and project land acreage above the reservoirs is shown in Table 10. Data furnished by Washington Department of Game on estimated populations of principal wildlife species before project construction are shown in Table 11.

Big Game. Moderate numbers of mule and white-tailed deer inhabited the canyon slopes and bottom lands. Migrant deer from bordering uplands used the canyon during the hunting season and severe winters, and depended on the streamside vegetation and brushy draws for food and cover. The pre-project area contributed to the support of many deer that made an important contribution to the hunting harvest in surrounding areas.

TABLE 10

SUMMARY OF ACREAGES AVAILABLE FOR WILDLIFE
UNDER PRE-PROJECT AND POST-PROJECT CONDITIONS

Project Units	River Acreage 1/	Inundated Acreage	Pre-Project Vegetated 2/ Acreage	Approximate Project Land Acreage 3/ Above Reservoir
Ice Harbor	5,122	3,253	356	4,864
Lower Monumental	3,517	3,073	92	8,397
Little Goose	5,185	4,840	155	6,790
Lower Granite	5,640	3,260	520	5,440
TOTAL	19,464	14,426	1,123	25,491

1/ Area occupied by river prior to project construction.

2/ Consists of high brush, trees, and orchards in narrow shoreline strips. Scaled from aerial photos made prior to clearing. All other lands inundated were grasslands with some sagebrush and rocky areas.

3/ Available for revegetation where soil and topography permit, except for those areas in use as industrial or recreation areas. Includes lands for relocation of railway and roads.

TABLE 11

ESTIMATED POPULATIONS OF PRINCIPAL GAME SPECIES IN WASHINGTON BEFORE INUNDATION OF APPROXIMATELY 140 MILES OF LOWER SNAKE RIVER BY HYDROPOWER DEVELOPMENT(1)

Species	Base No. Before Inundation (2)
Big Game	
Deer	1,800
Upland Game	
Pheasant	22,000
Quail	56,900
Huns	19,800
Chukar	52,100
Doves	120,200
Cottontail	8,400
Subtotal	279,400
Waterfowl (3)	
Ducks	17,500
Geese	2,200
Subtotal	19,700
Fur Animals	
Beaver	1,100
Muskrat	26,900
Mink	2,300
Otter	200
Raccoon	2,600
Subtotal	33,100
Game Units	
Total	334,000

(1) Ice Harbor, Lower Monumental, Little Goose, Lower Granite Projects.
(2) Determined from special survey of 1964-65-66 Harvest in Project Areas, Numbers rounded.
(3) Reflects Hunting Season Population only - Does not indicate production changes. Actual Pre-project production in the project area approximated 600 goslings from a resident population of 400 geese.

Surveys conducted by the Washington Department of Game indicate that approximately 1,800 deer were dependent upon habitat within the reservoir areas prior to inundation. These animals would have supported an estimated 12,600 hunter-days annually and a harvest of about 400 deer annually throughout the 100-year project life without the project.

Upland Game. Brush and trees interspersed with agricultural lands along the flood plain provided excellent living conditions for California quail, ring-necked pheasant, and cottontail rabbit populations. Chukar partridge occurred in abundance along numerous side draws and talus slopes adjacent to the project-affected river reaches, and gray or Hungarian partridge occurred locally where the upper slopes border agricultural lands.

The area influenced by the project supported high quality hunting based on liberal hunting seasons, a diversity of upland game, and good access along many reaches. Hunters were attracted to the area from considerable distances for these reasons. According to the survey data, it is estimated that approximately 279,400 upland game birds and animals were dependent upon habitat within the influence of the project areas. These birds and animals would have supported about 43,900 hunter-days annually with a harvest of about 27,400 animals annually within the project-affected area during project life without the project.

Fur Animals. Beavers, muskrats, mink, raccoons, skunks, weasels, bobcats, river otters, badgers, and coyotes were found along the river and ajacent slopes with beaver, muskrat, and mink being the principal species of economic importance. Fur harvests fluctuated according to market demands and recent low demand for most furs resulted in pelt harvests many times lower than fur animal populations would support. The data indicate that approximately 33,100 fur animals inhabited the tproject area with estimates that an average annual harvest of 4,200 pelts would be taken from the affected river area without the project.

Migratory Game Birds. Mourning doves and waterfowl used the canyon seasonally and as resident species. Doves nested, rested, and fed extensively along the canyon walls, side draws, islands, and bars during the summer months, finding food in abundance on adjacent agricultural lands and water readily available in the river and its tributaries.

Thousands of ducks and geese wintered annually on embayments, shorelands, and islands along the lower Snake River, and were dependent on local and adjacent agricultural lands for winter food. Island habitat was of particular importance for resting by waterfowl in general and for resting and nesting by geese. Although a few ducks nested in the area, an estimated 400 Canada geese reared 600 goslings annually in the project area.

Restrictions prohibited waterfowl hunting on or near the river for 84 miles of the Snake River and 3 miles of the lower Clearwater River, but hunting in adjoining counties was largely dependent on duck and goose populations that would winter on the river and fly out to feed on nearby croplands. The average annual hunter use of waterfowl based on goose production on project-affected areas is estimated to be 1,100 hunter-days without the project.

Nongame Wildlife. Mild temperatures and vegetative cover along the river encouraged many migratory and resident nongame wildlife species to the area year round. Nature enthusiasts and academic interests enjoyed the variety of birds and other nongame wildlife in the area.

Appreciative Use. Based on 17 years of data, the Washington Department of Game estimates that the present appreciative use (man-days spent in bird watching, studying, and just seeing wild animals) of wildlife species approximately equals man-days of hunting and is increasing at the rate of 4.14 man-days per year in proportion to the consumptive, or

hunting, use. A monetary value of $1.00 per day has been used by the Department in evaluating this appreciative use.

PRESENT PROJECT CONDITIONS

Reservoirs resulting from the construction of Ice Harbor, Lower Monumental, Little Goose, and Lower Granite Dams will result in the inundation of 140.2 miles of riparian habitat varying from about 100 feet above the natural river level at each dam to approximately zero feet at the head of each reservoir. With the completion of Lower Granite Dam, the impoundments will have a total reservoir area of 33,890 acres, of which approximately 19,500 acres have always been occupied by the Snake River and 14,400 additional acres will be inundated which were occupied by bottom lands and canyon walls. These impoundments result in the loss of 48 islands five acres or larger in size, and 34 embayments five acres or larger in size. Only two islands of considerable size will be formed. Six of the embayments result from flooding of bottom lands at the Palouse River, Tucannon River, Alkali Flat, Deadman Creek, Penawawa Creek, and Alpowa Creek. Virtually all brushy shoreline, agricultural bottom land, and river island habitat has been lost resulting in a serious reduction in wildlife populations and wildlife-oriented recreation. Some higher side drainages with brush, trees, and shrubs remain unaffected above the lake levels, notably upstream from Central Ferry in the Little Goose-Lower Granite portion of the canyon. Railroad and roadway relocations have resulted in riprap embankments replacing much of the shoreline and creating hazards in gaining access to the water, particularly for larger forms of wildlife. Such bank protection measures also preclude re-establishment of vegetation that is vital to the survival of wildlife. Table 12 summarizes the impacts of the project on wildlife as estimated by the fish and wildlife agencies.

Table 12. Average Annual Wildlife User-Days, Lower Snake River Project, Washington State

Group	Without Project (Man-Days)	With Project (Man-Days)	Difference
Hunting Use 1/ (Big game, upland game, waterfowl)	57,600	18,200	- 39,400
Appreciative Use 2/ (Game and nongame species)	63,600	20,100	- 43,500
Fur Animals	4,200 (pelts)	2,100 (pelts)	- 2,100 (pelts)

Big Game. Loss of shoreline vegetation and agricultural bottom lands, as well as the flooding of the lower brushy draws, has reduced deer production in the Snake River canyon and adversely affected the capacity of the canyon to harbor deer from upland areas during severe winters. Riprap embankments and the roads and railroads present hazards for big game in gaining access to the waterline and are sterile insofar as their ability to produce vital riparian cover and food plants. The fish and wildlife agencies estimate that, due to project construction, big game populations will be drastically reduced and approximately 9,900 hunter-days for big game will be lost annually if compensation is not provided.

Upland Game. Upland game populations have been severely reduced as a result of the loss of native streamside vegetation, islands, and agricultural bottom lands. The fish and wildlife agencies estimate that this loss of essential riparian habitat has incurred a loss of about 120,800 small game birds and animals with a resultant reduction of 28,500 man-days of hunting annually without compensation.

1/ From BSFW-NMFS Report - Appendix A.

2/ From Washington Department of Game, 1974 Use figure. Appreciative use increasing at average rate of 4.14 man-days per year in proportion to hunting use in State of Washington.

Fur Animals. Beavers, muskrats, mink, raccoons, weasels, and river otters have suffered from the loss of streamside vegetation and the change from a free-flowing river to a reservoir situation. Skunks, bobcats, badgers, and coyotes have been adversely affected by loss of habitat and, also, by resultant reductions to upland game and nongame birds and animals which comprise their main food source. The fish and wildlife agencies estimate that the average annual fur animal harvest will be reduced by about 2,100 pelts annually and the population will be reduced by approximately 13,400 animals.

Migratory Game Birds. Doves have suffered from reduction of nesting and rearing areas and loss of agricultural bottom land food sources, but the effect has not been as severe as with other bird species. Waterfowl have been affected by the loss of 48 islands ranging in size from 5 to 150 acres and totalling nearly 1,500 acres in resting and nesting area. The loss of resting area from the flooding of these islands and 34 embayments, five or more acres in size, has been partially compensated by the formation of 92 embayments, five or more acres in size. Seven project-formed islands totalling 275 acres will not contribute significantly toward making up the loss of 48 potential goose nesting islands. Additionally, the loss of streamside forage and rearing areas on islands, bars, and agricultural bottom lands has significantly reduced goose production. Although little loss of waterfowl hunting will be realized due to the preponderance of winter migrants, the fish and wildlife agencies estimate that there will be an average loss of 1,000 man-days annually based on the loss of local goose production.

FISH AND WILDLIFE AGENCIES' RECOMMENDED COMPENSATION MEASURES FOR WILDLIFE LOSSES

To achieve compensation for Lower Snake River Project-caused losses of wildlife delineated in the preceding section of this report, the fish and wildlife agencies have recommended the following studies and measures in their report (Appendix A).

1. a. A three-year study designed to formulate a habitat development plan for big game, fur animals, and nongame wildlife on project lands. The study would be conducted cooperatively by Bureau of Sport Fisheries and Wildlife, Washington Department of Game, and Corps of Engineers. Estimated cost - $60,000.

b. Estimated project funds in the amount of $2,370,000 be made available to Washington Department of Game and Bureau of Sport Fisheries and Wildlife for development of wildlife habitat on project lands. Fund disbursement would be made on the basis of study findings outlined in the above recommendation. The annual operation, maintenance, and replacement of waterfowl habitat (OM&R) costs are estimated at $40,000 for the initial five-year period. Following this period, the OM&R costs would be assumed by the projects as a function of their normal operation and in conjunction with other park and recreational plantings.

2. a. A five-year study designed to formulate a waterfowl habitat development plan on projects' area. The study would be conducted cooperatively by Washington Department of Game and Washington State University in consultation with Bureau of Sport Fisheries and Wildlife and Corps of Engineers. Estimated cost - $100,000.

b. Estimated project funds in the amount of $201,250 be made available to Washington Department of Game and Bureau of Sport Fisheries and Wildlife for development, operation, maintenance, and replacement of waterfowl habitat on projects' lands and waters. These funds would be allocated on the basis of the study findings outlined in the above recommendation. Estimated annual operation, maintenance, and replacement costs would be $5,000.

3. a. A two-year study designed to upgrade habitat for upland game birds on lands in the vicinity of the projects. Suitable sites would be located and watering devices and water control structures would

be constructed and evaluated to determine their effectiveness in offsetting project-incurred losses. Washington Department of Game and Bureau of Sport Fisheries and Wildlife would jointly conduct the study. Estimated cost - $40,000.

b. Estimated project funds in the amount of $16,250 be made available for installation of about 65 watering facilities to be located on lands adjoining the projects as determined by the study outlined in the above recommendation. Annual OM&R would be project costs estimated at $500. Washington Department of Game would be responsible for OM&R through the transfer of project funds from Corps of Engineers.

c. Estimated project funds in the amount of $120,000 be made available for acquiring perpetual public access easements on 32,000 acres of rangeland surrounding the installed watering devices as determined by the above study recommendation pertaining to this item. Corps of Engineers in cooperation with Washington Department of Game and Bureau of Sport Fisheries and Wildlife would obtain the necessary easements.

4. An upland game management program be undertaken with project funds to offset project-incurred upland game losses. The program would include land acquisition of about 660 acres costing $328,500. About 14,250 acres of land surrounding the land parcels acquired in fee would be placed in perpetual easement status under landowner agreements at an estimated cost of $1,069,000. Habitat development costs for all management lands are estimated at $146,200 with annual operation, maintenance, and replacement amounting to about $5,350. Washington Department of Game would be responsible for initiating and managing this program with project funds.

5. A game bird farm be constructed (or suitable alternate provided) in the projects' vicinity and managed for stocking the wildlife management units proposed in the above recommendation. This facility would

have an estimated capital cost of $1,000,000 and annual operation, maintenance, and replacement costs estimated at $68,000. These costs designed to mitigate project-incurred losses are considered to be a project responsibility. Washington Department of Game would assume management responsibility.

6. Destruction of vegetation on project lands be held to a minimum. Plans for vegetation retention be cooperatively developed by Corps of Engineers, Washington Department of Game, Idaho Fish and Game Department, and Bureau of Sport Fisheries and Wildlife.

7. Corps of Engineers' placement of spoil and programs using herbicides and pesticides on project lands or waters be evaluated in cooperation with Environmental Protection Agency, Bureau of Sport Fisheries and Wildlife, National Marine Fisheries Service, Washington Departments of Fisheries and Game, and Idaho Fish and Game Department.

8. In accordance with the February 12, 1972, Joint Policy of the Departments of the Interior and the Army, relative to reservoir project lands and waters, all project lands and waters that are of value for fish and wildlife management as may be mutually determined by Corps of Engineers, Bureau of Sport Fisheries and Wildlife, and Washington Department of Game, should be made available to Washington Department of Game under terms of a general plan and subsequent cooperative agreement.

9. A zoning plan be developed to assure equitable use of the reservoir and adjacent lands for fishing and hunting as well as other recreational purposes. Such a plan should be developed by Corps of Engineers in cooperation with Bureau of Sport Fisheries and Wildlife, National Marine Fisheries Service, Bureau of Outdoor Recreation, Washington Department of Fisheries, Washington Department of Game, and Idaho Fish and Game Department.

10. Federal lands and project waters in the project areas be open to the public for hunting, fishing, and related recreation uses except for areas reserved for safety, efficient operation, or protection of public property, or those areas where closures may be found necessary by Washington Department of Fisheries, Washington Department of Game, National Marine Fisheries Service, and Bureau of Sport Fisheries and Wildlife to conserve and/or develop fish and wildlife resources.

11. Leases of Federal lands in the project areas assure the right of public use of such lands for hunting, fishing, and related activities.

12. Such reasonable modifications be made in the authorized projects' facilities and operations as may be agreed upon by Directors of the Bureau of Sport Fisheries and Wildlife, National Marine Fisheries Service, Washington Departments of Fisheries and Game, Idaho Fish and Game Department, and Chief of Engineers, for conservation, improvement, and development of fish and wildlife resources.

DISCUSSION

Shoreline vegetation, which provides vital food and cover for big game, upland game, waterfowl, fur bearers, and nongame wildlife, has been and will be removed or inundated nonselectively by the filling of the reservoirs behind the four lower Snake River dams. This riparian habitat existed as scattered, narrow strips along the river and in bushy canyons and draws interspersed with rocky outcroppings. The rest of the inundated lands consisted of rocky cliffs and rather steep hillsides covered mostly with sagebrush and dryland grasses. This unique combination of water, food, cover, forbs, and surrounding low elevation lands sustained a large variety and number of wildlife animals which provided considerable hunting recreation both in the project and the surrounding areas. This habitat provided an essential element at some particular stage of the life cycle of these animals.

Although all animals have specific requirements of space, food, and cover, different species may occupy the same area without competition because of different requirements. Wildlife will occupy all available space which provides these necessary requirements. Elimination of the habitat within the reservoir areas means that the animals which depended on this habitat will either be eliminated or crowded into adjacent lands. Since these adjacent lands will only support a given number of animals, and are probably already supporting the maximum number possible, the overall wildlife population will be reduced by nearly the total number of animals whose habitat was eliminated. To increase the carrying capacity of these adjacent lands, and retain total wildlife numbers at a pre-project level in the region, it is necessary to develop the habitat in other areas to accommodate a greater number and variety of animals than existed previously. Compensation of project-caused losses to wildlife requires that these displaced animals be replaced in numbers and kind or that these resources be replaced with an alternative satisfactory to the fish and wildlife agencies.

Prior to construction, the river shore supported about 1,123 acres of brush and tree-type vegetation backed by fertile bottom lands in many areas. Raising of the reservoirs has eliminated all of this riparian vegetation, except for some brushy draws, and replaced the fertile bottom lands with dry steep slopes, rocky cliffs, and riprapped embankments along much of the shoreline. Resident mule and white-tailed deer depended on the shoreline vegetation for food and cover throughout their life cycle. During hunting seasons and hard winters, migratory deer which summered in surrounding higher farmland areas also depended on this river-bottom land for food and cover during this critical time. Surveys conducted by the Washington Department of Game indicate that approximately 1,800 deer were dependent upon this shoreline habitat annually. Destruction of this habitat eliminates critical winter range and forces the animals to winter in higher, open lands which cannot support that many head under present condition. Consequently, these

animals will die or overuse the range, depleting it badly, thereby reducing its carrying capacity below what it was normally. This means that those deer dependent on the streamside vegetation for existence would be eliminated from the total population.

Upland game birds and small game animals have varied requirements for food, cover, and water, but the riparian vegetation strips fulfill vital needs for each of them in their life cycle. Because of their dependence on this area, it becomes a limiting factor in determining the numbers of the various species populating the surrounding area. In early spring the birds will be widely scattered for nesting and hatching of young because the spring growth of vegetation provides adequate food and cover for this purpose, and spring rains provide water holes and small streams over a wide area. The diet of newly hatched birds requires a high protein content which is furnished mainly by insects. As the vegetation in higher areas dries up and water supplies disappear in the summer, the birds move down to the shoreline to rear their young. As the birds mature, their diets convert to seeds and sprouting grasses in the fall. This diet change and hunting pressure scatters the birds throughout the surrounding areas. With winter weather, the birds congregate in the lower shoreline vegetation again for food, cover, and water. As with the big game animals, the total numbers of small game animals are reduced considerably with elimination of the essential shoreline habitat. Of the estimated 279,400 small game birds and animals present under pre-project conditions, some 120,800 will be lost because of the project.

Fur animals are entirely dependent on a close vegetation-water relationship. Beaver and muskrat are vegetarians which live in the water. Mink, otter, and raccoon are predatory animals which live on fish, crayfish, and other small animals. This food source is abundant in the

riparian habitat. With elimination of this vegetation, the sources of food and cover are removed and the animals are displaced. According to survey estimates, 33,100 fur animals inhabited the area prior to construction. Without compensation, about 13,400 of these animals will be lost.

With regard to migratory game birds, some waterfowl reside in the area but are mostly transient visitors in the late fall, winter, and early spring. There was some nesting by ducks along the river shoreline and the islands were used by Canada geese for nesting sites. The young of both utilized the early spring grasses on the flat shoreline areas for grazing until they were big enough to migrate. The reduction in duck nesting is probably not serious, but almost all of the goose nesting islands have been inundated. Also, the fertile bottom lands used as grazing areas by the young birds have been replaced by steep hillsides with raising of the reservoirs. The larger water areas of the reservoirs will probably attract more waterfowl to the area for resting than occurred on the open river, but goose production in the area, estimated at some 600 birds annually, has been drastically reduced because of the inundation of some 40 potential goose nesting islands and adjacent grazing areas in the Project area.

For project purposes, some 25,000 acres of land surrounding the reservoirs have been purchased from private owners and placed under Federal ownership. Within these Project lands, certain areas have been set aside for port and recreation sites, and much of the shoreline has been used for relocation of roads and railroads. There is still considerable acreage within these lands which can be developed for wildlife habitat. In order to develop this habitat to the maximum potential with

the least delay, the Walla Walla District retained independent consultant services to provide them with a comprehensive habitat development plan. This plan is being submitted as a design memorandum for approval, funding, and immediate implementation under existing authority. In the development of this habitat plan for Project lands all aspects were considered such as land formation, soil types, vegetation, and relationship to adjacent land uses. The development plan recommends certain areas be intensively managed by planting shrubs, trees, and other food and cover crops. Irrigation will be required to maintain the habitat and certain areas will require fencing to prevent damage by cattle.

According to data furnished by the Washington Department of Game, present wildlife populations on Project lands are approximately 56 percent of the pre-project level. Planned habitat development on these lands is expected to increase these populations to about 70 to 80 percent of pre-project numbers (Table 13). The cost of implementing this development plan is estimated at $2,600,000 for initial development and $120,000 annual operation and maintenance.

While the Project areas hold the potential for some compensation, full compensation for Project-caused losses cannot be provided on these lands. Also, the time required to develop these lands to their fullest potential can be as much as 10 to 15 years. The agencies have therefore recommended acquisition of certain off-project lands of high wildlife value and development potential. These lands, along with development of Project lands, are essential for the purpose of providing compensation. Since full compensation for all species of wildlife lost through Project construction cannot be provided, the Washington Department of Game plans to stock pheasants on both project and off-project lands for hunter use as a substitute for those certain species which cannot be fully compensated as well as for lost hunter opportunity on Project lands.

The numbers in the fish and wildlife agencies' report pertaining to wildlife population estimates, hunter-day use, harvest levels, and

TABLE 13

WILDLIFE POPULATION ESTIMATES - LOWER SNAKE RIVER PROJECT

	Upland Game	Chukar	Doves	Deer	Total
Pre-Project 1/	107,100	52,100	120,200	1,800	281,200
Post-Project 1/	40,300	12,500	105,800	600	159,200
Recoverable 2/	13,600	11,700	2,900	700	28,900
TOTAL (Post-Project and Recoverable) 3/	53,900	24,200	108,700	1,300	188,100

1/ Data supplied by Washington Department of Game.
2/ Estimated increase from wildlife habitat development on project lands.
3/ Estimated total wildlife populations after development of habitat on project lands.

land amounts have been developed on the basis of field survey information. Use and harvest estimates were developed from base data obtained by Washington Department of Game through aerial flight observations, car counts, checking station information, questionnaires, and personal interviews. Projections of use and harvest for Project life were related to anticipated population growth in the region and available information on trends in proportions of population groups that hunt or otherwise use the wildlife resource. Animal population estimates were made in part by direct survey and by calculation from harvest figures and sample age class analysis techniques.

Land amounts are in general related to the amount of key habitat actually lost, the extent of adjacent lands and their capability to carry the wildlife populations and the amount of space needed to accommodate levels of human use of the resources based on experience at existing public hunting areas. In this plan an effort will also be made, insofar as possible, to replace riparian type habitat with the same type of critical and vital habitat.

It is recognized that the enumeration of wildlife populations, human use, harvest levels, and land needs for this plan are based on limited information. In this context, the qualifications used in the fish and wildlife agencies' report appear to be reasonable to establish the general extent of wildlife losses and compensation requirements created by the Lower Snake River Project and to use as a basis for authorization and further detailed planning.

ALTERNATIVES TO THE PROPOSED ACTION

The compensation plan presented in this report contains features which are considered to hold the greatest potential for restoring fish and wildlife losses caused by construction of the four lower Snake River dams. The recommended actions contained in the fish and wildlife agencies' report were selected by the seven agencies involved: U.S. Fish and Wildlife Service, National Marine Fisheries Service, Washington Department of Fisheries, Washington Department of Game, Fish Commission of Oregon,

Oregon Game Commission, and Idaho Department of Fish and Game, from a number of alternative actions based on their experience with these alternatives under various field and research conditions. During the preparation of that report, 1966 to 1972, a thorough analysis of these various means was made. The final actions recommended in this report are the result of considerable coordination between the Walla Walla District Corps of Engineers and the fish and wildlife agencies, results of later research, reports from independent consultants who reviewed the data, and comments from the general public.

Representative alternative actions considered in formulation of the final recommendations are:

No Action - This does not meet the requirements of the Fish and Wildlife Coordination Act, and losses caused by project construction would still remain.

Removal of Dams - This is not feasible because of the money already spent for construction and the relinquishment of benefits derived from the projects.

More Intensive Development of Wildlife Habitat on Project Land - This would reduce the amount of off-project land required for compensation of wildlife losses. The amount of developable land remaining along the shoreline has been severely reduced after project construction because of extensive reaches of riprapped railroad and highway relocations, and vertical barren cliffs. Those areas which can be developed are not capable of replacing the amount and kind of habitat and wildlife numbers existing along the open river. Present plans for development of habitat on project lands, as developed by independent consultants, demonstrate the maximum improvements obtainable which are economically feasible.

PLAN OF DEVELOPMENT

GENERAL:

Raising of the Project reservoirs has eliminated almost all of the riparian vegetation along the river bottom except for some brushy draws, and replaced the fertile bottom lands with dry steep slopes, rocky

cliffs, and riprapped embankments along much of the shoreline. For Project purposes, some 25,000 acres of land surrounding the reservoirs have been purchased from private owners and placed under Federal ownership.

Within these Project lands, certain areas have been set aside for port and recreation sites and much of the shoreline has been used for relocation of roads and railroads. There is still some acreage within these lands which can be developed for wildlife habitat.

Through a comprehensive plan developed by an independent consultant, maximum compensation possible will be accomplished on these lands. Implementation of this development will be accomplished as rapidly as possible, pending approval by the wildlife agencies. Because of the length of time required for plant growth and the difficulty of supplying water to them, full development of good vegetative cover will require a period of 10 to 15 years. Certain areas can be more suitably developed for certain wildlife game species while nongame birds and animals will benefit from all development. While the Project areas hold the potential for some compensation, it is believed that only 70 to 80 percent of pre-project wildlife populations can be supported on Project lands.

To minimize the delay in providing compensation, the acquisition of certain off-project lands is proposed on which immediate development and compensation can be accomplished. These lands would serve the purpose of providing compensation during the interim period until development of Project lands occurred and will be retained after Project lands are developed.

Pheasant stocking on these off-project lands for hunter use will be provided as an immediate replacement for upland game birds and animals affected by the Project and for certain other game and nongame species which cannot be compensated for.

The wildlife review report prepared by an independent consultant, Appendix D, recommends that immediate development of Project lands should be the first step in providing wildlife compensation. Because of the fact that it will take some years for the Project land habitat development to be fully productive and the fact that it will never provide full compensation, the report also recommends that acquisition of additional off-project lands is necessary if adequate compensation is to be realized.

DEVELOPMENT OF PROJECT LANDS

An independent report on wildlife habitat development on Project lands has been completed and is under review by the state and Federal wildlife agencies and the Corps of Engineers. After completion of this review and acceptance of the recommended plan, this report will be forwarded to higher authority for implementation and funding as a normal Project budgetary function. Development of habitat on Project lands is an important factor in providing partial compensation for wildlife losses caused by the Project. Authority already exists to conduct this development since these lands are under Federal ownership. Therefore, other than this discussion on the development and its relationship to the overall Project compensation plan, it will not be included in this recommendation for separate Congressional approval and funding.

The first step in development of Project lands was a comprehensive study to determine those areas to be developed primarily for wildlife excluding port and industrial sites, and those which have other designated uses but would be compatible with wildlife, such as recreation areas which would have some benefit on a seasonal basis. Soil types, availability of water, either ground or irrigation, and types of vegetation most suitable for wildlife production in these areas were determined. Revegetation will serve to replace some of the riparian habitat which existed under pre-project conditions and served as wintering and brood-rearing areas for upland game birds and other wildlife. Some degree of compensation for lost hunting will also be provided in the Project area.

Included in this plan is development of waterfowl habitat for implementation within the Project area. This plan is aimed toward developing goose nesting sites for replacement of islands inundated by the reservoirs. A prime requirement for successful goose nesting is the proximity of the nest to a grazing area for the young birds. Sites have been selected at which floating islands could be located or artificial nesting platforms could be constructed.

Based on the recommendations of this plan, it is proposed to proceed with an aggressive habitat development program on Project lands and waters, using funds obtained through normal Project appropriations means.

Initially, some types of vegetation will require irrigation to become established. Plantings would be selected and located to provide food and cover. Such shrubs as serviceberry, chokecherry, and hawthorn, a variety of trees and various grasses and forbs would be provided. Work of a structural nature such as construction of small islands, subimpoundments in bays and inlets, fences, and artificial goose nests may also be required. Cost of development is estimated to be $2,600,000 for habitat development on Project lands for big game, upland game birds and animals, fur animals, and nongame wildlife, with annual operation and maintenance cost of $120,000. Actual development work and the operation and maintenance of on-project habitat compensation areas would be accomplished by the Corps of Engineers. The Washington Department of Game will be consulted on this development and will be requested to perform periodic evaluations beginning in the fifth year after development is begun to determine the effectiveness of habitat development. It is estimated that this evaluation would require five years and cost $50,000. These costs have been included in the above cost estimate.

DEVELOPMENT OF OFF-PROJECT LANDS

Completion of the four dams in the Project area has caused considerable loss of wildlife in the area because of habitat destruction. Because of the length of time, 10 to 15 years, necessary to establish

new vegetation on Project lands and since full compensation cannot be obtained on Project lands, it is necessary to immediately provide means of compensation to prevent further losses. To do this will require acquisition of nearby off-project lands which can be developed with immediate results. Upland game birds and animals have been most affected by loss of habitat and will derive the most benefit. Big game and other animals would also benefit from habitat development for upland game birds.

As the method to compensate for losses to upland game bird habitat which cannot be compensated for on Project lands, it is proposed that off-project land be acquired in areas that would accomplish necessary compensation, be available from willing sellers, be in the general Project vicinity, and provide as much riparian type habitat as possible.

The Washington Department of Game has estimated that even with habitat development on Project lands, it would require 500 acres of existing riparian habitat and 10,000 acres of farmland surrounding the habitat to replace the lost upland game birds and hunter opportunity. To be effective, this riparian habitat which would furnish food, cover, and nesting areas, should be acquired in several parcels and should be acquired in fee. The lands would be fenced to prevent overgrazing by cattle. Water access for cattle would be permitted, however, to reduce the impact of the acquisition on the landowners. The surrounding farmlands would also provide some food and cover and be a dispersal area for the birds. Easements would be required on these lands to assure hunter access in order that they could more fully utilize the extensive compensation efforts. To provide hunter access to these lands, parking areas could be provided periodically along a public road with corridors from the parking areas to the easement lands. All land acquisitions, both in fee and easements, will be from willing sellers only.

Plans are underway, however, to develop wildlife habitat on Project lands. Since this development will require a period of 10 to 15 years

to become established, the Washington Department of Game requests that some of these off-project lands be acquired immediately to replace the game birds and hunter opportunity as quickly as possible to compensate for these losses. The Washington Department of Game estimates that immediate acquisition of 400 acres of existing riparian habitat, to be acquired for access, would permit them to stock a sufficient number of birds to replace the lost hunter-day use. As habitat is developed on Project lands, the stocking intensity on these acquired lands would decrease proportionate to the Project land development. These lands would still be retained, however, and stocked with birds as a substitution for certain nongame species for which full compensation is not economically feasible or possible.

The Washington Department of Game should be the agency designated to select and acquire the lands with funds provided by the Corps of Engineers. The Department would acquire within an approximate 10-year period from initial appropriation of funds the necessary lands using the willing-seller concept. Assurances under Sections 210 and 305 of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646; 84 Stat. 1894) will be required of the Department prior to entering into an agreement for acquisition. Performance under the acquisition agreement will be monitored by the Corps of Engineers.

It is recommended that authority be granted to acquire approximately 400 acres in fee and 8,000 acres in easement as an immediate step in compensating for pheasants and pheasant hunter-day losses. It is also recommended that authority be granted to enter into agreement with the Washington Department of Game under which the Department would conduct the acquisition and development. Estimated costs are $2,100,000 which include estimated present-worth value of the land costs, administrative overhead, and initial development costs for fencing and parking areas. Land and initial development costs would be reimbursed to the Washington Department of Game. Operation and maintenance, and funding for that purpose, would be the responsibility of the Department.

In order to compensate for the effect of lost riparian habitat on chukar partridges, the wildlife agencies recommended that approximately 32,000 acres of land along the breaks of the Snake River adjacent to Project lands be acquired in easement for installation of watering devices and public hunting. These watering areas would extend the range and numbers of birds which the total area could accommodate.

Because of the extent of lands in the area already under Federal ownership, agreement was reached with the wildlife agencies that a portion of the 25,500 acres of Project lands suitable for chukar development could be credited against the 32,000 acres requested to reduce the amount of additional lands to be acquired and placed under partial Federal jurisdiction. This reduction would leave about 15,000 acres to be acquired in easement. These lands would be located in specific side draws which offer the best opportunity for development, in corridors extending from a public road to the Project lands. It may be desirable, also, to obtain additional lands adjacent to the mouth of selected draws which have high wildlife potential.

The Project lands are open to hunting except for designated safety areas and acquisition of easements on private land corridors would permit hunters to gain access to the Project lands at various locations. Parking areas would be provided at these various access points. It is proposed to acquire perpetual easements from willing sellers, during the hunting season only, on approximately 15,000 acres of off-project lands for assuring future public access for chukar partridge hunting at an estimated cost of $263,000. This acquisition of easements would be conducted by the Corps of Engineers, within a 10-year period following initial appropriation of funds, and development, operation, and maintenance would be the responsibility of the Corps as an integral part of development on Project lands.

To expand game-bird range on all off-project lands indicated above where lack of water is the limiting factor, and thus compensate

for Project-caused losses, it is proposed to install watering devices and develop springs and natural drainages at strategic sites for use by upland game (principally chukars). Preliminary investigations indicate the need for installation of about 50 cisterns and development of a few springs and natural drainages. Protective fencing around these cisterns would be required, each of which would require approximately 0.1 acre of land. Landowner agreement would be required for installation of such devices and for access to accomplish maintenance of them. Capital costs for cistern installation, waterway development, and fencing are estimated at $16,000. Estimated annual operation, maintenance, and replacement costs would be $1,000.

To provide the birds for stocking, the agencies recommend construction of a game bird farm or enlarging an existing Washington Department of Game facility. The present facilities operated by the State of Washington do not have this capability. Approximately 20,000 birds annually are required. The facility for production of game birds for these lands was estimated by the wildlife agencies to cost $1,000,000, with annual operation and maintenance costs of $68,000, and to require approximately 25 acres of land.

The concept of stocking pheasants on the compensation lands is concurred with in the consultant's report, Appendix D; however, alternate suggestions were made to: purchase these birds from an approved source for a period of years after habitat development was begun until a natural brood stock could be built up; or to construct a bird farm in conjunction with other outdated units operated by the Department which would be phased out after a period of years as a brood stock became established.

A minimum period of stocking pheasants appears to be 20 years after authorization of the compensation plan. This would encompass the 10 years for land acquisition, 5 years for development of habitat, and 5 years to establish a natural brood stock. At an estimated present cost of $5.00 per bird, the cost of stocking for the 20-year period would be $2,000,000. The Department does not favor introducing a strain which would not be compatible with the native birds.

It is recommended that authority be granted to the Corps of Engineers to enter into an agreement with the Washington State Department of Game whereby the present worth value of $2,000,000 which is $1,159,000 at present Federal interest rate of 5-7/8 percent would be made available to the Department and the Department would supply 20,000 birds per year to fulfill the compensation requirements either by constructing a new game bird farm or enlarging an existing facility, or by outright purchase of birds.

Full compensation is defined as the maintenance of habitat and production of game animals which will sustain the hunting pressure, appreciative use which would have occurred if the Project had not been constructed, and the maintenance of nongame animals at pre-project levels. This hunting pressure and appreciative use have been estimated at 121,200 man-days annually. It is intended that the substantial comprehensive development of project and non-project lands described in this plan will provide full compensation for habitat, animals and related hunting pressure reduced by the Project.

Because the various increments of the wildlife plan are interdependent in achieving full compensation, including development of Project lands, they are evaluated for justification as a single unit and also appear in the summary economic analysis in Table 15. The analysis is based on a 100-year project life.

Initial Cost, Lands and Development	$6,138,000
Annual Costs	
Interest and Amortization, 5-7/8 percent	$ 361,804
Operation and Maintenance	121,000
Total Federal Cost	$ 482,804

Annual Benefits

Big Game Hunting Value	
9,900 hunter-days at $9.00 per day	$ 89,100
Upland Game Hunting Value	
28,500 hunter-days at $9.00 per day	256,500
Waterfowl Hunting Value	
1,000 hunter-days at $9.00 per day	9,000
Appreciative Use	
43,500 user-days at $2.25 per day	97,895
Total Annual Benefits	$ 452,495
Benefit-Cost-Ratio	0.94:1

Tangible benefits, as evaluated above for the total compensation plan, will accrue from management of existing project lands and additional lands proposed in this report which are contiguous to the existing project lands. Wildlife production is interrelated and benefits will accrue proportionally to the investments in each component part of the total plan. Because of the intangible nature of the wildlife resource not subject to monetary evaluation, the benefit-to-cost ratio does not measure adequately the total value of the resource. Wildlife compensation plans are considered well justified based on both tangible and intangible benefits. All costs and benefits are based on 1974 prices.

The user-day values used in computing the foregoing benefit-cost ratio are based on the Water Resource Council's "Establishment of Principles and Standards for Planning", dated September 1973.

A summary of the estimated costs of proposed wildlife plan is included in Table 14.

Public meetings and subsequent input to the meeting records indicate both support and opposition. Environmental groups generally support the plan; some, in fact, saying the proposed plan is too conservative. Others, including farmers and landowners, are staunchly opposed to the off-project land acquisitions.

ALLOCATION OF COSTS

As proposed on page 52, because of similarity of the four Snake River projects and because they were authorized as a single project, it is appropriate to allocate the wildlife costs equally among the four projects and assign these costs to the existing project. Since wildlife losses are primarily created through inundation of lands, the costs would apply to both navigation and power. These costs would, therefore, be considered as joint-use costs, and distribution between navigation and power would be in accordance with the approved cost allocations.

The cost allocation for Ice Harbor project is final and has been approved by the Federal Power Commission. Cost allocations for the other projects are tentative and are subject to revision before final approval. The distribution of costs using these allocations is shown on the following page.

Estimated total first cost to the United States for implementation of the foregoing fish and wildlife compensation plan is approximately $45,788,000. The total Federal cost for annual operation, maintenance, and replacement is estimated at approximately $2,951,000. Federal funding for acquisition and initial development of habitat and fisherman and hunter access lands by the State would be subject to their agreement to fund any additional development and annual operation and maintenance costs. These costs should be applied against the original project. Capital costs should be amortized at the interest rate applicable to the original project. Based on present tentative cost allocations, $1,507,000 of capital costs and $32,000 of annual operation and maintenance costs would be allocated to navigation and $44,281,000 of capital costs and $2,919,000 of annual operation and maintenance costs to power. Power costs will be reimbursed from power revenues. This allocation is subject to change when final allocations are approved on Lower Monumental, Little Goose, and Lower Granite.

LOWER SNAKE RIVER WILDLIFE COMPENSATION
ALLOCATION OF COSTS

	Project Construction Cost ($1,000)	Annual Operation & Maint. ($1,000)
Ice Harbor Dam		
Joint Use - Navigation	189	0
Power	696	0
Subtotal	885	0
Lower Monumental Dam		
Joint Use - Navigation	128	0
Power	756	0
Subtotal	884	0
Little Goose Dam		
Joint Use - Navigation	230	0
Power	655	0
Subtotal	885	0
Lower Granite Dam		
Joint Use - Navigation	27	0
Power	857	1
Subtotal	884	1
GRAND TOTAL	3,538	1

TABLE 14

SUMMARY OF ITEMS AND COSTS OF WILDLIFE COMPENSATION FACILITIES

LOWER SNAKE RIVER PROJECT

Item	Initial Cost	Annual O&M
Off-Project Lands		
Riparian and Farm Lands		$5,000 1/
Fee, 400 Acres	$ 225,000	
Easement, 8,000 Acres	1,700,000	
Initial Development	175,000	
Range Land Canyons		
Easement	263,000	
Development	16,000	$1,000
Game Bird Replacement	1,159,000	
Total Federal Cost	$3,538,000	$1,000

1/ Operation and maintenance of these lands and budgeting of necessary funds will be a State responsibility.

TABLE 15

SUMMARY ECONOMIC ANALYSIS
LOWER SNAKE RIVER FISH AND WILDLIFE COMPENSATION PLAN

	Initial Cost	Annual Cost	Annual Benefits	B/C Ratio 1/
Fishery				
Fall Chinook Facilities	$ 6,200,000	$ 815,459	$ 1,748,160	2.14:1
Spring-Summer Chinook Facilities	11,500,000	1,577,867	5,601,060	3.55:1
Steelhead Facilities and Sport Fishery Access Lands	21,550,000	2,780,265	3,476,600	1.25:1
Resident Sport Fish Facilities	3,000,000	265,800	607,500	2.29:1
Total Fishery	$42,250,000	$ 5,439,391	$11,433,320	2.11:1
Wildlife				
On-Project Features	$ 2,600,000	$ 273,257	$ 256,112	0.94:1
Off-Project Features	3,538,000	209,547	196,383	0.94:1
Total Wildlife	$ 6,138,000	$ 482,804	$ 452,495	0.94:1
TOTAL FISH AND WILDLIFE	$48,388,000	$ 5,922,195	$11,885,815	2.01:1
TOTAL AUTHORIZATION REQUEST 2/	$45,788,000	$ 5,638,938	$11,629,703	2.06:1

1/ These economic analyses are not normal project benefit-cost studies. The compensation actions recommended herein are required to replace project-caused losses and return the resource to a level which existed prior to project construction and therefore are not benefits to the total project. The benefit-cost ratios discussed here only evaluate the efficiency of moneys recommended for these compensation actions in relation to the value of the resource which is to be replaced.

2/ This report seeks authority for the off-project portion of the plan.

TABLE 16

SUMMARY OF FACILITIES AND COSTS OF WILDLIFE COMPENSATION FACILITIES

LOWER SNAKE RIVER PROJECT

Facility	Land Requirements	Initial Cost[1/]	Cost Annual O&M
Fish			
Fall Chinook Hatchery	40 Acres	$ 6,200,000	$ 450,000
Spring and Summer Chinook Hatchery	80 Acres	11,500,000	900,000
Steelhead Trout Hatchery	80 Acres	20,500,000	1,500,000
Rainbow Trout Hatchery	10 Acres	3,000,000	100,000
Fisherman Access Lands & Development	750 Acres	1,050,000	
Total		$42,250,000	$2,950,000
Wildlife			
Acquisition and Development of Off-Project Lands	23,400 Acres[2/]	$ 2,379,000	$ 1,000
Game Bird Replacement		1,159,000	
Total		$ 3,538,000	$ 1,000
TOTAL COST		$45,788,000	$2,951,000

1/ Includes initial development of lands.

2/ Includes 23,000 acres in easement and 400 acres in fee.

STATEMENT OF FINDINGS

SPECIAL REPORT

LOWER SNAKE RIVER FISH AND WILDLIFE COMPENSATION PLAN
LOWER SNAKE RIVER, WASHINGTON AND IDAHO

1. PROJECT DESCRIPTION:

The Lower Snake River Project consists of four dams: Ice Harbor, Lower Monumental, Little Goose, and Lower Granite. These dams were authorized in Public Law 14, 79th Congress, 1st Session, approved 2 March 1945, to provide hydroelectric power, irrigation, and slackwater navigation from the Columbia River to the Lewiston, Idaho-Clarkston, Washington, area.

Initial plans for each dam provided for three power-generating units, a navigation lock, and fish passage facilities for upstream migrating salmonid fish. Space was also provided in the powerhouse for three additional power units to be added at a later date. Provisions were later made for bypass systems to allow downstream migrating juvenile salmonids to escape from the gatewells and permit deflection of fish from the penstocks. The three additional generating units are now being completed at Ice Harbor Dam and are scheduled for installation and completion at the other three dams by 1979.

2. PURPOSE OF THE REPORT:

Provisions for compensation of fish and wildlife losses caused by construction of the Project were not included in the original Project authorization. It has become increasingly obvious since completion of Ice Harbor Dam in 1962 that losses to these resources have occurred, and are continuing to occur, and have increased with the completion of each succeeding dam. It is the purpose of the report to evaluate those

losses and to recommend the most feasible means for providing compensation. The data contained in the report are based on information provided by the U.S. Fish and Wildlife Service; National Marine Fisheries Service; the fish and wildlife agencies of the States of Washington, Oregon, and Idaho; independent analyses of the agencies' data by two independent consultants retained by the Walla Walla District; and four public meetings. The Fish and Wildlife Coordination Act, PL 85-624, 85th Congress, enacted 12 August 1958, is the basic authority under which the report is submitted.

3. RECOMMENDED COMPENSATION MEASURES:

In order to compensate for fish and wildlife losses caused by construction of the Lower Snake River Project, it is recommended that:

a. Hatchery and associated facilities be constructed to maintain returning adult runs of 18,300 fall Chinook salmon, 58,700 spring and summer Chinook salmon, and 55,100 steelhead trout.

b. Provisions be made for replacement of 67,500 angler-days of lost resident fishery use.

c. Lands be acquired off Project in fee or easement for hunter and fisherman access for project-caused losses to chukar partridges, and for stocking of pheasants to compensate for lost hunter-day use.

d. Provisions be made for production of pheasants to stock Project and acquired lands to replace wildlife losses.

4. FINDINGS:

In view of the extensive and continuing losses to the anadromous fish runs of the Snake River drainage, to wildlife habitat and population

numbers, it appears that the recommended measures contained in the Special Report, Lower Snake River Fish and Wildlife Compensation Plan, Lower Snake River, Washington and Idaho, are the most practical and reasonable means at present of compensating for losses to those resources caused by construction of the Project.

Since completion of the Project was deemed to be in the best interest of the total public, I find that compensation for losses to the fish and wildlife resources of the area is a necessary part of the Project responsibility.

CONCLUSION

From the data presented in this report and supported by the reports of the State and Federal fish and wildlife agencies, attached as Appendixes A and B, and by reports furnished by independent consultants attached as Appendixes C and D, it has been concluded that serious losses have occurred to the fish and wildlife resources of the area through construction of the four lower Snake River dams. It is further concluded that these losses can be compensated for by implementation of the plan as outlined in this report. A summary of the recommended features with associated costs is shown in Table 16 and described in the following paragraphs:

1. Compensation of Fishery Losses:

a. Hatchery and associated trapping and holding facilities to rear the progeny of 2,290 adult female fall Chinook salmon, produce 101,800 pounds of smolts, and to be capable of returning 18,300 adults to the project area. These facilities would require approximately 40 acres of land to be acquired in fee. The estimated initial construction cost is $6,200,000 with annual operation and maintenance costs of $450,000.

b. Hatchery and associated trapping and holding facilities to rear the progeny of 2,145 adult female spring and summer Chinook salmon, produce 450,000 pounds of smolts, and to be capable of returning 58,700 adults above the project. These facilities would require approximately 80 acres of land to be acquired in fee and have an estimated initial construction cost of $11,500,000 and annual operation and maintenance costs of $900,000.

c. Hatchery and associated trapping and holding facilities to rear the progeny of 3,390 adult female steelhead trout, produce 1,377,500 pounds of smolts, and to be capable of returning 55,100 adults above the

project. These facilities would require approximately 80 acres of land to be acquired in fee. Estimated initial construction costs are $20,500,000 with annual operation and maintenance costs of $1,500,000.

d. Design and construction of these hatcheries would be funded through future appropriations to the Corps of Engineers. Operation and maintenance would be funded through future appropriations to the U.S. Fish and Wildlife Service or National Marine Fisheries Service. Prior to the actual design of the facilities, the level of hatchery compensation will be reviewed and possibly adjusted depending on the success of bypass, truck and haul, Dworshak hatchery returns, and any adverse effects of expanded powerhouses and increased peaking operations.

e. Hatchery facilities capable of producing 93,000 pounds of trout annually for stocking local streams to replace the lost sport-fishing opportunity or other alternatives of equal or lesser cost. The estimated construction cost of these hatchery facilities is $3 million, and annual operation and maintenance cost is $100,000. These facilities would require approximately 10 acres of land to be acquired in fee. The determination of the actual method of replacing the lost fishing opportunity will be determined by the Corps of Engineers in cooperation with the Washington Department of Game. Construction of the hatchery or other alternate measures will be funded through future appropriations to the Corps of Engineers. Operation and maintenance of the constructed facilities would be funded through future appropriations to the U.S. Fish and Wildlife Service.

f. The Corps of Engineers would, if appropriate, transfer title of the above hatchery and fish cultural facilities to the appropriate Federal or State fishery agency in a manner consistent with desires of the Administration and Congress under authority of the Fish and Wildlife Act of 1956 (16 USC 742) or by mutual agreement with the appropriate agency.

g. Acquisition of 750 acres of land along the Snake River and tributaries of streams adjacent to the lower or middle Snake River in easement or fee to partially replace loss of stream-type steelhead

and salmon sport fishery in the 150 river miles of the project area. Acquisition and development would be accomplished under an agreement between the Corps of Engineers and the States of Washington and Idaho with ownership vested in the States. The States would acquire the land on a willing-seller concept and accomplish the initial development with costs to be reimbursed by the Corps of Engineers. Based on the percent of project lands affected in each State, the acquisition would be allocated as 700 acres to the State of Washington and 50 acres to the State of Idaho. Assuming funding is available, acquisition of these lands would be accomplished within a period of 10 years following initial appropriation of funds, or the authorization in total or part would be canceled. Estimated cost of acquisition is $750,000 with initial development cost of $300,000. Funding of land acquisition and development would be by future appropriation to the Corps of Engineers. Future development, if any, and operation and maintenance of these lands would be the responsibility of the State in which they are located.

2. Compensation of Wildlife Losses:

a. Acquisition of approximately 400 acres of riparian habitat in fee and 8,000 acres of farmland in easement surrounding these riparian lands to provide partial compensation for project-caused pheasant and quail hunting losses and additional hunting opportunity as a substitute compensation for nongame species. Acquisition of the land would be by agreement between Corps of Engineers and the Washington State Department of Game whereby the Game Department would undertake the actual acquisition on a willing-seller concept within a 10-year period after initial appropriation of funds. Under this agreement, title to the fee lands would be vested with the State for such period of time that the land is used for fish and wildlife management purposes. At the end of such time title to any portion not being used for this purpose would be conveyed to the United States Government without additional compensation. The Corps will require that selection of hunter easements and wildlife habitat "core" areas be accomplished in a manner to provide viable wildlife management units, that all involved landowners in a given management unit are in agreement (willing sellers), that each management unit plan be concurred in by the involved County Planning Commission, and that the payment considerations be fair and reasonable. Costs for acquisition and initial

development of these lands by the State would be reimbursed by the Corps of Engineers. Ownership of estates in the lands would be vested in the State. The initial cost of these lands is estimated at $2,100,000 for acquisition, administrative overhead, and initial development. Annual operation and maintenance costs would be a State responsibility.

b. Acquisition of approximately 15,000 acres of land in easement to provide hunter access as partial compensation for project-caused losses to chukar-partridges. Acquire approximately 50 small select parcels of land (0.1 acre each) in easement or fee and construct bird-watering devices on these lands. The land would be located in the draws along the sides of the Snake River Canyon adjacent to the project area and would provide access to project lands from surrounding private lands. Access to these lands would be acquired by the Corps of Engineers on a willing-seller concept and would be managed by the Corps of Engineers in conjunction with adjacent project lands. Land access acquired by easement would be limited to the hunting seasons and would not be fenced so that normal rangeland activities could be continued by the owners. Lands around the bird-watering devices would be fenced. Acquisition of these lands and construction of watering devices are estimated to cost $279,000 and the annual operation and maintenance cost $1,000. Assuming funding is available, acquisition of these lands would be accomplished within a period of 10 years following initial appropriation of funds.

c. The Corps of Engineers would enter into an agreement with the Washington Department of Game to provide game birds to stock project and acquired off-project lands for compensation of lost hunter-day use and animals caused by the project construction. The necessary stocking effort to fulfill compensation is estimated to be 20,000 birds per year for a 20-year period by which time habitat and a natural brood stock should be established. The agreement would provide for a lump-sum payment of $1,159,000, estimated capitalized value of the 20-year stocking period, to the Washington Department of Game to provide the birds either by outright purchase, remodeling an existing bird farm, or constructing a new facility.

3. Estimated total first cost to the United States for implementation of the foregoing fish and wildlife compensation plan is approximately $45,788,000. The total Federal cost for annual operation, maintenance, and replacement is estimated at approximately $2,951,000. Federal funding for acquisition and initial development of habitat and fisherman and hunter access lands by the State would be subject to their agreement to fund any additional development and annual operation and maintenance costs.

RECOMMENDATIONS

I recommend that additional measures be authorized for development to compensate for fish and wildlife losses incurred at existing projects on the lower Snake River generally as described in this special report, with such modifications as, at the discretion of the Chief of Engineers, may be advisable, at an estimated first cost to the United States of $45,788,000 for construction and $2,951,000 annually for operation and maintenance and replacement.

NELSON P. CONOVER
Colonel, CE
District Engineer

NPDPL-ER (30 May 75) 1st Ind
SUBJECT: Special Report - Lower Snake River Fish and Wildlife Compensation Plan, Lower Snake River, Washington and Idaho

DA, North Pacific Division, Corps of Engineers, 210 Custom House, Portland, Oregon 97209 10 October 1975

TO: Chief of Engineers

I concur in the conclusions and recommendations of the District Engineer.

WESLEY E. PEEL
Major General, USA
Division Engineer

APPENDIXES

A. A Special Report on the Lower Snake River Dams, Ice Harbor, Lower Monumental, Little Goose, Lower Granite, Washington and Idaho; National Marine Fisheries Service, Bureau of Sport Fisheries and Wildlife, September 1972.

B. Appendix to Special Report on the Lower Snake River Dams, Ice Harbor, Lower Monumental, Little Goose, Lower Granite; Fish Commission of Oregon, March 1973.

C. Special Report to the U.S. Army Corps of Engineers on Two Reports Concerning Proposed Compensation for Losses of Fish Caused by Ice Harbor, Lower Monumental, Little Goose, and Lower Granite Locks and Dams Projects, Washington and Idaho; Ernest O. Salo, 26 June 1974.

D. Report on the Lower Snake Wildlife Mitigation Proposals; W. L. Pengelly, et al., 1 June 1974.

UNITED STATES DEPARTMENT OF COMMERCE
NATIONAL MARINE FISHERIES SERVICE

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE

A SPECIAL REPORT
ON THE

LOWER SNAKE RIVER DAMS

ICE HARBOR
LOWER MONUMENTAL
LITTLE GOOSE
LOWER GRANITE

WASHINGTON AND IDAHO

PORTLAND, OREGON
SEPTEMBER 1972

APPENDIX A

UNITED STATES DEPARTMENT OF COMMERCE
NATIONAL MARINE FISHERIES SERVICE

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE

A SPECIAL REPORT

ON THE

LOWER SNAKE RIVER DAMS

ICE HARBOR

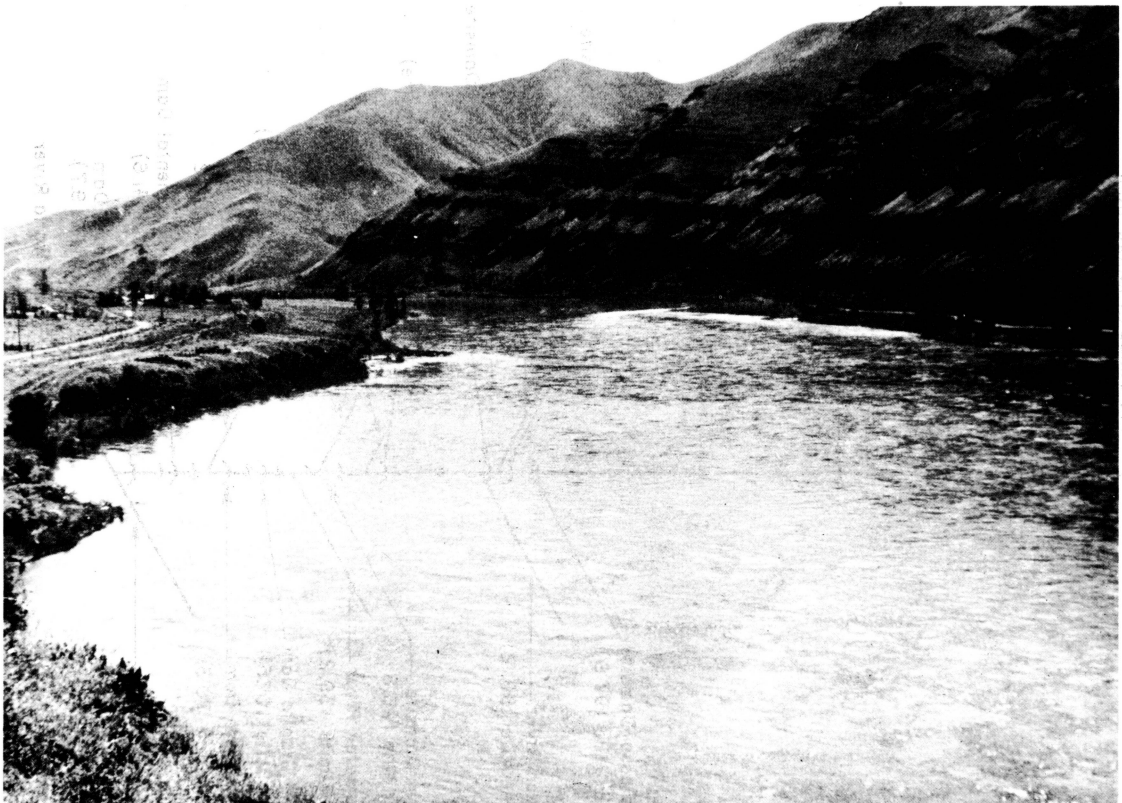
LOWER MONUMENTAL

LITTLE GOOSE

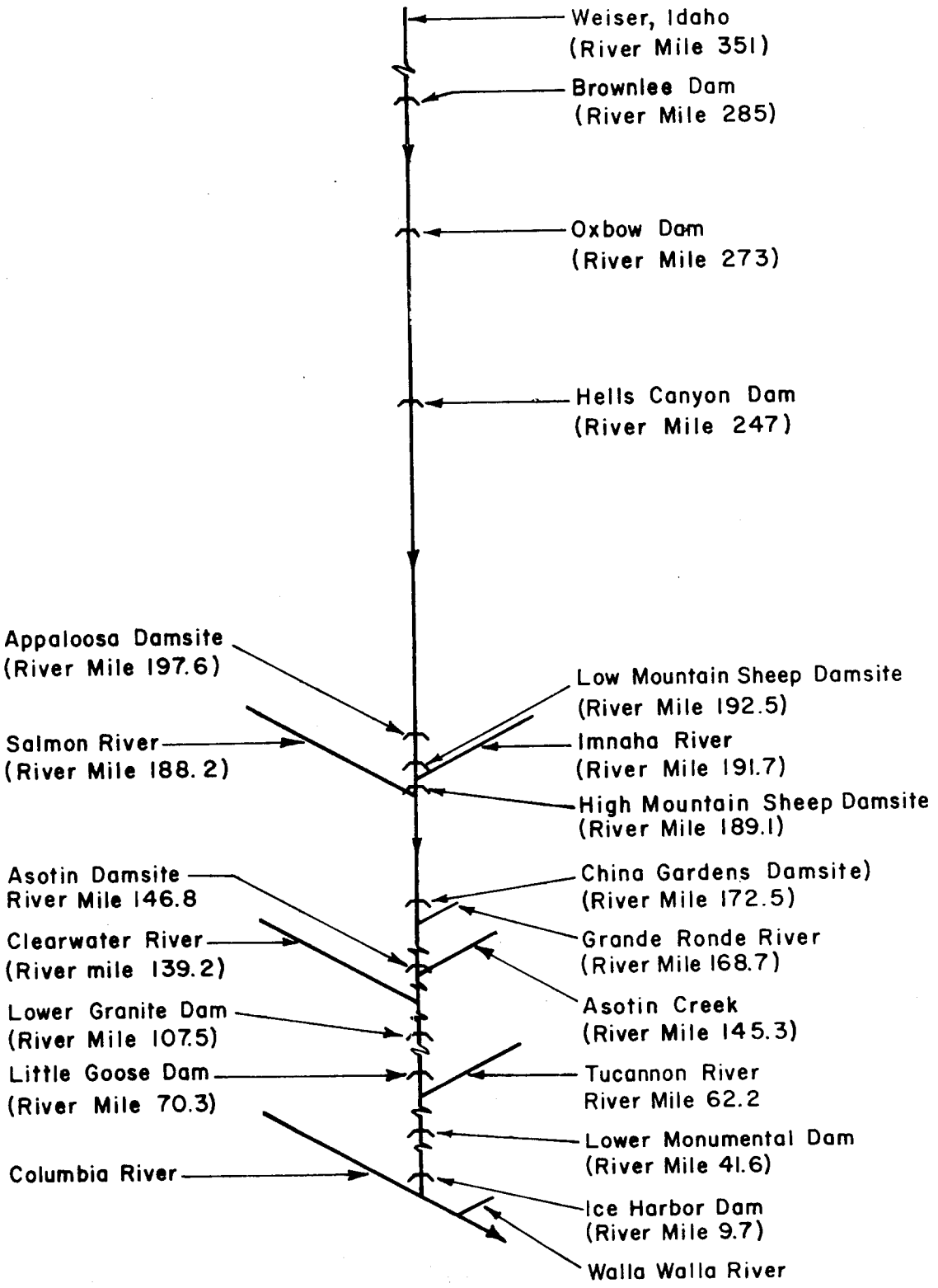
LOWER GRANITE

WASHINGTON AND IDAHO

SEPTEMBER 1972



The last remaining freeflowing reach of lower Snake River provides essential fish and wildlife habitat. (Bureau of Sport Fisheries and Wildlife photo)



SNAKE RIVER FROM MOUTH TO WEISER, IDAHO

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE

1500 N. E. IRVING STREET
P. O. BOX 3737
PORTLAND, OREGON 97208

September 30, 1972

District Engineer
Walla Walla District, Corps of Engineers
Building 602, City-County Airport
Walla Walla, Washington 99362

Dear Sir:

This is a special report of the Bureau of Sport Fisheries and Wildlife and National Marine Fisheries Service on effects of Ice Harbor, Lower Monumental, Little Goose, and Lower Granite Lock and Dam projects, Snake River, Washington and Idaho, on fish and wildlife and means to reduce project-incurred losses.

This report was prepared in response to Colonel Frank McElwee's April 11, 1966, letter to former Regional Director, Paul T. Quick, Bureau of Sport Fisheries and Wildlife. It augments substantially our previous reports on Ice Harbor, Lower Monumental, and Little Goose projects, and eliminates the need to release a separate Lower Granite project report.

We recognize that your agency continues to disagree with some elements of our fish and wildlife conservation plans as presented in this report. However, these evaluations and recommendations have been generally accepted by concerned conservation agencies as providing the basis for a sound fish and wildlife management plan. Your desire to achieve full compensation for fish and wildlife losses caused by projects under your jurisdiction is commendable. In line with your position, we believe that all reasonable alternatives to our plan should be given full consideration in our joint efforts to obtain adequate compensation for project-incurred fish and wildlife losses.

We would appreciate notification of any material changes in project plans so that if necessary, we may prepare a revised report to provide additional comments.

Please notify us of your proposed actions regarding each recommendation.

Sincerely yours,

JOHN L. FINDLAY
Regional Director
Bureau of Sport Fisheries and Wildlife

Regional Director
National Marine Fisheries Service

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PREFACE

Ice Harbor, Lower Monumental, Little Goose, and Lower Granite Lock and Dam projects, Snake River, Washington and Idaho, were authorized by Public Law 14, 79th Congress, 1st Session, approved March 2, 1945. This report has been prepared under the authority of and in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended, 16 U.S.C. 661 et seq.) and is based upon information and engineering data provided by the Corps of Engineers, Walla Walla District, through March 1972. Washington Department of Fisheries, Washington Department of Game, Idaho Fish and Game Department, Fish Commission of Oregon, and Oregon State Game Commission supplied data useful in the preparation of this report. National Marine Fisheries Service prepared the fishery section. The monetary values assigned to recreational type fish and wildlife benefits are based upon criteria in Supplement No. 1 to Senate Document No. 97.

INTRODUCTION

These four projects are well suited for combined analysis because of their juxtaposition, construction status, and the interrelationship of fish and wildlife resources throughout the lower Snake River system.

Our analysis is based upon a 100-year project life for the years 1962, when the Ice Harbor project was completed, through 2061. Further resource studies, engineering changes, and consideration of presently unknown factors concerning project impact on fish and wildlife resources may require changes in recommended mitigative measures.

This report has been reviewed and concurred in by Idaho Fish and Game Department, Fish Commission of Oregon, Oregon State Game Commission, Washington Department of Fisheries, and Washington Department of Game, as indicated by the appended copies of letters from the respective Directors of these agencies.

Director Crouse of Washington Department of Game indicates concurrence with the report, but provided additional comments on certain elements. We agree that provisions should have been made for more adequate studies of project-affected fish and wildlife resources. However, this report is based on the best information available under imposed manpower and time limitations. The report was revised to reflect as many of Director Crouse's editorial suggestions as possible.

Previous U. S. Fish and Wildlife Service reports on these projects include: (1) A Detailed Report on the Fish and Wildlife Resources, Ice Harbor Lock and Dam Project, Snake River, Washington, May 1, 1959; (2) A Detailed Report on Fish and Wildlife Resources Affected by Lower Monumental Lock and Dam Project, Snake River, Washington, September 1960; and (3) A Detailed Report on Fish and Wildlife Resources Affected by Little Goose Lock and Dam Project, Snake River, Washington, May 7, 1963. This four-project report augments substantially these previous reports and eliminates the need to release a separate Lower Granite project report. In the earlier reports, proposed measures to reduce project-caused fish and wildlife losses were restricted to the immediate project vicinity. Fishery measures recommended included fish passage at each dam and artificial propagation facilities for salmon and steelhead trout. Recommended wildlife measures included management of small land and water areas located along each reservoir. Implementation of recommended fish and wildlife measures was limited to fish passage at the dams.

Initial proposals for offsetting some project-incurred fish and wildlife losses were based on very limited engineering and biological data. Subsequently, more intensive surveys of project-related fish and wildlife revealed much higher losses than originally estimated. Our analysis of more recent biological information derived from limited project studies and other sources necessitates major changes in and additional to various earlier recommendations to significantly offset such losses.

This report emphasizes the importance of offsetting losses of critical fish and wildlife resources and habitat related to the inundated river. The needs of fish and wildlife affected by the four projects have been reconsidered with limited fish and wildlife facilities in place, and additional measures designed to reduce project-related losses have been recommended. Although three of the four lock and dam projects are completed, and early completion of the fourth is anticipated, our analyses of the projects' effects are treated on a "without" and "with" the project basis for ease in evaluation.

DESCRIPTION OF THE AREA

Physical Features

Snake River drains an area of 109,000 square miles, including portions of Idaho, northwestern Wyoming, northern Utah and Nevada, southeastern Washington, and eastern Oregon.

Snake River flows through a canyon that varies in depth from about 5,500 feet in upstream Hells Canyon (and in the projects' area, from 2,000 feet near Lewiston, Idaho), to about 100 feet near its confluence with the Columbia River. There are many islands and gravel bars within the river channel. The canyon is bounded by terraced bluffs throughout the projects' area. Upland soils are of loessal origin. Alluvial bottomland soils in this area vary from sandy to silty loams which are frequently interspersed with basalt rock outcroppings. These soils support productive riparian vegetation. Winters are moderately cold with much milder conditions along the river than on adjoining Palouse uplands. Summers are hot and dry. The mean annual precipitation varies from 10 to 15 inches, mostly occurring during winter and spring. Snake River runoff is characterized by low flows from August through February and high flows from March through July.

Commercial Features

The four projects are located within a sparsely populated area. Water is pumped from the river to irrigate some fertile bottomlands. Cattle and sheep graze most of the adjoining slopes. The region's economy is largely dependent on dryland grain farming and livestock production.

Union Pacific, Burlington Northern, and Camas Prairie railroad lines extend along much of the projects' affected reaches. Access to the lower Snake River canyon is mostly by county and private roads extending along most reaches of the river. Major highway crossings occur at several points. Limited barge navigation presently occurs on Ice Harbor, Lower Monumental, and Little Goose Reservoirs. When Lower Granite Reservoir is impounded, however, barge traffic to the Lewiston-Clarkston area is expected to be substantial. Washington Water Power Company operates Lewiston Dam on the Clearwater River near its Snake River confluence. A series of Federal and privately owned dam, located mostly on Snake River upstream from Hells Canyon, are operated primarily for irrigation and power production.

Major sources of water pollution affecting the lower Snake River are upstream logging, livestock feedlots, agricultural crops, industrial and domestic sewage, and nitrogen supersaturation. A pulp mill at Lewiston, Idaho, is also a source of heavy air and water pollution.

The major fish and wildlife developments in the vicinity of lower Snake River are the McNary Wildlife Recreation Area operated by Washington Department of Game and the adjoining McNary National Wildlife Refuge administered by Bureau of Sport Fisheries and Wildlife. Both of these wildlife management areas are located adjacent to McNary Reservoir on Columbia River near its Snake River confluence. Other nearby wildlife management areas operated by Washington Department of Game include Asotin Wildlife Recreation Area near Clarkston, and William T. Wooten Wildlife Recreation Area on upper Tucannon River. The latter includes Tucannon Trout Hatchery and rearing and fishing ponds.

DESCRIPTION OF THE PROJECTS

Ice Harbor, Lower Monumental, Little Goose, and Lower Granite Lock and Dam projects were authorized to provide slackwater navigation, irrigation, and hydroelectric power generation. Lower Granite project is also expected to provide flood protection for the Lewiston-Clarkston area. Ice Harbor, Lower Monumental, and Little Goose Lock and Dam projects were basically completed in 1962, 1969, and 1970, respectively. The upstream Lower Granite project is scheduled for completion in 1975.

The completed projects are similar in design and operation. Developments include concrete dams with powerplants, navigation locks, recreation areas, and fish passage facilities. They involve railroad relocation or reconstruction and bridge modification. Levees with pumping plants will be constructed in the Lewiston-Clarkston area.

Pool elevations of the projects will vary according to seasonal runoff, power operations, and navigational requirements. Pool levels will fluctuate up to several feet daily for power peaking purposes. Tailwater fluctuations for power peaking operations may range up to five feet in the case of the Ice Harbor project (table 1), but may range up to 35 feet under flood flows depending on timing and volume of reservoir releases.

Table 1. Pertinent Engineering and Operation Data, Lower Snake River Projects

Project	Elevation (feet) m.s.l.	Capacity (acre-feet)	Surface Area (acres)	Stream Inundated (river miles)
Ice Harbor				
Normal pool	440	417,000	9,200	35.0
Tailwater	337 - 342*			
Lower Monumental				
Normal pool	540	377,000	6,590	29.0
Tailwater	437 - 441*			
Little Goose				
Normal pool	638	565,000	10,025	37.2
Tailwater	537 - 541*			
Lower Granite				
Normal pool	738	485,000	8,900	39.0
Tailwater	633 - 639*			
Totals		1,844,000	34,715	140.2

* Tailwater range for nonflood period.

FISH RESOURCES

General

The Snake River Basin is one of the most important fish producing systems in the United States. It supports large populations of anadromous and resident fish. Anadromous fish from the Snake River, particularly chinook salmon, contribute substantially to commercial and sport fisheries in the Pacific Ocean from California to Alaska. Steelhead trout support a huge sport fishery throughout the lower Columbia and Snake River and its tributaries. Most of the adult chinook salmon and steelhead trout that migrate upstream in Columbia River past McNary Dam enter Snake River. The sport fishery for anadromous, as well as resident species has developed substantially in the lower Snake River within the past decade.

Water development projects throughout the Snake River system have greatly reduced anadromous fish numbers. A portion of the runs of spring chinook and steelhead reaching Hells Canyon Dam on the Snake has been relocated to the Salmon River system. Vast areas of once important spawning and rearing habitat for anadromous fish have been inundated by large reservoirs, or made inaccessible by dams and, therefore, are unavailable for production.

Prior U. S. Fish and Wildlife Service reports on Ice Harbor, Lower Monumental, and Little Goose projects recommended measures to minimize fishery losses on an individual project basis; such measures were largely limited to upstream fish passage facilities at the dams, spawning channel development, and artificial propagation of anadromous species. Fish passage facilities have been the only features provided. According to the Corps of Engineers, these facilities were constructed at a cost of $38,844,000. Research is being conducted to develop measures to provide improved conditions for juvenile fish migration at the four lower Snake River dams. The initial measures for minimizing losses to anadromous and resident fisheries were based on insufficient information and were not adequate to maintain these fisheries. Therefore, to maintain the runs of anadromous fish in the Snake River system and to offset losses to the sport fishery for anadromous and resident species, measures recommended in the earlier reports must be augmented and accomplished.

This proposed plan for offsetting anadromous fish losses is based on salmon and steelhead trout counts at Ice Harbor and McNary Dams. It does not include compensation for losses due to nitrogen supersaturation, but assumes that every possible means to promptly eliminate this problem is being explored. Additionally, the plan does not consider mitigation for losses of sockeye and coho salmon which occur in lesser numbers in the Snake River system.

Figure 1. An excellent catch of Snake River run steelhead trout. (Idaho Fish & Game Dept. photo)

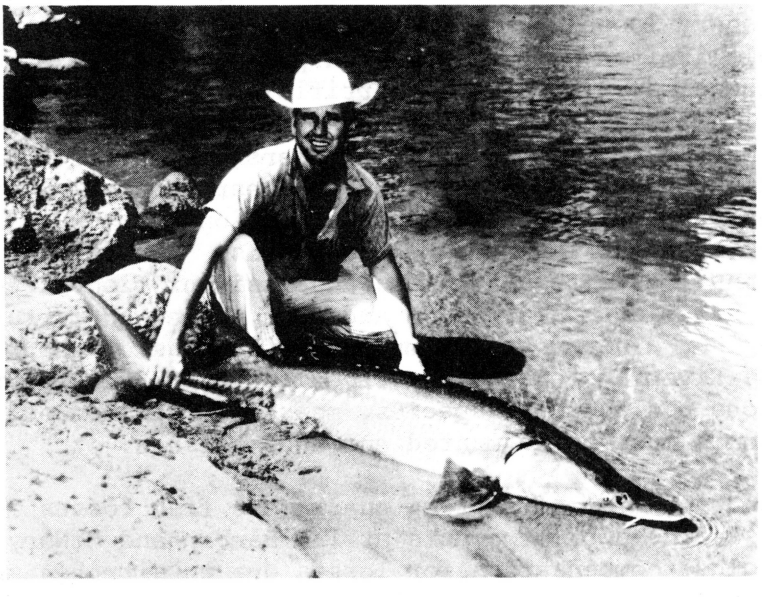

Figure 2. Diminishing white sturgeon population in Snake River is confined to the few freeflowing reaches. (Idaho Fish & Game Dept. photo)

Without the Projects

Anadromous Fish

Prior to construction of Ice Harbor Dam, there was no record of the actual number of anadromous fish utilizing the Snake River system. Determination of the representative numbers in this system of each species is based on the maximum count at McNary Dam from 1954 to 1967 and the maximum percentage of McNary count passing over Ice Harbor Dam from 1962 to 1967 (table 2 and schematic diagram). At both dams, unknown numbers of steelhead trout migrated upriver during noncounting periods in most years, and larger runs occurred at McNary Dam prior to the years of counting at Ice Harbor Dam.

The following method is intended to determine a reasonable estimate of average annual Snake River escapements before major dam construction started in the early 1950's. However, in this report compensation is not being recommended for losses caused by other than lower Snake River dams.

Production rates (i.e., return per spawner) since the mid-1950's (the period of record at McNary Dam) for spring chinook, summer chinook, summer steelhead, and sockeye are only about half that of earlier years. Also, the percentage Ice Harbor of McNary counts of spring and summer chinook in 1969 and 1970 exceeded 60 percent whereas 55 percent is used as the "maximum" value in table 2. (Actually, percentage Ice Harbor of Ice Harbor plus Priest Rapids counts for those years exceeded 70 percent in 1969 and 1970.) Consequently, maximum values at McNary for the years 1954-67 and at Ice Harbor for the years 1962-67 are probably conservative estimates of average annual runs in earlier years.

Having calculated representative numbers for each of the species utilizing the Snake River (table 2), estimated percentage losses attributed to passage at the four dams were applied to these to determine the estimated numbers of fish that must be produced by hatcheries to offset the losses.

An important sport fishery for steelhead trout in the project area amounting to about 130,000 angler-days annually during project life, would have been maintained without the projects.

Resident Fish

Principal resident game fish in the lower Snake River project area are smallmouth and largemouth bass, white sturgeon, and channel catfish. Less important species are rainbow and brown trout, Dolly

Table 2. Estimated Distribution of Salmon and Steelhead Trout Runs to Snake River System in Percent and Number*

River Segment	Fall Chinook Maximum Count McNary Dam 97,500 (1958) Distribution Percent	Fall Chinook No. Fish	Spring-Summer Chinook Maximum Count McNary Dam 222,100 (1957) Distribution Percent	Spring-Summer Chinook No. fish	Steelhead Maximum Count McNary Dam 172,600 (1962-63) Distribution Percent	Steelhead No. Fish
Snake River						
Lwr. Monumental-China Gardens (main stem spawning)	26.5	17,600			4.0	4,600
Tucannon River			2.0	2,400	3.0	3,400
Clearwater River	0.5	300	0.5	600	37.5	43,200
Asotin Creek					1.5	1,700
Grande Ronde River			10.0	12,200	14.0	15,900
Snake River:						
China Gardens-High Mtn. Sheep	5.5	3,600				
Salmon River			79.5	97,200	30.5	35,200
Imnaha River	0.5	300	5.5	6,700	3.5	4,000
Snake River:						
High Mtn. Sheep-Appaloosa	1.5	1,100				
Appaloosa-Pleasant Valley	5.5	3,600				
Pleasant Valley-Hells Canyon	33.0	22,000				
Hells Canyon Dam Fish Facilities	27.0	17,800 4/	2.0	2,500	5.0	5,700
Small Tributaries:						
Imnaha River-Hells Canyon Dam			0.5	600	1.0	1,100
	100.0	66,300 1/	100.0	122,200 2/	100.0	114,800 3/

1/ McNary Dam maximum count 97,500 x 68% = 66,300 (rounded to nearest 100) (68% is the highest percent of McNary counts over Ice Harbor 1962-67.)

2/ McNary Dam maximum count 222,100 x 55% = 122,200 (rounded to nearest 100) (55% is the highest percent of McNary counts over Ice Harbor 1962-67.)

3/ McNary Dam maximum count 172,600 x 66.5% = 114,800 (rounded to nearest 100) (66.5% is the highest percent of McNary counts over Ice Harbor per fish year 1962-67 adjusted to include estimates of fish migrations during months when no counts were made.)

4/ The highest count at Oxbow Dam (1958) prior to construction of Hells Canyon Dam. This includes 3,497 known mortality downstream from the dam in October.

Note: Counting period breakdown: Fall chinook..... August 9 to October 31
Spring-summer chinook... April 1 to August 8
Steelhead..... July 1 to June 30

*Table based on data available through 1967 and does not reflect distribution that could occur within any section or tributary in any given year.

Varden, brown bullhead, mountain whitefish, white crappie, and bluegill. Nongame fish include carp, squawfish, suckers, chiselmouth, and shiners. Since 1964, Washington Department of Game has conducted evaluation studies on the lower Snake River sport fishery. Based on these studies, estimated average annual man-days use during project life would have been 250,000 angler-days without the projects.

With the Projects

Anadromous Fish

Large numbers of upstream migrating fish are killed each year as a result of fish passage and nitrogen supersaturation problems at Columbia River and Snake River dams. Very large numbers of smolts are killed as they migrate downstream through the reservoirs and dams. Spawning and rearing areas for anadromous fish are being lost because of dam construction on lower Snake River. As a result of these developments anadromous fish runs in Snake River are expected to continue to decline. Because of current efforts to alleviate the nitrogen supersaturation problem, this report does not include compensation plans for nitrogen related mortality.

Studies at Ice Harbor Dam indicate a 30-percent mortality to salmonid smolts passing through the turbines. This includes mortalities due to predation on stunned fish. Many studies have verified a direct mortality without predation of 11 percent for turbines of the type used at the lower Snake projects. Considering the fact that in the future most of the water will pass through the turbines, an estimated total mortality of 15 percent per dam may be conservative. In passing the four-dam complex, this would result in a cumulative 48-percent loss of salmon smolts. Since ocean mortalities on salmonids spending a year or more in salt water are not likely to be density dependent, a 48-percent smolt kill can be translated to a 48-percent reduction in returning adults.

There are other project-related factors influencing fish survival. Adult migrant mortalities have not been considered, although losses in lower Columbia River between 1962 and 1967 indicate an average mortality of 16 percent per dam. Counts at Lower Monumental and Little Goose Dams in 1970 did not indicate such a direct loss of adults, but after completion of Lower Monumental Dam an all time high count at Ice Harbor Dam in 1969 produced an all time low spawning ground count in Idaho streams. This indicates that delayed mortalities upstream from Lower Monumental Dam were very great. Although no percentage can be calculated, much of this loss may have been due to nitrogen supersaturation. In any case, the proposed plan does not consider mortalities due to nitrogen on either adult or juvenile migrants. Also, probable effects due to delay of juvenile migrants

are not considered. On the other hand, if current efforts to transport or bypass downstream migrants are successful they may counter some of the losses. In this event appropriate adjustments can be made in the program after all favorable and unfavorable factors have been evaluated. The urgency of initiating this program without awaiting such evaluation cannot be overstressed if important runs are to be maintained at a viable level.

Traveling fish screens have been installed on an experimental basis in the intakes to one of the turbines at Little Goose Dam and are scheduled to be installed in all of the turbine intakes at this dam prior to the downstream migration period in the spring of 1973. The fishery agencies have recommended that these be evaluated from a mechanical and biological standpoint before proceeding with similar installations at the other projects. The Corps of Engineers has scheduled design and construction of traveling screens at all of its Snake and middle Columbia River projects. Studies to date indicate that up to 80 percent of the downstream migrants may be diverted by such screens making them available for bypass around individual dams or a series of dams by means of truck transport. To the extent that the screens reduce the fingerling mortality, the requirements for artificial propagation will be reduced. In any event, it is anticipated that substantial hatchery programs will still be required to compensate for losses occurring to upstream migrants as a result of delay and mechanical injury, losses of fingerling through the turbines and in connection with screening and bypass and/or transportation facilities, losses resulting from delay or downstream migrant passage through the reservoirs, and losses resulting from inundation of spawning grounds. Construction and operation of such hatchery facilities should be initiated as quickly as possible to offset these losses. In view of the time element involved in initiating hatchery construction, we foresee no possibility of overcompensating for these losses.

Resident Fish

Since Ice Harbor Dam was completed, studies show a much higher fishery loss than originally anticipated.

The high quality stream fisheries for smallmouth bass, white sturgeon, and channel catfish within Ice Harbor, Lower Monumental, and Little Goose Reservoir areas have been converted to a low quality reservoir-type fishery with abundant populations of undesirable fish. However, fisherman use for resident game fish species within the remaining freeflowing river portion of the project area has increased many times since initiation of Ice Harbor Dam construction in 1960.

Figure 3. The 25-pound flathead catfish (1970 Idaho record) and channel catfish were caught in Snake River near Lewiston. (Idaho Fish & Game Dept. photo)

Figure 4. Project development has adversely affected the excellent smallmouth bass sport fishery on lower Snake River. (Washington Dept. of Game photo)

A fishery for warmwater species will develop in the impoundments with average annual use during the project life estimated at 205,000 angler-days. Such a fishery would not compensate for the 250,000 stream angler-days lost in the reservoir areas. The loss is actually greater than the 45,000 difference, because two stream angler-days are equivalent to three reservoir angler-days in value. Loss of the white sturgeon fishery in Snake River within the project area cannot be offset.

Plan of Development

Anadromous Fish

Runs of spring and summer chinook salmon and steelhead trout comparable to the preproject runs can be maintained in the Snake River system through appropriate fishery programs, including improved fish passage, both upstream and downstream at dams on Columbia, Snake, and Clearwater Rivers; artificial propagation; habitat improvement; control of nitrogen supersaturated water in Snake River; and implementation of any additional measures necessary to prevent further losses resulting from project development at the four lower Snake River dams.

The plan presented in this report provides partial compensation for fishery losses incurred as a result of the four-dam complex and features artificial propagation. Plan adoption would provide the number of salmon and steelhead trout needed in the Snake River system to help maintain commercial and sport fisheries for anadromous species on a sustaining basis in the Columbia River system and Pacific Ocean.

Fall Chinook Salmon. The representative run of fall chinook salmon in the Snake River is 66,300 (table 2). Spawning habitat for approximately 5,000 adults will be lost by inundation within the project area. The downstream migrant progeny of the remaining 61,300 will undergo an estimated 48-percent mortality. This will reduce the run by an additional 29,400 so that compensation for a total of 34,400 adults will be required (table 3). State and Federal fishery agencies have determined that fall chinook salmon contribute little to the sport fish resources in the Snake River drainage and that the entire run could conceivably be relocated to lower Columbia River downstream from McNary Dam. A hatchery capable of handling 8,800 adult chinook would be required to produce the 34,400 adults (table 4).

Table 3. Commercial Landings and Sport Fishing Use, With and Without Compensation [1/] in Columbia River System and Pacific Ocean (Anadromous Species) and in Lower Snake River Project Area (Resident Species)

Areas and Species	Commercial Fisheries									Sport Fisheries [4/]		
	With Compensation			Without Compensation			Difference					
		Landings			Landings			Landings				
	Escapement	Pounds	Value	Escapement	Pounds	Value	Escapement	Pounds	Value	W/Comp. Ang.days	WO/Comp. Ang.days	Diff. Ang.days
Columbia R. System, Ocean												
Fall chinook [2/]	66,300	3,381,000	$1,893,000	31,900	1,627,000	$911,000	34,400	1,754,000	$982,000	332,000	160,000	172,000
Spring and summer chinook [2/]	122,200	6,232,000	3,490,000	63,500	3,238,000	1,813,000	58,700	2,994,000	1,677,000	611,000	318,000	293,000
Steelhead [3/]	114,800	692,000	208.000	59,700	360,000	108,000	55,100	332,000	100,000	763,000	397.000	366,000
Totals	303.300	10.305,000	$5,591,000	155,100	5,225,000	$2,832,000	148,200	5,080,000	$2,759,000	1,706,000	875,000	831.000
L. Snake Project Area												
Resident										250,000	205,000	45,000

[1/] Insofar as possible "with compensation" is intended to reflect the preproject condition.

[2/] Calculations based on catch to escapement ratio of 4:1 (commercial catch 3:1 and sport catch 1:1) average weight per fish of 17 lbs.; and commercial value of $0.56 per pound.

[3/] Calculations based on catch to escapement ratio of 2:1 (commercial catch 0.67:1 and sport catch 1.33:1); average weight per fish of 9 lbs.; and commercial value of $0.30 per pound.

[4/] Angler-days for anadromous fish are based on catch to escapement ratios (footnotes 2 and 3) and an estimated 5 days of effort per fish (the value of an angler-day for anadromous fish is $6.00).
Angler-days for resident fish are based on creel studies of Washington Department of Game and the ratio of 3 reservoir angler-days to 2 stream angler-days.

Table 4. Estimated Losses, and Artificial Propagation Costs Associated With Anadromous and Resident Fish Maintenance, Following Lower Snake River Project Construction 5/

Species	Maximum Run	Loss (Adults)	Hatchery			Collecting, Eyeing, Holding, & Transportation	
			Number (Adults)	Capital Costs	Annual OM&R Costs	Capital Costs	Annual OM&R Costs
Fall chinook	66,300	34,400 1/	8,800	$ 4,360,000	$ 244,000	$ 935,000	$ 50,000
Spring & summer chinook	122,200	58,700 2/	3,800	8,960,000	502,000	432,000	50,000
Steelhead trout	114,800	55,100 2/	7,200	18,140,000	834,000	819,000	95,000
Rainbow trout			(85,000) 3/	1,275,000 4/	96,000 4/		
Total Costs				$32,735,000	$1,676,000	$2,186,000	$195,000

1/ Based on total replacement for 5,000 adults in inundated spawning area, plus cumulative smolt loss of 48% at four dams.

2/ Based on 15% smolt loss for each of the four dams or cumulative loss of 48%.

3/ Number of pounds needed for liberation at three to the pound.

4/ Costs include collecting, eyeing, holding, and transportation as well as hatchery requirements.

5/ Total capital costs of $39,121,000, are obtained by adding land acquisition and development costs for fishing access of $4,200,000, to the total capital costs given above. Similarly, total OM&R costs are $1,901,000. These costs were developed in 1968; consequently, substantial increases can be anticipated at the time of construction.

Spring and Summer Chinook Salmon. The representative number of adult spring and summer chinook salmon in the Snake River system is 122,200 (table 2). Downstream smolt losses through the project area are estimated at 48 percent. To offset this loss, hatchery facilities would be required capable of producing 58,700 adults to the Snake River upstream from Lower Granite Dam (table 3). Hatchery facilities would have to be provided to produce to smolt size the offspring from 3,800 adult salmon (table 4).

Steelhead Trout. The representative run of adult steelhead trout to be maintained in the Snake River system after completion of the four dams on lower Snake River is 114,800 fish (table 2). Estimated total loss of downstream migrants at the four dams is 48 percent. To offset this loss, artificial propagation facilities capable of producing 55,100 adult steelhead trout to the escapement upstream from the project area would be necessary (table 3). To provide these fish, hatchery facilities capable of rearing progeny from 7,200 adults will be required in the Snake River system upstream from the project area (table 4). The sport fishery for steelhead trout in this area will be virtually destroyed by inundation of 140 miles of freeflowing stream. Preproject annual steelhead fishing use in the area was estimated at 52,000 angler-days. This would project to 130,000 angler-days annually during the 100-year project life. There is no known way to mitigate this loss other than by providing permanent public fishing areas along streams of known high use, such as Grande Ronde River in Washington and Oregon, Salmon and Clearwater River in Idaho, and Tucannon River in Washington.

Hatchery Requirements. Location and size of the hatchery sites and rearing facilities and the operating entities would be determined at a later date by the interested State and Federal fishery agencies. Capital, operation, maintenance, and replacement costs for all mitigation measures should be project funded.

Estimated annual value of the anadromous fish resources affected by the four-dam complex is approximately $5,591,000 to the commercial fisheries with compensation and $2,832,000 without compensation measures, a difference of $2,759,000 (table 3). Angler-day use of the sport fishery for anadromous fish resources affected by the projects would be 1,706,000 with compensation and 875,000 without compensation measures, a difference of 831,000 angler-days (table 3). Offsetting project-incurred losses to anadromous fish by construction of hatcheries would require a total capital investment of $33,646,000, and $1,775,000 annually for their operation and maintenance (table 4).

Resident Fish

The plan also provides for establishment of a high quality sport fishery for resident species in streams tributary to the project area to offset, in part, losses of the excellent smallmouth bass, channel catfish, and white sturgeon fisheries in lower Snake River.

Loss of 45,000 angler-days of the stream fishery for resident species in the project area (table 3), could be offset by supplemental stocking of catchable size rainbow trout in southeastern Washington streams tributary to Snake River such as Asotin Creek, and Touchet, Walla Walla, and Tucannon Rivers. Compensation would require artificial propagation facilities capable of producing 85,000 pounds of catchable size rainbow trout, three to the pound (table 4). Estimated capital cost is $1,275,000. Annual operation, maintenance, and replacement costs would be approximately $96,000 (table 4).

WILDLIFE RESOURCES

Without the Projects

Habitat

The rich alluvial soils along Snake River within the area of influence of Ice Harbor, Lower Monumental, Little Goose, and Lower Granite projects supported many kinds of trees, shrubs, grasses, forbs, and cultivated crops which provided essential food and cover for wildlife. Willows, alders, hackberries, and an understory of teasel, poison oak, sumac, wild rose, cocklebur, cheatgrass, and wild rye, comprised natural streambank cover. Dryer areas supported sagebrush and rabbitbrush, interspersed with grasses. Other plants included Russian thistle, lupine, Jim Hill mustard, downy chess, and sanddock. Crops on agricultural land consisted primarily of grain, forage, and orchards.

Big Game

Resident mule and white-tailed deer herds inhabited the bottomlands and adjoining slopes in moderate numbers. Significant numbers of migrant deer from bordering uplands utilized the river valley during fall and severe winters. Bottomland habitat within the project area helped support many deer that contributed substantially to the harvest on surrounding areas. The highest deer populations occurred in Little Goose and Lower Granite project areas of influence. The average annual hunter use expended over the project life for deer that were dependent upon habitat within the four reservoir sites and adjacent project-affected lands is estimated at 12,600 hunter-days without the projects. Estimated annual harvest is 400 deer.

Figure 5. Before inundation by reservoir waters, streamside vegetation provides vital food and cover for wildlife. (Bureau of Sport Fisheries and Wildlife photo)

Figure 6. Following inundation, the banks are bare and eroding, and little habitat remains to sustain wildlife. (Bureau of Sport Fisheries and Wildlife photo)

Upland Game

A variety of upland game inhabited the flood plain and contiguous lands. The most abundant species were California quail, ring-necked pheasant, chukar, gray partridge, and mourning dove. They were common in the projects' area and all were highly dependent upon habitat along the river.

Shrubs and trees interspersed with agricultural lands on the flood plain provided excellent living conditions for pheasant, quail, and cottontail populations. The abundant chukars and other arid land wildlife occurring in numerous canyons and on slopes adjacent to the project-affected river reaches were seasonally dependent upon stream-side habitat. The four-dam areas of influence supported high quality hunting, diverse species, and good public access along many river reaches. These factors attracted hunters from considerable distances. The average annual hunter use for upland game dependent on project-affected lands was about 43,900 man-days without the project with about 27,400 small game animals harvested.

Fur Animals

Fur animals living along the lower river were beavers, muskrats, minks, raccoons, skunks, weasels, bobcats, river otters, badgers, and coyotes. Beaver, muskrat, and mink were the species of principal economic importance. Fur harvest fluctuates markedly according to market demands. Low demand for most furs resulted in a pelt harvest several times lower than fur animal populations could support. The average annual harvest from the reservoir sites was 4,200 pelts without the projects.

Waterfowl

Lower Snake River provided important waterfowl habitat. Islands and shorelands along the river provided resting and feeding areas used annually by observed peak winter populations of 140,000 ducks and 35,000 geese. An estimated 600 goslings were reared to flight stage annually by 400 resident Canada geese along the lower Snake. A few ducks nested in the project area. Waterfowl hunting in adjoining counties was largely dependent on duck and goose populations that wintered on the lower river and flew out to feed on nearby croplands. Waterfowl hunting restrictions along most reaches of the river served to hold wintering waterfowl that supported local field hunting. The average annual hunter use of waterfowl based upon goose production on project-affected areas was 1,100 hunter-days without the projects.

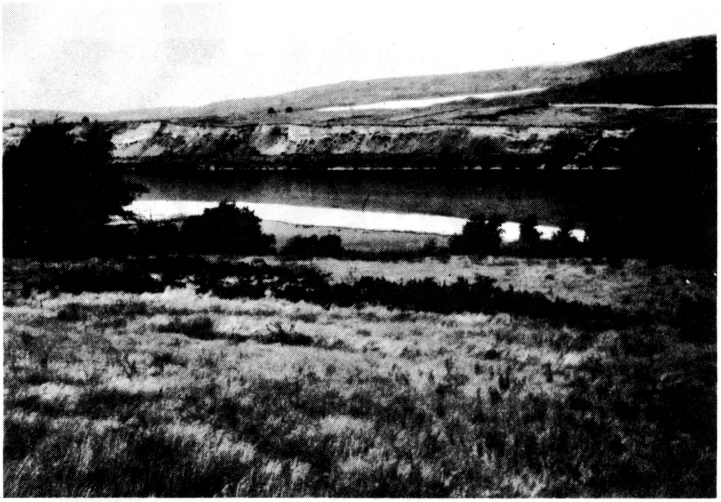

Figure 7. Islands in lower Snake River provide important resting and breeding habitat for numerous waterfowl. (Bureau of Sport Fisheries and Wildlife photo)

Figure 8. Project reservoirs have inundated numerous islands formerly utilized by resident geese as production areas. (Washington Dept. of Game photo)

Figure 9. Chukars and other upland game sought by hunters depend upon habitat being lost to lower Snake River reservoirs. (Washington Dept. of Game photo)

Figure 10. Wildlife observation is a significant recreational activity in riverine habitat. (Bureau of Sport Fisheries and Wildlife photo)

Nongame Wildlife

Relatively mild temperatures and excellent vegetative cover along the river promoted heavy year-round use of the project area by migratory and resident nongame wildlife species. Numerous migratory perching birds including sparrows, warblers, vireos, flycatchers, kingbirds, tanagers, orioles, robins, and woodpeckers, depend upon streamside habitat destroyed by the projects. Other species affected by the project include hawks, owls, kingfishers, and shorebirds. Less conspicuous wildlife destroyed include several species of snakes, lizards, amphibians, and small mammals including the uncommon Merriam's shrew. Growing numbers of nature enthusiasts and students enjoyed the variety of birds and other nongame wildlife found here.

With the Projects

Habitat

Project reservoirs and related construction have or will have destroyed most of the natural environment that provided essential food and cover for wildlife living along the lower 140 miles of Snake River. Terrestrial habitat loss from inundation, railroad relocation, and other project effects was or will be about 3,600 acres at Ice Harbor, 3,900 acres at Lower Monumental, 5,300 acres at Little Goose, and 3,600 acres at Lower Granite project. We estimate that for most wildlife the projects either directly or indirectly affect adversely over 100,000 acres of habitat in a mile-wide band extending along lower Snake River canyon. Big game range influenced is considered to cover roughly a ten-mile-wide band along the canyon. The original land-water relationship was adversely changed with virtually a complete loss of interspersed brushy shoreline, agricultural land, and river island habitat. Wildlife populations and wildlife-oriented recreation dependent on the habitat were drastically reduced.

Big Game

Project reservoirs have destroyed habitat areas along Snake River that contributed substantially to deer production. These habitat losses are reflected in reduced deer populations and hunting success. Additionally, loss of public access has further reduced deer harvest along the river canyon. With the projects the average annual man-days use for big game will be 2,700 hunter-days.

Upland Game

California quail, ring-necked pheasant, chukar, gray partridge, mourning dove, and cottontail populations have been greatly reduced because of the loss of native streamside vegetation which provided essential habitat. Other game species have been less severely affected. Loss of public access from road inundation has resulted in additional losses of upland game hunting opportunities. Destruction of habitat and road access along the river is reflected in reduced game harvest in the bordering counties extending from the Idaho-Washington line to the Snake River mouth. There will be an anticipated overall average annual use of 15,400 man-days of upland game hunting with the projects.

Fur Animals

Project reservoirs have destroyed considerable fur animal habitat. Beaver numbers have been drastically reduced with lesser losses sustained by other species. The average annual fur animal harvest is estimated at 2,100 pelts with the projects.

Waterfowl

Waterfowl have been adversely affected by the combined effects of the four projects. There has been a serious loss of goose-nesting sites and a decrease in overall goose and duck use of the area caused by loss of islands, flats, and gravel bars. Project reservoirs have or will inundate an estimated 40 islands comprising 550 acres. Several islands formed by the reservoirs will reduce overall losses to about 490 acres. The local waterfowl harvest has been reduced. Although a large island will be formed in Lower Granite Reservoir in the vicinity of Silcott, and several lesser islands have been formed elsewhere, most of the goose-nesting habitat has been destroyed. Additionally, streamside pastures needed for goose grazing and production have been inundated. There will be an average annual use of 100 man-days of waterfowl hunting based on goose production with the projects.

Nongame Wildlife

Severe losses of resident and migratory nongame wildlife have resulted from project effects. These losses are directly related to destruction of the rich alluvial lands that support vegetation providing wildlife cover and food. Over 3,100 acres of critical nongame wildlife habitat was destroyed by inundation, railroad relocation, and other project activities. Environmental quality has declined over a wide area because esthetic and natural pest control values provided by seed-eating and insectivorous birds have been lost. A comparison of nongame wildlife "before" and "after" inundation of riparian woody vegetation shows that numerous valuable birds such as yellow warblers, song sparrows, western tanagers, house wrens, black-headed grosbeaks,

red-shafted flickers, lazuli bunting, flycatchers (sp), robins, yellow breasted chats, sparrow hawks, and vireos (sp) are replaced predominantly by a few blackbirds and meadowlarks, species that do not require extensive stands of shrubs and trees required by the previously mentioned varieties. Other less conspicuous nongame wildlife destroyed by the projects include several species of reptiles, amphibians, and small mammals including the uncommon Merriam's shrew. The extent of such losses cannot be readily measured in terms of human use because of their largely intangible nature. However, increasingly heavier use by birdwatchers, photographers, and other nature enthusiasts of State and Federal wildlife recreation and refuge areas indicates importance of nongame wildlife. These people are part of a group engaged in the fastest growing form of outdoor recreation in this region.

Wildlife values in the project areas are summarized in table 5.

Table 5. Average Annual Wildlife Values in User-Days, Lower Snake River Projects

Group	Without Projects (Hunter-Days)	With Projects (Hunter-Days)	Difference (Hunter-Days)
Big game	12,600	2,700	- 9,900
Upland game	43,900	15,400	-28,500
Waterfowl 1/	1,100	100	- 1,000
Nongame 2/	3,100 (acres)	0	- 3,100 (acres)
Fur animals 3/	4,200 (pelts)	2,100 (pelts)	- 2,100 (pelts)

1/ Based on project-related goose production only.
2/ Evaluated in terms of critical habitat rather than hunter-days.
3/ Evaluated in terms of pelts harvested rather than trapper-days.

DISCUSSION

Fish

Anadromous Fish

The Snake River drainage is the most important production area for anadromous fish in the Columbia River system. Most of the spring and summer chinook salmon and steelhead trout migrating upstream in the Columbia past McNary Dam are destined for the Snake River system (table 2). Anadromous fish reared in this area contribute substantially to both the sport and commercial fisheries in Oregon, Washington, Idaho, California, and Alaska and Pacific Ocean. With artificial propagation, continuation of fishery management programs and measures to reduce nitrogen supersaturation of water, large numbers of salmonids of inestimable value can be maintained in the Columbia and Snake River systems.

Studies conducted by National Marine Fisheries Service demonstrate that losses of juvenile anadromous fish migrating through lower Snake River have been as high as 70 percent, primarily as a result of nitrogen supersaturation (up to 146 percent). Losses of a similar magnitude have been demonstrated during high spill periods between Ice Harbor and Bonneville Dams and between Bonneville Dam and Rainier, Oregon. In the past few years, serious additional mortality has occurred to adult salmonid migrants as a result of this critical problem.

With planned construction and operation of Lower Granite Dam, the cumulative effect of nitrogen supersaturation in Snake River could possibly eliminate anadromous fish from this drainage. This definitely represents a crisis situation which must be resolved immediately.

The cycle of nitrogen supersaturation in Snake River water occurs annually. Such waters do not equilibrate rapidly in slackwater of Columbia and Snake River impoundments. The dissolved nitrogen concentration tends to be cumulative from one impoundment to the next. Lack of circulation tends to slow the equilibration rate and this combined with increases in surface water temperature increases the fish mortality.

Subsurface impoundment water drafted through turbine intakes does not increase dissolved nitrogen concentrations in tailrace water. With development of the power potential at the four dams on lower Snake River, spillway flows could be substantially reduced during the critical period of both upstream and downstream anadromous fish migrations, provided that electrical energy loads were adjusted within the power system to permit full loading of generator units at these projects, thus reducing nitrogen concentration and fish mortality rates from that source.

Hatchery facilities are proposed to offset losses, other than those due to nitrogen, that have occurred and will continue to occur to anadromous

fish as a result of the projects. Such facilities would be based on water reuse and recirculating systems, and their size would be dependent upon the number of adults needed for artificial production.

Spawning area for approximately 5,000 fall chinook salmon will have been inundated by the impoundments. Approximately 61,000 adult fall chinook have utilized Snake River upstream from the projects and would be adversely affected by these dams. Full compensation for fall chinook losses could be provided by development of artificial propagation facilities on Columbia River downstream from Ice Harbor Dam to produce 34,400 adults. This would also require construction of a collection and holding facility at one of the lower Snake River dams and a hauling facility to the hatchery.

Estimated capital cost for the hatchery and rearing facility in Columbia Basin downstream from the projects' area, to rear the progeny from 8,800 adult chinook salmon, is $4,360,000. Annual operation, maintenance, and replacement costs are estimated at $244,000.

Estimated capital cost for the collection, holding, and transportation facility for 8,800 adult fall chinook salmon is $935,000. Annual operation, maintenance, and replacement costs are estimated at $50,000.

To offset losses caused by the four dams and to maintain the representative run of 122,200 spring and summer chinook salmon in the Snake River system, artificial propagation facilities capable of producing 58,700 adults to the spawning escapement upstream from the projects' area will be required. Collection, holding, and eyeing facilities will be required in upper Grande Ronde River, Oregon, and Salmon River. Hatchery facilities sized to rear the progeny from 3,800 adult spring and summer chinook, located in the upper Snake River drainage, at the best natural water supply, would be necessary. Transportation facilities to haul smolts from the hatchery to the rearing streams would also be required.

Estimated capital cost for hatchery rearing, and hauling facilities on upper Snake River to rear the progeny from 3,800 adult, spring, and summer chinook to smolt size and transport them to their parent streams is $8,960,000. Annual operation, maintenance, and replacement costs are estimated at $502,000. The technique for estimating hatchery requirements is presented in the appendix.

Estimated capital cost for collection, holding, eyeing, and transportation facilities on Grande Ronde and Salmon Rivers is $432,000. Annual operation, maintenance, and replacement costs are estimated at $50,000.

An important sport fishery for steelhead trout in Snake River averaging about 130,000 angler-days annually during project life, will be lost because of the impoundments. There are no known means in the project

area to offset the loss of a stream sport fishery for steelhead trout that has been displaced by a reservoir. Partial compensation may be achieved by acquiring approximately 150 linear miles of lands averaging 100 feet in width adjacent to streams of known high quality steelhead trout fishing, such as Grande Ronde in Oregon and Washington, Salmon and Clearwater Rivers in Idaho, and Tucannon River in Washington and reserving them for public fishing access. Estimated acquisition cost of private lands along these rivers to accommodate 130,000 angler-days annually is $2,700,000. Estimated cost for developing public access to these areas is $1,500,000; estimated annual maintenance and replacement is $30,000.

To maintain the representative number of steelhead trout in the Snake River system and to offset the loss of downstream migrants through the turbines at the four dams, artificial propagation facilities capable of producing 55,100 adults from 7,200 adults would be necessary. Acquisition of a hatchery site at the best available water supply in the upper Snake River system would be necessary. Smolts could be hauled to Snake tributary streams in Idaho, Washington, and Oregon for liberation, thus supplementing natural production and maintaining sport fishing for anadromous fish in streams affected by the projects.

Estimated capital cost for the steelhead trout hatchery and rearing facilities is $18,140,000. Estimated annual, operation, maintenance, and replacement costs are $834,000. These costs include the acquisition of 100 acres of land for hatcheries.

Estimated capital cost for steelhead trout collection, holding, and eyeing facilities is $819,000. Annual operation, maintenance, and replacement costs are estimated at $95,000.

Resident Fish

The stream fishery for resident fish within the project area, prior to 1950, was relatively undeveloped. Since then, the interest and utilization of the sport fish resources in lower Snake River have increased greatly.

With development of slackwater navigation on Columbia and Snake Rivers to Lewiston, Idaho, and hydroelectric projects on middle Snake River from Hells Canyon Dam to Weiser, Idaho, the 351 miles of stream fish habitat in the Snake have been reduced more than 50 percent. With ultimate development of all authorized projects on Snake River, within the project area of influence, only 15 percent of the river system will remain as freeflowing stream. As a result of these developments and conditions, the ever-increasing amount of sport fishing effort for resident species in Snake River has been restricted and confined to the greatly reduced amount of remaining stream fishery habitat.

Increasing human population with its demand for high quality fishing opportunities will undoubtedly result in additional fishing pressure on streams tributary to Snake River within the project area.

The loss of quality stream fishery for smallmouth bass, white sturgeon, and channel catfish in the project area cannot be totally offset. However, 45,000 angler-days could be provided by supplementing the stocking programs of Washington Department of Game, and Idaho Fish and Game Department. Stocking of catchable size trout in streams such as Tucannon, Touchet, Walla Walla, and Clearwater Rivers, and Mill and Asotin Creeks could create a higher quality fishery than presently exists in these tributaries.

With construction of a new hatchery or enlargement of existing artificial fish propagation facilities in the Snake River system and proper management, the fisheries in streams tributary to the project area could be improved to offset 45,000 angler-days of fishery losses within this area.

Estimated capital cost for a new hatchery would be $1,275,000. Annual operation, maintenance, and replacement costs are estimated at $96,000.

Wildlife

The wildlife plans presented in U. S. Fish and Wildlife Service reports on Ice Harbor, Lower Monumental, and Little Goose Lock and Dam projects were based on management of small tracts of land scattered along the projects' reservoirs. These wildlife management plans were not implemented because of adverse factors such as the Corps' "interim use" concept (wildlife use permitted until a "higher use" i.e., industry was found for the area) and lack of project funding for development, operation, maintenance, and replacement of wildlife measures designed to minimize losses.

Development of artificial nesting sites, provision of grazing pastures for Canada geese, and plantings of woody vegetation for nongame wildlife, fur animals, and big game should provide considerable onsite mitigation of wildlife losses. However, substantial reduction of upland game losses will depend largely upon control and development of suitable habitat on nonproject lands. Alternative or additional means to offset wildlife losses may be required. All measures and studies designed to reduce project-incurred wildlife losses should be funded by the projects. Measures designed to minimize such losses are as follows:

Habitat Preservation

Opportunities to replace the extensive wildlife habitat destroyed by the projects are limited. Remaining native vegetation located in side draws and along the reservoirs should be preserved. Plans for retention of remaining wildlife habitat should be cooperatively developed by Corps of Engineers, Washington Department of Game, Idaho Fish and Game Department, and the Bureau of Sport Fisheries and Wildlife.

Pollution Control

Loss and damage to fish and wildlife habitat should be minimized by careful placement of spoil from project construction and maintenance activities. No pesticide or herbicide should be used without consultation with wildlife agencies because of the harmful effects of some chemicals on fish and wildlife. The pollution control plan should be cooperatively developed by the State and Federal agencies responsible for natural resource conservation and Federal and State public health agencies.

Habitat Control, Development, and Management

Project lands not inundated will provide fair opportunities to offset big game, fur animal, nongame wildlife, and waterfowl losses with appropriate zoning and development. Significant mitigation of upland game losses will require control, intensive development, and stocking of offsite lands or comparable measures. Development, operation, maintenance, and replacement costs for all wildlife management proposals should be the projects' responsibility. Proposed habitat management plans for reducing project-incurred losses are:

A. Wildlife Management Plans for Project Lands

(1) Study Plan for Big Game, Fur Animals, and Nongame Wildlife.

A comprehensive study of project lands is required to formulate a habitat development plan for big game, fur animals, and nongame wildlife. Results would facilitate inclusion of appropriate wildlife measures in overall plans for beautification and other project requirements.

Project lands and waters to undergo habitat development study should include areas considered amenable to wildlife use. Areas utilized for industrial, port facilities, and similar commercial purposes would be excluded from consideration. Most other land use catagories, including recreational, and multi-purpose may present opportunities for compatible wildlife uses.

Plantings of suitable grasses, shrubs, and trees at favorable sites along the reservoirs is believed to offer the best potential for upgrading this habitat. Numerous parcels of land are associated with each reservoir. They all have different characteristics including soil types and depths; elevations above water; accessibility; and strategic location in relation to parks, sidehill draws, and tributary streams. The study plan would determine the most feasible and productive development program for available project lands for partially offsetting substantial project-incurred losses to fur animals, big game, and nongame wildlife. Potentials for upland game habitat management on project lands are limited.

The proposed study would start as soon as project funds are available and extend over a three-year period and would be conducted cooperatively by Bureau of Sport Fisheries and Wildlife, Washington Department of Game, Idaho Fish and Game Department, and Corps of Engineers. The study would cost an estimated $60,000.

(2) Big Game Management Plan. The plan for minimizing big game losses would involve the planting and establishment of shrubs and trees in plantations at select sites along the reservoirs to provide food and cover. These plantings, consisting of such shrubs as serviceberry, chokecherry, and hawthorn, would be made on those project lands determined most suitable by the aforementioned study. Some development work would be required such as fencing against beaver and rabbit depredations and establishing watering systems to assure initial success of the plantings. The plantings would also help beautify the reservoirs and minimize deer depredation problems at parks and other recreation lands.

The amount of money to be allocated to deer habitat development and management on project lands will depend upon the findings of the proposed three-year study of these lands.

(3) Fur Animal Management Plan. Plantings should be made in plantations at select sites along the reservoirs for the purpose of offsetting beaver losses by establishing a food supply. Incidental benefits to other fur animals would occur. The plantings would consist of cultivated saplings of several species and willow cuttings. Additionally, the plantings would beautify and provide limited habitat for songbirds and other wildlife provided berry and seed producing plants are included. Replacement of the destroyed beaver food supply coupled with a trapping program would provide a means to control beaver damage to shrubs and trees planted for other purposes such as parks. This has been a long-standing problem of Corps of Engineers and Washington Department of Game. The managed beaver population would have a high esthetic value to the public with minimal adverse impact on other project values.

The estimated cost of measures designed to restore and maintain original beaver numbers located along lower Snake River would be about $4,000,000. The Bureau of Sport Fisheries and Wildlife does not consider the funding of such a venture reasonable or in the public's interest. The Bureau would support maintenance of a limited beaver population as determined by the aforementioned study of project lands.

(4) Nongame Wildlife Management Plan. Nongame wildlife losses could be partially offset by planting suitable shrubs and trees along the reservoir. Plans for project parks and other strategic

public use sites should make provisions for such plantings to assure maximum public enjoyment of wildlife resources. The plantings would supplement shade tree and beautification measures. With proper cultivation and irrigation, the localized green belts would provide habitat for a variety of songbirds and other nongame wildlife as well as some game animals. The amount of money to be allocated to nongame wildlife habitat development and management will depend upon the findings of the proposed three-year study of project lands.

The estimated costs of a realistic wildlife management program for big game, fur animals, and nongame wildlife on project lands are $2,270,000. This includes costs for studies, operation, maintenance, and replacement during an initial five-year development period. Funds should be made available for habitat development as study findings permit. The projects would assume operation, maintenance, and replacement costs as a part of park and public use operational costs after the above development period. Washington Department of Game under agreement with Corps of Engineers would be responsible for habitat development and maintenance.

(5) Study and Management Plans for Waterfowl. The plan would be designed to develop ways and means of offsetting the loss of Canada goose nesting and rearing habitat caused by the reservoirs. Goose production may be increased through the installation of artificial nesting structures, creation of small islands, and development of grass grazing areas.

During 1969, Corps of Engineers, Washington Department of Game, Washington State University, and Bureau of Sport Fisheries and Wildlife initiated a preliminary cooperative study at several sites along impounded and remaining freeflowing reaches of lower Snake River to determine if means to increase goose nesting production were possible on the reservoir system as compared to a freeflowing river. During 1970, the effectiveness of about 40 goose-nesting structures and several manmade islands were evaluated. Results to date have been largely negative but are considered inconclusive and premature because of disturbance by project activities.

The plan would extend the joint study for not less than a five-year period. The study would determine the effectiveness of artificial nesting structures and/or islands and development of adjoining parks, forage crops, and farm pastures as a feasible means of producing geese. The extended study, to be conducted cooperatively by Washington Department of Game and Washington State University in consultation with Bureau of Sport Fisheries and Wildlife and Corps of Engineers, would cost an estimated $100,000. Estimated capital expenditures for installation, maintenance, and replacement of structures, islands, and other

measures during the project life would be about $201,250. Annual operation, maintenance, and replacement costs are estimated at $5,000. These funds would be allocated on the basis of study findings. Funds should be made available for habitat development as study findings permit.

B. Wildlife Management Plans for Nonproject Lands

Management of selected offsite areas in the vicinity of the four-dam project area would reduce most project-incurred upland game losses. Limited reduction of big game, waterfowl, fur animal, and nongame wildlife losses is also anticipated with these measures. Excessively high costs, estimated at several times those for the comparable offsite plan, and lack of enough development sites, dictates against use of project lands for other than limited upland game management purposes. Other means to attain comparable compensation for upland game losses must be developed as a project feature if the following proposals are not accepted. A possible alternate plan would be congressional funding to provide Washington Department of Game with the capability to offset inundated or otherwise destroyed habitat by lower Snake River projects. Compensation actions would be done through cost reimbursement contracts with the Bureau of Sport Fisheries and Wildlife and the State of Washington.

The following wildlife plans on nonproject lands are proposed:

(1) Control, development, and under-gun game bird stocking of selected nonproject lands along specific streams to offset most upland game bird hunting losses. Six areas comprising a total of 14,920 acres were deemed adequate as a major element of the overall wildlife management plan. About 660 acres would be acquired in fee and the remaining 14,260 acres would be operated under perpetual easements with the landowners. The in-fee land would serve as a nucleus to be intensively managed and would be surrounded by the easement lands. This measure would assure public access and suitable wildlife habitat without significantly changing the basic economy of the farms involved.

The units would be readily accessible to major human population centers. The sites chosen for inclusion in the wildlife management plan would have a high potential for upgrading of habitat to support increased game populations. They would be managed for intensive public use through large-scale stocking. Also, some losses to other wildlife forms would be offset by habitat measures.

Specific parcels of land designed for inclusion in the wildlife management plan would be dependent upon finding willing sellers. Therefore, the above described examples of development sites are presented here only to indicate the extent of this management plan.

If landowners object to acquisition or leasing, other landowners holding comparable areas would be approached. Land leasing and acquisition for wildlife management purposes would be carried out cooperatively by Corps of Engineers and Washington Department of Game.

In-fee acquisition of 660 acres needed for implementation of the above described wildlife plan would cost an estimated $328,500. This land would require development such as fencing, cattle guards, roads, parking, turnouts, cover crop plantings, and water supplies. The estimated cost of development is $146,200, with estimated annual operation, maintenance, and replacement expenses of $5,350. The cost of perpetual wildlife easements on 14,260 acres of private lands is estimated at $1,069,000 for the project life. Land controlled by acquisition and under perpetual easement would require annual stocking of game farm birds.

(2) Installation of watering devices and development of springs and natural drainages at strategic sites on adjoining lands for use by upland game (principally chukars). The plan would expand game bird range where lack of water is the limiting factor. Site selection would be based upon wildlife studies carried out over a two-year period on uplands bordering the four-dam complex. They would be conducted cooperatively by Bureau of Sport Fisheries and Wildlife and Washington Department of Game. Ultimate site selection would depend upon study findings. Preliminary investigations indicate the need for installation of 50 to 75 cisterns and development of a few springs and natural drainages. Cisterns, small check dams, and protective fencing would be required. Use of supplementary pumping facilities may be feasible.

Landowner agreements in the form of perpetual easements for public access would be required to insure site maintenance and public access with the cistern and waterway plans. Estimated study costs would be $20,000. Capital costs for cistern installation, waterway development, and fencing are estimated at $16,250. Estimated operation, maintenance, and replacement costs would be $500. Washington Department of Game would be responsible for OM&R through project funds transferred from Corps of Engineers. Perpetual easement costs for public access to 32,000 acres of land anticipated with wildlife water development are estimated at $120,000. Easements would be obtained by Corps of Engineers in cooperation with Washington Department of Game and Bureau of Sport Fisheries and Wildlife.

(3) A game farm should be constructed in the project vicinity and managed to provide upland game birds for annual stocking of proposed offsite wildlife management units. It would be designed to occupy about 160 acres of productive land. Estimated capital cost of the facility to rear about 20,000 pheasants annually would be $1,000,000, and annual operation, maintenance, and replacement costs are estimated at $68,000. Washington Department of Game would assume management responsibility. An alternate plan to attain a comparable degree of loss compensation should be designed and implemented as a project function if the game farm plan is not accepted as a project feature or is used as a temporary measure until habitat development is adequately accomplished.

The wildlife management plan would be cooperatively developed by the Bureau of Sport Fisheries and Wildlife and Washington Department of Game. Capital, operation, maintenance, and replacement costs over the 100-year life of the four-dam complex would be a Federal responsibility and would be funded by the projects.

Full implementation of the wildlife mitigation plan would offset, in terms of human use, most big game losses, upland game and waterfowl losses. In terms of wildlife populations, the plan would reduce substantially fur animal and nongame wildlife losses. However, reduction of wildlife losses through implementation of measures recommended herein would not offset severe project-caused losses of irreplaceable wildlife environment and related human use opportunities.

Estimated costs of the proposed wildlife mitigation plan are summarized in table 6.

Table 6. Estimated Costs of Measures Needed to Reduce Project-Incurred Wildlife Losses, Lower Snake River Projects

Measure	Costs	
	Capital	Annual OM&R
Project Areas		
Wildlife Management Plan		
3-year study	$ 60,000	
Wildlife habitat development	2,370,000 1/	
Subtotal	$2,430,000	
Waterfowl Management Plan		
5-year study	$ 100,000	
Island and pasture development	200,000	
Goose-Nesting platforms	1,250	
Combined OM&R		$ 5,000
Subtotals	$ 301,250	$ 5,000
Nonproject Areas		
Water Supply Plan		
2-year study	$ 20,000	
Watering devices (65 @$250)	16,250	$ 500
Perpetual land easements (32,000 A)	120,000	
Wildlife Management Areas		
Land purchases (660 A)	328,500	
Land leases (14,250 A)	1,069,000	
Developments (plantings, etc.)	146,000	5,350
Game farm	1,000,000 2/	68,000 3/
Subtotals	$2,699,950	$ 73,850
Totals	$5,431,200	
Contingencies 15%	814,680	
Grand Totals	$6,245,880	$ 78,850

1/ Includes $40,000 OM&R annually to be expended during initial five years. OM&R to be assumed by Corps of Engineers as project operation cost following initial five-year period.
2/ Includes cost of 160-acre irrigated farm at $140,000.
3/ Cost of stocking game farm pheasants $3,40 each.

RECOMMENDATIONS

It is recommended that:

1. project funds be provided to finance construction and annual operation, maintenance, and replacement costs for artificial fish propagation, collection, and transportation facilities, capable of producing and transporting adequate numbers of salmon and steelhead trout smolts to offset project-related fish losses in the Snake River system. Estimated total capital cost of facilities is $33,646,000 and estimated annual operation, maintenance, and replacement costs $1,775,000, allocated in the following manner:

   a. construction of fish propagation facilities, in the Columbia River system downstream from Ice Harbor Dam, capable of collecting and rearing the progeny from 8,800 adult fall chinook salmon. Estimated construction cost of hatchery facilities is $4,360,000 and estimated annual costs of operation, maintenance, and replacement would be about $244,000. Estimated cost of necessary equipment for collecting, holding, and transporting fish is $935,000, with estimated annual operation, maintenance, and replacement costs of $50,000.

   b. construction of hatchery and rearing facilities in the upper Snake River system for the progeny of 3,800 adult spring and summer chinook salmon. Estimated construction cost of hatchery and rearing facilities is $8,960,000 and estimated annual operation, maintenance, and replacement costs would be $502,000. Construction would include facilities for collection, eyeing, holding, and transportation of 3,800 adult spring and summer chinook salmon and their progeny. Estimated construction cost is $432,000 and estimated annual operation, maintenance and replacement costs would be about $50,000.

   c. construction of steelhead trout hatchery facilities in the upper Snake River system to rear the progeny from 7,200 adult steelhead trout. Estimated construction cost of hatchery facilities is $18,140,000 and estimated operation, maintenance, and replacement costs are about $834,000. Construction of collection, eyeing, holding, and transportation facilities on Snake River tributaries to handle 7,200 adult steelhead trout would cost an estimated $819,000. Estimated annual operation, maintenance, and replacement costs are $95,000.

2. hatchery, rearing, holding, and transportation facilities be constructed in the Snake River system to rear 85,000 pounds of rainbow trout at three fish per pound to supplement the Washington Department of Game and Idaho Fish and Game Department stream fishery management programs. Estimated construction of hatchery facilities is $1,275,000 and estimated annual operation, maintenance, and replacement costs are about $96,000.

3. To partially compensate for losses to stream sport fishery for steelhead trout a minimum of 150 linear miles of streamside land, averaging 100 feet in width, along Grande Ronde River in Oregon, Salmon and Clearwater Rivers in Idaho, and Tucannon River in Washington, be acquired primarily for public fishing areas. Location of land strips to be determined cooperatively by fishery agencies of Washington, Oregon, and Idaho. Estimated cost of land acquisition is $2,700,000. Estimated development cost is $1,500,000 with annual operation, maintenance, and replacement costs estimated at $30,000. It is suggested that these lands be acquired as they become available. If it becomes evident that acquisition of land does not keep pace with the demand, other means of compensation should be developed.

4. a. the projects provide an estimated $60,000 for a three-year study designed to formulate a habitat development plan for big game, fur animals, and nongame wildlife on project lands. The study would be conducted cooperatively by Bureau of Sport Fisheries and Wildlife, Washington Department of Game, and Corps of Engineers.

   b. estimated project funds in the amount of $2,370,000 be made available to Washington Department of Game and Bureau of Sport Fisheries and Wildlife for development of wildlife habitat on project lands. Fund disbursement would be made on the basis of study findings outlined in recommendation 4a. The annual OM&R costs are estimated at $40,000 for the initial five-year period. Following this period the OM&R costs would be assumed by the projects as a function of their normal operation and in conjunction with other park and recreational plantings.

5. a. the projects provide an estimated $100,000 for a five-year study designed to formulate a waterfowl habitat development plan on projects' area. The study would be conducted cooperatively by Washington Department of Game and Washington State University in consultation with Bureau of Sport Fisheries and Wildlife and Corps of Engineers.

b. estimated project funds in the amount of $201,250 be made available to Washington Department of Game and Bureau of Sport Fisheries and Wildlife for development, operation, maintenance, and replacement of waterfowl habitat on projects' lands and waters. These funds would be allocated on the basis of the study findings outlined in recommendation 5a. Estimated annual operation, maintenance, and replacement costs would be $5,000.

6. a. the projects provide an estimated $20,000 for a two-year study designed to upgrade habitat for upland game birds on lands in the vicinity of the projects. Suitable sites would be located and watering devices and water control structures would be constructed and evaluated to determine their effectiveness in offsetting project-incurred losses. Washington Department of Game and Bureau of Sport Fisheries and Wildlife would jointly conduct the study.

b. estimated project funds in the amount of $16,250 be made available for installation of about 65 watering facilities to be located on lands adjoining the projects as determined by the study outlined in recommendation 6a. Annual operation, maintenance, and replacement would be project costs estimated at $500. Washington Department of Game would be responsible for OM&R through the transfer of project funds from Corps of Engineers.

c. estimated project funds in the amount of $120,000 be made available for acquiring perpetual public access easements on 32,000 acres of rangeland surrounding the installed watering devices as determined by study recommendation 6a. Corps of Engineers in cooperation with Washington Department of Game and Bureau of Sport Fisheries and Wildlife would obtain the necessary easements.

7. an upland game management program be undertaken with project funds to offset project-incurred upland game losses. The program would include land acquisition of about 660 acres costing $328,500. About 14,260 acres of land surrounding the land parcels acquired in fee would be placed in perpetual easement status under landowner agreements at an estimated cost of $1,069,000. Habitat development costs for all management lands are estimated at $146,200 with annual operation, maintenance, and replacement amounting to about $5,350. Washington Department of Game would be responsible for initiating and managing this program with project funds.

8. a game bird farm be constructed (or suitable alternate provided) in the projects' vicinity and managed for stocking the wildlife management units proposed in recommendation 7. This facility would

have an estimated capital cost of $1,000,000 and annual operation, maintenance, and replacement costs estimated at $68,000. These costs designed to mitigate project-incurred losses are considered to be a project responsibility. Washington Department of Game would assume management responsibilty.

9. destruction of vegetation on project lands be held to a minimum. Plans for vegetation retention be cooperatively developed by Corps of Engineers, Washington Department of Game, Idaho Fish and Game Department, and Bureau of Sport Fisheries and Wildlife.

10. Corps of Engineers' placement of spoil and programs using herbicides and pesticides on project lands or waters be evaluated in cooperation with Environmental Protection Agency, Bureau of Sport Fisheries and Wildlife, National Marine Fisheries Service, Washington Departments of Fisheries and Game, and Idaho Fish and Game Department.

11. in accordance with the February 12, 1972, Joint Policy of the Departments of the Interior and the Army, relative to reservoir project lands and waters, all project lands and waters that are of value for fish and wildlife management as may be mutually determined by Corps of Engineers, Bureau of Sport Fisheries and Wildlife, and Washington Department of Game, should be made available to Washington Department of Game under terms of a General Plan and subsequent cooperative agreement.

12. a zoning plan be developed to assure equitable use of the reservoir and adjacent lands for fishing and hunting as well as other recreational purposes. Such a plan should be developed by Corps of Engineers in cooperation with Bureau of Sport Fisheries and Wildlife, National Marine Fisheries Service, Bureau of Outdoor Recreation, Washington Department of Fisheries, Washington Department of Game, and Idaho Fish and Game Department.

13. such reasonable modifications be made in the authorized projects' facilities and operations as may be agreed upon by Directors of the Bureau of Sport Fisheries and Wildlife, National Marine Fisheries Service, Washington Departments of Fisheries and Game, Idaho Fish and Game Department, and Chief of Engineers, for conservation, improvement, and development of fish and wildlife resources.

14. Federal lands and project waters in the project areas be open to the public for hunting, fishing, and related recreation uses except for areas reserved for safety, efficient operation, or protection of public property, or those areas where closures may be found necessary by Washington Department of Fisheries, Washington

Department of Game, National Marine Fisheries Service, and Bureau of Sport Fisheries and Wildlife to conserve and/or develop fish and wildlife resources.

15. leases of Federal lands in the project areas assure the right of public use of such lands for hunting, fishing, and related activities.

Appendix - Cost Estimate for Spring and Summer Chinook Hatchery Program 1/

To illustrate the methods of calculating the various parameters and costs, the procedure will be followed in detail for spring and summer chinook. Calculations for other species have been determined similarly.

Table 2 indicates a representative value of 122,200 spring and summer chinook passing Ice Harbor Dam. It has been noted that smolt mortalities, (percentagewise) can be translated directly into adult mortalities, and that a 15 percent smolt loss per dam would result in a cumulative 48 percent for the four dams. Consequently, 48 percent of 122,200 adults indicates that 58,700 adults would be required to counter the loss.

To produce 58,700 adults would require a hatchery to handle 1,900 females and then demonstrate that this is the case. Calculations are given in the following table:

Adult female requirement (3,800; 50% female)	1,900
Eggs needed at 5,000 per female	9,500,000
Smolts needed at 70% survival	
Numbers	6,720,000
Pounds at 15 per pound	448,000
Adult return at 0.61% survival	58,700
Capital cost at $20,00 per pound of smolts	$8,960,000 1/
OM&R at $1.12 per pound of smolts	$ 502,000 1/

Engineers have estimated that collecting, eyeing, holding, and transportation will entail estimated capital costs of $432,000 and OM&R of $50,000.

1/ These estimates of cost were prepared in 1968; substantial increases can be anticipated at time of construction.

IDAHO FISH AND GAME DEPARTMENT

January 17, 1972

POST OFFICE BOX 25
600 SOUTH WALNUT STREET
BOISE, IDAHO 83707

Mr. John D. Findlay, Regional Director
Bureau of Sport Fisheries and Wildlife
P. O. Box 3737
Portland, Oregon 97208

Dear John Findlay:

We have reviewed the Bureau of Sport Fisheries and Wildlife draft report on the Corps of Engineers Lower Snake River Dam project and have the following comments.

Page 5, paragraph 2, last sentence--"and private" should be inserted between "Federal" and "dams".

Page 5, paragraph 3--nitrogen supersaturation should be added as a major pollutant.

Page 8, last paragraph, first sentence, and Page 9, first partial paragraph, third sentence--we suggest substituting "minimize" for "offset".

Page 12, last paragraph, sentence 2--brown trout should be included among the less important resident game fish species.

Page 15, paragraph 3--In our opinion the difference between angler days use on the river and on the reservoir would be much greater than the 45,000 days indicated.

Page 17, first partial paragraph, second complete sentence--suggest the word "conceivably" be substituted for "feasibly". Action by the Idaho Fish and Game Commission approving relocation of the fall chinook run contained several conditions and qualifications. While there is no reason to believe these conditions and qualifications cannot be met in the future, they have not been resolved to date.

Page 33, first paragraph, sentence 3--dissolved nitrogen is not technically completely cumulative from one project to the next.

Page 51, item 1, sentence 1--we suggest insertion of the words "project related" between "offset" and "fish".

Page 58, item 13--The Director of the Idaho Fish and Game Department should be included as one of the parties acting on the recommended modifications.

Wildlife

We disagree with the statements contained in the first two sentences under "B" on pages 45 and 46 and the first sentence under (1) on page 46. It is our conviction that the recommended mitigation measures or any other feasible measures will not significantly compensate for wildlife losses due to impoundment. Project involved wildlife resources are minimal in Idaho, however, and we will defer detailed comment to the Washington Department of Game.

We appreciate the opportunity of reviewing this draft report. The importance of initiating measures for compensation of fish and wildlife, particularly anadromous fish, cannot be overemphasized.

It appears to us that there may conceivably be difficulties in resolving the wildlife issue pointed out in the report. If these difficulties should arise we would urge that, if possible, the urgently needed anadromous fish compensation measures be pursued independently of the wildlife phases. In view of present project related losses occurring in the Snake River anadromous fish runs, it is imperative that action to return the runs to pre-project levels be initiated as soon as possible.

Sincerely,

IDAHO FISH AND GAME DEPARTMENT

Joseph C. Greenley
Director

cc: BSFW, Spokane

FISH COMMISSION

OFFICE OF THE DIRECTOR

307 STATE OFFICE BLDG. • 1400 S.W. 5th AVE. • PORTLAND, OREGON • 97201

TOM McCALL
GOVERNOR

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EDW. G. HUFFSCHMIDT
Vice Chairman
McKEE A. SMITH
Member

January 14, 1972

Mr. John D. Findlay
Regional Director
Bureau of Sport Fisheries and Wildlife
Post Office Box 3737
Portland, Oregon 97208

Dear John:

We have reviewed the draft report entitled "A Special Report Presenting Plans to Mitigate Fish and Wildlife Losses Caused by Ice Harbor, Lower Monumental, Little Goose and Lower Granite Lock and Dam Projects".

Members of our staff have participated in preparation of this report. We are familiar with its contents and concur in them. The anadromous fishery portion of the report is unprecedented in that it seeks compensation for upstream and downstream fish passage losses at the four Snake River projects as well as losses for inundated spawning area. Past compensation efforts have been confined to losses of spawning area inundated or blocked by dam construction because of the extreme difficulty of evaluating upstream and downstream passage losses.

It is urgent that processing of this report be completed as soon as possible. It has been understandably complex to prepare and has been delayed several times because of this and other reasons. We have recently heard there may be problems with the wildlife section of the report which could cause further delay. If this is true, we would suggest that you consider separating the fish from the wildlife section of the report so the fishery section can be submitted and processed without delay.

We believe implementation of the recommendations in this report in essentially their present form is extremely important as regards salvation of the troubled Columbia River anadromous fish runs. Funding of this program is almost as critical as resolution of the nitrogen supersaturation problem. We ask that your bureau alert appropriate conservation groups

to support this report in Washington, D.C. and that it keep these groups and the concerned fish and game agencies fully apprised of how this report is faring as it moves through the various levels of governmental decision makers in this area and the capitol.

We appreciate the opportunity to review this report.

Sincerely,

Thomas E. Kruse

THOMAS E. KRUSE, ACTING
STATE FISHERIES DIRECTOR

cc Bureau of Sport Fisheries and Wildlife, L. Edward Perry
Cannon, Kessler
Corps of Engineers, North Pacific Division
Corps of Engineers, Walla Walla District
Idaho Fish and Game Department, Monte Richards
Northwest Steelheaders, Bill Luch
Oregon Division, Izaak Walton League, James Potter
Oregon State Game Commission, William Pitney
Oregon Wildlife Federation, George Reed
Washington Department of Fisheries, William Rees
Washington Department of Game, John Douglas

GAME COMMISSION

OFFICE OF THE DIRECTOR

P.O. BOX 3503 • 1634 S.W. ALDER ST. • PORTLAND, OREGON • 97208 • Ph. 229-5551

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GOVERNOR

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JOHN W. McKEAN
State Game Director

January 25, 1972

Mr. John D. Findlay
Regional Director
Bureau of Sport Fisheries & Wildlife
P. O. Box 3737
Portland, Oregon 97208

Dear Mr. Findlay:

We have reviewed your special report to the Corps of Engineers to compensate for fish and wildlife losses caused by the lower Snake River dams. We have only one comment.

On page 17, the second paragraph concerns hatchery capability to return 50,700 spring-summer chinook adults upstream from Lower Granite dam. The appendix states that smolts would be released at 15 to the pound. Our experience has been that smolts between 6 and 8 per pound yield much higher returns of adult fish. This significantly reduces the number of smolts that need to be reared.

We thank you for the opportunity to review this report.

Sincerely yours,

John W. McKean
Director

cc Fish Commission of Oregon
River Basin Studies - Spokane

WASHINGTON
Department of
FISHERIES

DANIEL J. EVANS
GOVERNOR

ROOM 115, GENERAL ADMINISTRATION BUILDING • PHONE 753-6600
OLYMPIA, WASHINGTON 98504

THOR C. TOLLEFSON
DIRECTOR

February 7, 1972

Mr. John D. Findlay
Regional Director
Bureau of Sport Fisheries and Wildlife
Post Office Box 3737
Portland, Oregon

Dear Mr. Findlay:

We are pleased that your report, "A Special Report Presenting Plans to Mitigate Fish and Wildlife Losses Caused by Ice Harbor, Lower Monumental, Little Goose and Lower Granite Lock and Dam Projects" is nearing completion. The preparation of the report has taken considerable time and effort but in view of the importance of the resources involved and the interests of the various fish and wildlife agencies we feel it was justified. Further, the present plan has the advantage of the latest knowledge and technology and therefore should present the best opportunity for preserving for future generations the valuable runs of Snake River salmon and steelhead.

We appreciated the opportunity to review and contribute to the report and we concur with your November, 1971 draft. We are anxious to see the plan implemented and, if we can be of further assistance, please call on us.

Sincerely,

Thor C. Tollefson

Thor C. Tollefson
Director

cc: Charles M. Chambers, BSF&W, Spokane

DEPARTMENT OF GAME

600 North Capitol Way / Olympia, Washington 98504

March 22, 1972

Mr. John D. Findlay, Director
Pacific Region, Bureau of Sport
Fisheries and Wildlife
1500 N. E. Irving Street
Portland, Oregon 97208

Dear John:

We have reviewed the report on the effect of Corps of Engineers' dam structures on fish and wildlife resources of the Snake River. We find the report generally lacking in figures on the fish and wildlife resources. It is unfortunate that the Corps of Engineers did not comply with the Fish and Wildlife Coordination Act and consult with the states involved so that studies could have commenced early enough to gather adequate data to obtain a true picture of the impact of the projects on fish and wildlife. It is fortunate that this Department had some data gathered on routine investigation of the area involved, or none would have been available. It is, therefore, with reluctance that we make the following comments on the report:

1. Without adequate preflooding investigations on fish and wildlife resources, limited information exists for scientific evaluation of project impact. A report on pre-existing fish and wildlife resources prepared with limited data and, in fact, after the resource has been eliminated is saddled with inherent weakness and questionable credibility.

2. The only number and distribution data included are for fish and geese. This weakness in the report affects evaluation of preflooding resources, as well as what might have been the potential without the project.

3. The use of man-days of recreation to assign basic values to a natural resource is at best faulty. It reflects economic value only and does not consider the potential use of a resource that existed in an area of limited accessibility and rugged terrain.

4. Information on non-hunted wildlife is inadequate. No population estimates are given and even a list of species is lacking. It is, therefore, difficult to evaluate losses and develop mitigation proposals for a resource that is increasingly assuming a more significant role in outdoor recreation activities.

5. No evaluation has been made as to the effect of project-related activities (railroad rights of way, borrow areas, staging sites) on the habitat of wildlife species.

6. The mere provision for escapement of 55,100 steelhead above the project does not compensate for project-related losses of fishing opportunities. Angler opportunity for steelhead has been significantly reduced by the project and merely purchasing stream bank easements on tributary streams does not solve the problem. Additional steelhead stocking in these streams will be necessary to partially compensate for losses.

7. Creel census and questionnaire data by this Department at its own expense from 1964-1970 indicate a decline in reservoir angler-days spent fishing for resident species. The projection of 205,000 annual angler-days for warm water species in the reservoir area is too high, in our opinion. Therefore, the difference between angler-days use on the river and on the reservoirs is greater than the 45,000 angler-days used.

8. Distribution of catchable trout to partially compensate for lost angler-days of fishing for resident species should be based upon where the losses occurred. Most of the lost opportunity occurs in Washington and the report does not establish the portion of these fish to be allotted to Washington.

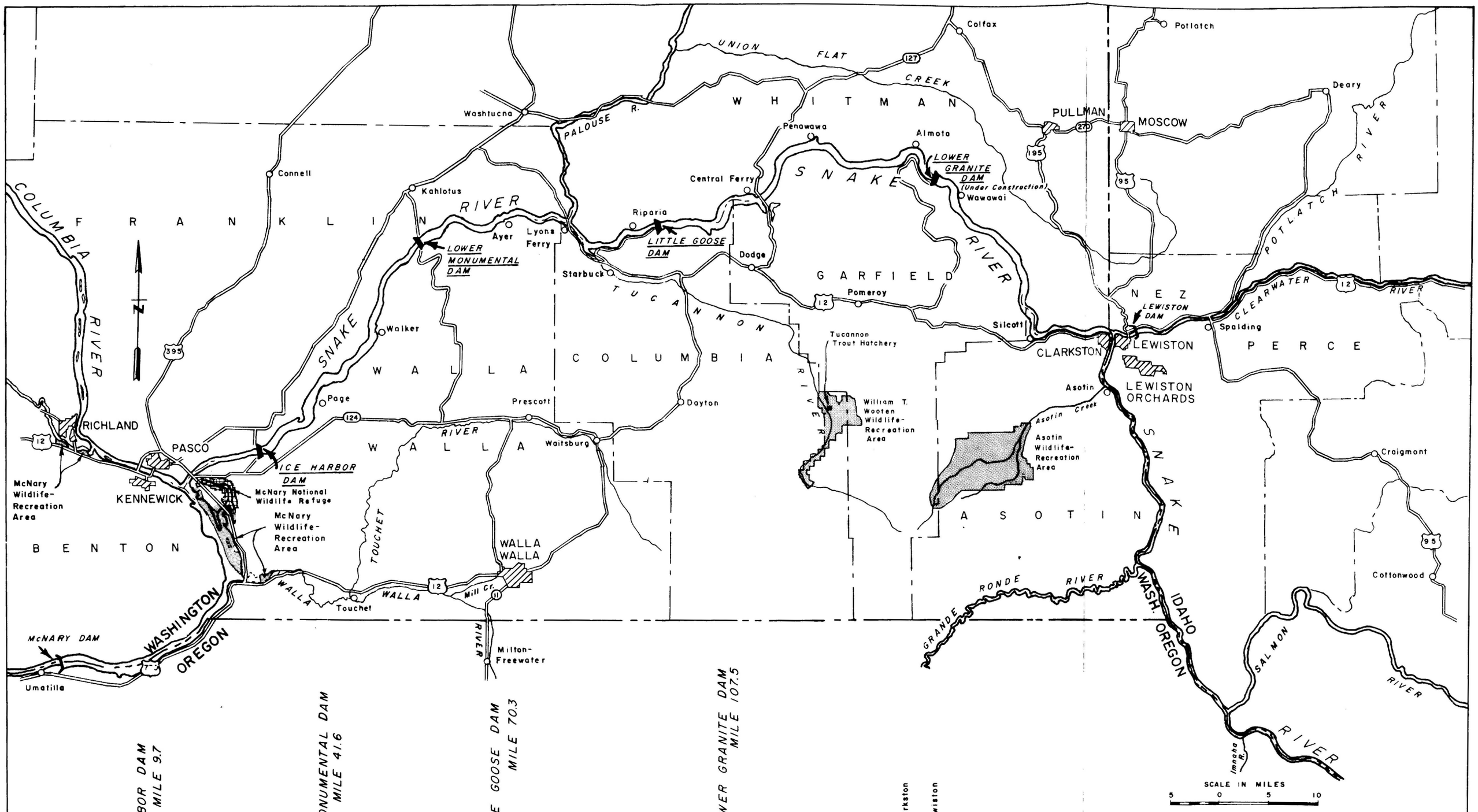
Our first reaction to your report was to not concur. However, after due consideration of the limitation on funds to accomplish development of all the fish and wildlife data needed and the constraints under which the mitigation proposals must be developed, we will reluctantly agree that the proposals presented are somewhat reasonable under the circumstances. We do not feel that true replacement of fishing and hunting opportunities in the project areas are being accomplished and at best we may expect to obtain minimal mitigation, which the plan in the report appears to do.

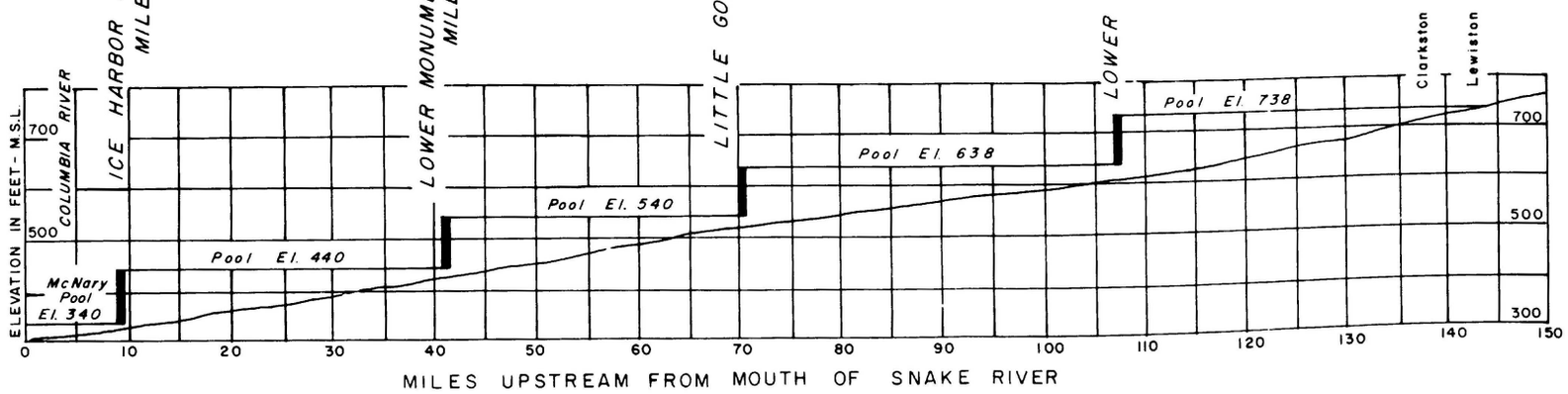
Very truly yours,

THE DEPARTMENT OF GAME

Carl N. Crouse, Director

CNC:mm
cc: Environmental Mgt. Division





PROFILE OF SLACKWATER PLAN

ADAPTED FROM CORPS OF ENGINEERS MAP

UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF SPORT FISHERIES AND WILDLIFE

GENERAL MAP
CORPS OF ENGINEERS

LOWER SNAKE RIVER LOCK AND DAM PROJECTS

SNAKE RIVER
WASHINGTON AND IDAHO

MAY 1972

PORTLAND, OREGON

A P P E N D I X

to Special Report on the

LOWER SNAKE RIVER DAMS

Ice Harbor
Lower Monumental
Little Goose
Lower Granite

Prepared by Fish Commission of Oregon as supplement
to report of National Marine Fisheries Service and
Bureau of Sport Fisheries and Wildlife, September 1972

Portland, Oregon

March 1973

Appendix to Special Report on Lower Snake River Dams

INTRODUCTION

The report entitled "Special Report on the Lower Snake River Dams, Ice Harbor, Lower Monumental, Little Goose, and Lower Granite" was submitted by the fisheries agencies to the Corps of Engineers in September 1972. The report concerns fish and wildlife compensation for the effects of these dams. It was prepared in response to Colonel Frank McElwee's April 11, 1966, letter to former Regional Director Paul T. Quick of the Bureau of Sport Fisheries and Wildlife.

We recognize that the report is difficult to follow for those not intimately connected with Columbia and Snake River fisheries problems. Consequently, we are supplementing the report with this appendix. In this appendix we shall demonstrate that use of the concept of "maximum" dam count to assess liability is justifiable. We shall show the levels of runs which should be maintained in the Columbia River system in order to counter the effects of dams constructed in recent years. This will be related to compensation being requested for the lower Snake River dams. We shall also give evidence of mortalities to adult salmonids resulting from the lower Snake projects which evidence was not available at the time the original report was prepared. We shall demonstrate that the dam counts which have seemingly held up favorably over the years are artifacts created by extensive curtailment of commercial fisheries to counter losses of adult fish passing dams. Finally, we shall demonstrate the serious impact of the main stem dams on our major fisheries.

ESTIMATE OF LOSSES DUE TO McNARY AND SUBSEQUENT DAMS IN COLUMBIA AND SNAKE RIVERS

In confining our attention to the more immediate effects of the four lower Snake River projects, we artificially fragment the broad picture and

tend to lose perspective. Dam construction occurring prior to the lower Snake projects has had a tremendous effect in depressing the Snake River runs. To base compensation at the four lower Snake River dams on these depressed levels is tantamount to ruining a man's business and then buying him out at a price far below its actual value. Most of this inequity and the resulting confusion in trying to measure it would not have occurred had it been possible to completely compensate for the effects of each dam at the time of completion. Prior to the current lower Snake River proposal, compensation for anadromous fish has been almost exclusively limited to restitution for runs completely blocked from spawning areas. Losses of adults and juveniles due to adverse passage conditions at and between dams have never been compensated for. That such losses do exist and are serious is well established by numerous studies by the fisheries agencies and the Corps.

In an effort to correct for these heretofore uncompensated losses in the entire Columbia River system, the fishery agencies early in 1971 requested an improved program to seek restitution. In a letter of February 22, 1971, General Roy S. Kelley (former Division Engineer of the North Pacific Division of the U. S. Army Corps of Engineers) suggested that a program for the mitigation of additional losses "should be initially formulated and recommended to us by the joint fishery agencies of the Northwest who possess expertise in these matters. We would then have a basis for documenting the severity of the problem, the justifiability of proposed measures, and should be in a sound position to make appropriate recommendations to higher authority in the Corps of Engineers and the Congress."

As a first step toward such a program, the Fish Commission of Oregon prepared what we include here as Appendix Tables 1 and 2. Appendix Table 1

demonstrates that following the completion of McNary Dam in 1953 and the ensuing construction of a series of major dams, adverse conditions severely reduced the productivity of the spawning escapement. To illustrate this, data on Columbia River salmon (spring chinook, summer chinook, and sockeye) and steelhead are tabulated for two periods:

(1) Pre-McNary-The Dalles brood years (1942-52) for which effects of Rock Island, Bonneville, and Grand Coulee dams were included.

(2) Post-McNary-The Dalles brood years (1957-67) which were additionally influenced to varying degrees by six dams on the Snake River and seven dams on the Columbia River (completed since 1957).

In Table 1, the measure of productivity for comparing the pre- and post-McNary periods is "return per spawner." To illustrate, if on the average one spawner produces one adult returning to the river 4 years later, the return per spawner is 1.0 and no harvest could be permitted if the run size were to be maintained. Moreover, if on the average each pair of spawners produces five adults returning to the river, the return per spawner would be 2.5, and three of each five fish or 60% of the run could be harvested and still maintain the run at the same level. We refer in the table to run size as a measure of "return" to the river and escapement as a measure of the "spawners."

The run size is the total number of adult fish returning to the Columbia River annually. It is estimated by adding the number of fish caught in the fisheries below Bonneville Dam to the Bonneville Dam count. Escapement is defined as the number of fish permitted to escape from the lower river fisheries, i.e., the numbers of fish passing over Bonneville Dam minus the commercial and Indian catches above Bonneville Dam. The term "escapement" used in this sense is meaningful since if upstream dams

Appendix Table 1. Basic Columbia River Salmon and Steelhead Data for Estimating the Production Rates (return per spawner) for the 11 Brood Years Preceding the Completion of McNary Dam and the 11 Brood Years After the Completion of The Dalles Dam

Period	Parameter	Salmon: Spring Chinook	Salmon: Summer Chinook	Salmon: Sockeye	Summer Steelhead
Pre- McNary-The Dalles brood years (1942-52)	Avg escapement (1942-52)	52,400	37,900	49,100	95,600
	Avg run size (Salmon: 1946-56) (Steelhead: 1947-57)	187,300	105,100	195,900	259,600
	Return per spawner	3.57	2.77	3.99	2.72
Post-McNary-The Dalles 1/ brood years (1957-67)	Avg escapement (1957-67)	83,200	82,500	72,500	130,000
	Avg run size (Salmon: 1961-71) (Steelhead: 1962-72)	172,500	94,500	100,400	200,800
	Return per spawner	2.07	1.15	1.38	1.54

1/ *It should be noted that the production in these years was also influenced in varying degrees by other dams: Brownlee (1958), Priest Rapids (1960), Oxbow (1961), Rocky Reach (1961), Ice Harbor (1962), Wanapum (1963), Wells (1967), Hells Canyon (1967), John Day (1968), Lower Monumental (1969), and Little Goose (1970).*

kill a portion of the escapement (or a portion of the juvenile migrants) the return per spawner will measure this reduction.

Although there is some variation in the age of returning adult salmon and steelhead, we have used a return age of 4 years for salmon and 5 years for steelhead based on scale analyses. Under this set up, we have assumed that the salmon escapements from 1942 to 1952 produced the salmon runs returning from 1946 to 1956. Similarly for steelhead we relate the runs returning from 1947 to 1957 to brood year escapement from 1942 to 1952. Ocean catches for runs considered here are generally minor and are therefore not included. Ocean catches of Columbia River steelhead and sockeye are insignificant, and scale studies of ocean caught chinook indicate that the vast majority of these are fall chinook.

As already stated, our measure of productivity is "return per spawner" which is merely the run size ("return") divided by the escapement ("spawners"). The reduction in return-per-spawner values for recent years is rather dramatic for every species considered here. We might particularly draw attention to the "post" value for summer chinook of 1.15, recognizing that when the value drops below 1.0 the run is not even reproducing itself. Currently no direct fishery[1/] is permitted on this run although historically it was the single most important run in the Columbia.

To effectively regulate a fishery on anadromous species, it is important to determine the "optimum" or most desirable escapement needed to produce the greatest sustainable yield. By the late 1950's the accumulation of data from the fisheries and Bonneville counts supplied an excellent basis for estimating "optimum" escapement levels which were 80,000 each for spring

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1/ *A few summer chinook are taken incidentally to the harvest of sockeye salmon.*

chinook, summer chinook, and sockeye salmon and 120,000 for summer steelhead (line 2, Appendix Table 2).

The optimum run (line 1 of Appendix Table 2) is estimated by multiplying the optimum escapements by the return per spawner for the pre-McNary period. These are the run sizes that could have been maintained if optimum escapement levels had been followed and if the series of dams starting with McNary had not been constructed. Optimum productions are maintained by harvesting the difference between run produced and escapement required. We refer to this harvest as the "optimum sustainable yield."

To estimate what our fisheries are now losing under current production we must estimate what yields can currently be maintained. As a starting point we have assumed in Table 2 (current period) that the magnitude of the runs maintained by the 1957-67 broods (Table 1) can still be maintained. It is not proper, however, to use the escapement values for this period, because increased adult losses particularly since the completion of John Day in 1968 required increased adult escapements from the fisheries to get the same number of adults to the spawning areas. Consequently average escapements for the years 1968 to 1972 have been used to represent the escapements in the current period in Table 2. As we have seen in studying the optimum condition, the current sustainable yield is the difference between the current run size and the current escapement.

Finally the average yearly loss to the fisheries from dams completed since 1953 may be estimated by subtracting the current yield from the optimum yield. It is of interest to compare these losses with estimated losses presented in the lower Snake River report, keeping in mind that the majority of the spring and summer chinook and summer steelhead runs considered in Tables 1 and 2 are produced by Snake River tributaries. Estimated

Appendix Table 2. Computation of Average Yearly Loss to Columbia River Fisheries Based on Difference between Optimum Yield 1/ and Current Yield

Period	Parameter	Salmon			
		Spring Chinook	Summer Chinook	Sockeye	Summer Steelhead
Pre McNary-The Dalles	Average optimum run	285,600	221,600	319,200	326,400
	Optimum escapement	80,000	80,000	80,000	120,000
	Optimum sustainable yield (difference)	205,600	141,600	239,200	206,400
Current	Average run >(Table 1)	172,500	94,500	100,400	200,800
	Average escapement >1968-72	115,400	74,800	68,700	129,800
	Average sustainable yield (difference)	57,100	19,700	31,700	71,000
Average yearly loss to fisheries (difference between yields)		148,500	121,900	207,500	135,400

1/ *Optimum yield is average yearly harvest that could have been taken by fisheries if McNary and subsequent dams had not been constructed.*

Snake River losses are 58,700 for spring and summer chinook combined while Columbia River losses are 270,400 (see Table 2, 148,500 spring chinook and 121,900 summer chinook). Estimated losses for Snake River summer steelhead are 55,100 compared to Columbia River losses of 135,400. Sockeye runs to the Snake River are small and no replacements have been requested for this species.

It is of interest to note that the average optimum run sizes (i.e., the run sizes that could have been maintained had McNary and subsequent dams not been built) given in Table 2 are reasonably close to the maximum run sizes since 1946 of 281,000 spring chinook (in 1955), 207,000 summer chinook (in 1957), 335,000 sockeye (in 1947) and 383,000 summer steelhead (in 1952). This illustrates why maximum rather than average run sizes during this period are representative of river potential. Average runs during this period were not representative. This largely resulted from an overharvest of the runs combined with a drastic translocation program following completion of Grand Coulee Dam.

In the Special Report on the Lower Snake River Dams, maximum counts since the completion of McNary Dam are used as estimates of representative runs in the pre-McNary period. For the Columbia River system we have seen that maximum runs are representative of potential river production. Consequently the use of "maximum" run does not subject the Corps to the responsibility for maintaining runs which nature would permit only on rare occasions. Rather the compensation program requested here in conjunction with compensation being requested for other projects in the Columbia basin will, if obtained, merely help us to approach yields of salmon and steelhead that could have been maintained on a sustained yield basis in the late 1940's and early 1950's and could still be maintained if these projects had not been constructed.

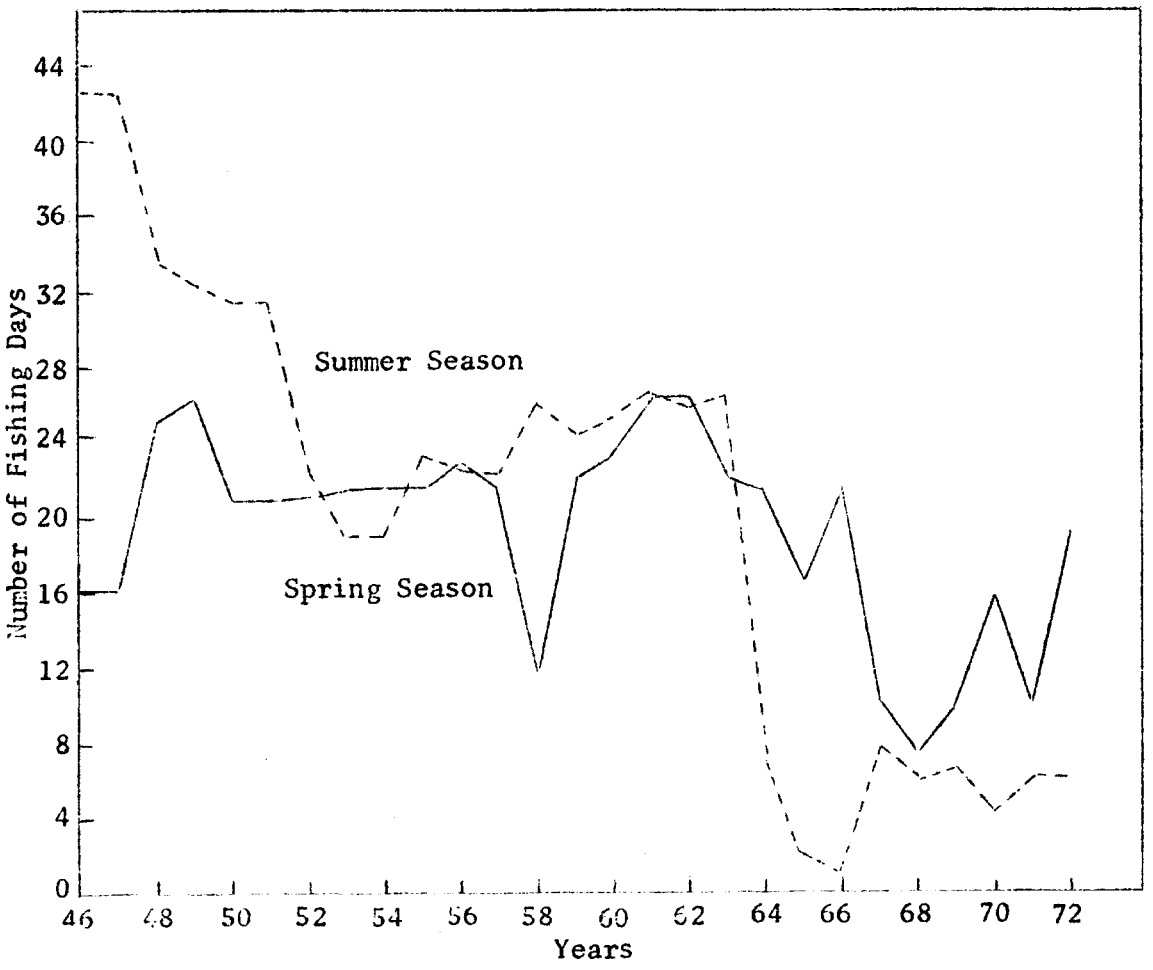
ACTUAL LOSSES TO FISHERY

The actual loss to the fishery in recent years is particularly distressing. In order to provide adequate escapement levels to spawning areas, increasing interdam losses of adult fish have been countered by severely curtailing the commercial fisheries. This has been accomplished both by reducing the number of fishing days allowed and by permitting fishing only during periods when fewer fish are present so that the resulting fishery is less efficient.

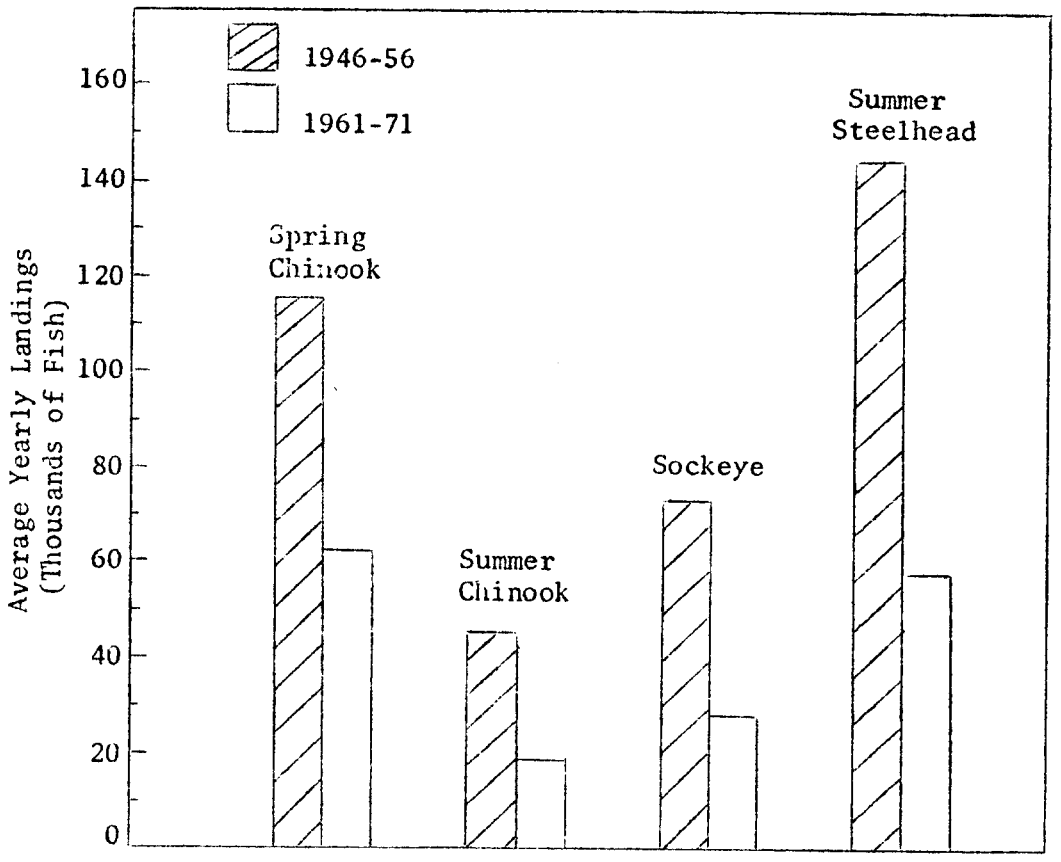
Appendix Figure 1 illustrates the decline in number of fishing days since 1946. Appendix Figure 2 shows the decline in the actual commercial landings of spring and summer chinook, sockeye, and summer steelhead for the same pre- and post-McNary years considered in Appendix Tables 1 and 2. It is clear that the landings of these species have been reduced to less than half their former levels.

In addition to compensating for increasing losses of fish between dams additional escapement has been allowed to compensate for prespawning mortalities occurring to fish after they have passed the uppermost dam. We believe that many of these mortalities resulted from nitrogen gas bubble disease. However, prespawning mortality was observed during 1972 when nitrogen levels were relatively low because of river flow regulation by the Corps. Observations of fish on and below their spawning grounds indicated that delayed mortalities resulted from a high incidence of physical injury to fish passing dams. This prespawning mortality is illustrated by the declining number of spawning nests (redds) per 100 fish counted over the uppermost dam (Appendix Figure 3). 1/

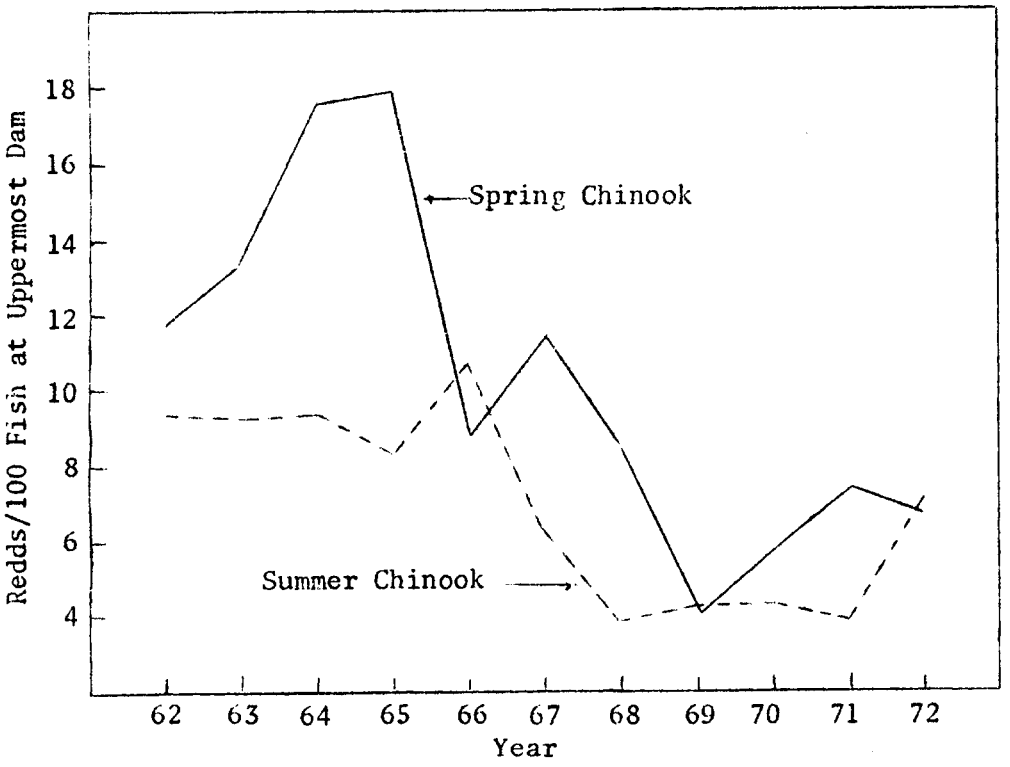
1/ *Redd counts supplied by Idaho Department of Fish and Game.*



Appendix Figure 1. Columbia River Commercial Fishing Seasons for Salmon Below Bonneville Dam, 1946-72



Appendix Figure 2. A Comparison of Average Annual Commercial Landings in Zones 1-6 for the Years 1946-56 and 1961-71 of Spring Chinook, Summer Chinook, Sockeye, and Summer Steelhead



Appendix Figure 3. Number of Redds in Standard Spawning Ground Survey Units in Idaho per 100 Fish Counted Over Uppermost Dam for Spring and Summer Chinook, 1962-72 1/

1/ *Redd count data supplied by Idaho Department of Fish and Game.*

IMPLICATION OF COLUMBIA RIVER LOSSES TO LOWER SNAKE RIVER PROGRAM

What should be most clear from the foregoing material is the magnitude of the fish losses in the Columbia River due to dams constructed in the last 20 years, and the inordinate hardship on the resource and the fisheries if reasonable compensatory procedures are delayed further. Losses due to Snake River projects have been expanding since the completion of Ice Harbor Dam in 1962, and serious losses related to main-stem Columbia River dams jumped sharply in the late 1950's and have continued year after year since that time. It could be argued that some of these losses result from environmental changes in tributary streams. However, during the period studied here, extensive screening of water diversions, other stream improvements, and increased hatchery production of spring chinook and steelhead have countered most of the adverse effects occurring in these tributaries during this period. It should be made clear that the hatchery production referred to is in no way connected with compensation for fishery losses at main-stem Corps projects.

We have given evidence that it is valid to consider maximum runs as rough estimates of optimum production. We have also shown that the numbers of spring and summer chinook and summer steelhead requested to compensate for Snake River projects is small when compared to total Columbia River losses and have pointed out that Snake River tributaries are the major producers of these stocks.

Modifications of lower Snake River projects to reduce mortalities (particularly to juvenile migrants) are currently underway. These include the installation of slotted bulkheads in existing skeleton units, the installation of deflectors in spillway units, and the development of

travelling screens to divert juveniles from entering the turbines. For the most part, these modifications are related to the serious nitrogen problem which has been developing in recent years. These modifications have not been considered in the lower Snake River report for a number of reasons. In the first place, no compensation has been requested for nitrogen losses although fisheries agencies as well as pollution control agencies in the Northwest have requested that the above measures be taken to reduce levels of nitrogen supersaturation. Secondly, the measures taken to reduce nitrogen levels introduce other sources of mortality. Direct mortalities to juvenile salmon passing through bulkheads are so great that at present the bulkheads are not used when large numbers of downstream migrants are in the river. Spillway deflectors are a possible source of mortality to both juvenile and adult salmonids. Travelling screens which may divert more than 80% of migrants approaching turbine units also induce mortalities. Furthermore, in the lower Snake River report no compensation has been requested for mortalities to adult salmon although serious delayed mortalities have been demonstrated, and serious mortalities to adults have been established directly at lower Columbia River dams as well as at Ice Harbor Dam, one of the Snake River projects under consideration. Consequently the losses we have not considered should more than counter any improvements from project modifications.

The process of obtaining reasonable compensation for both Snake and Columbia River projects will take quite a few years even if plans for hatchery construction are initiated immediately. Periodic evaluations can adjust for any benefits from project modifications as well as any additional losses due to peaking and other operational procedures. Further delay of the compensatory process, however, could have a serious impact on the viability

of our fish runs and our fisheries. Because of the Columbia and Snake River dams, fishermen have already lost an accumulation of tens of millions of pounds of prime salmon and steelhead. The present compensation program is not addressed to these past losses but rather is aimed at reducing such losses in the future.

In conclusion we would urge that plans for major hatchery construction not be delayed. If all of the hatcheries requested as well as project modifications presently considered are realized, the lower Snake River projects will not be over compensated. Considering the additional losses due to lower Columbia River projects it is clear that it is the resource and fisheries that are on the short side of the ledger.

Fish Commission of Oregon

March 7, 1973

REPORT ON THE LOWER SNAKE WILDLIFE MITIGATION PROPOSALS

June 1, 1974

Prepared By

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APPENDIX C

I. INTRODUCTION

In 1966, the Corps of Engineers, Walla Walla District requested the Washington Department of Game, and the Bureau of Sport Fisheries and Wildlife, USDI, to submit a report covering the impact (on wildlife) of all four dams (on the Lower Snake) and necessary compensation measures as a unit, which (they) could submit to Congress for approval and funding.

The first report was received from the BSF&W in November 1972. A follow-up report was prepared by the Corps and revised in April 1973, incorporating supplemental data from the fish and wildlife agencies. The Washington office of the Corps later recommended that the Walla Walla District retain consultants to

a.) review the recommendations and other available data,

b.) furnish a separate report evaluating the adequacy and feasibility of the proposals,

c.) and to either concur in the recommendations,

d.) or to present other means by which compensation of losses can be obtained.

I was contacted on 29 October 1973 regarding accepting the position as consultant and subsequently agreed. Due to the nature of the assignment and the short time schedule for report preparation, I asked two additional consultants to join me--Dr. Richard Shannon, Resource Economist, University of Montana, and James Posewitz, Administrator, Environment and Information Division, Montana Department of Fish and Game, Helena, Montana.

We visited the Walla Walla office of the Corps where we interviewed personnel, examined files and hearing transcripts, and on two occasions flew the length of the Lower Snake River, Union Flat Creek, Tucannon,

Touchet and Palouse Rivers. In addition, we visited Washington Department of Game District Offices in Walla Walla and Yakima and the State offices in Olympia where we interviewed the State Game Director and his personnel. They gave us full access to files and records and were extremely helpful in response to our questions. An extensive search of the literature relating to the wildlife and related land use practices of Southeastern Washington was made.

These materials were read to gain insight into the amount of research that has already been accomplished and to look for clues to support or deny statements made by the fish and wildlife agencies in their mitigation proposals.

In addition, we discussed key-points with resource specialists in Idaho and Montana. This preliminary report then, is based on our professional judgment, tempered by what we have read, heard, and seen. Our final report on June 30, 1974, will be a revision of this draft incorporating corrections and additions.

II. FAILURE OF THE WILDLIFE COORDINATION ACT

It has been stated that the goal of wildlife agencies is "...to maintain the productivity of ecologic systems at the highest level possible or consonant with other biological objectives; to retain the opportunity to manipulate habitats for the benefit of particular species; and to provide suitable (not always maximum) access to wildlife areas for harvest or other uses." We manage wildlife to prevent species extinction, to maintain productive ecosystems and to encourage and regulate beneficial uses of wildlife.

The specific responsibility of the Department of Game of the State of Washington is to preserve, protect, maintain, and enhance the wildlife resource for the people through regulations (enforcement) and continuing programs to provide maximum amounts of wildlife-oriented recreation for the people of the state. But state agencies seldom have the necessary authority to have full control (i.e., direct ownership) of land that may be needed for proper management of a wildlife species.

The commonest arrangement is through mutual cooperation. State fish and game agencies can become partners in negotiations (i.e., interagency agreements, examine permits, NEPA).

Most state constitutions fail to define clear-cut objectives for wildlife programs--vague, broad charges but with no implied veto power over all conflicting land uses. Federal agencies are also charged with responsibilities which may conflict with state game departments (especially in land use matters--i.e.--flood control, drainage, chemical spraying, prospecting for minerals in wilderness areas).

When direct conflicts arise in land use practices or priority allocations, wildlife generally loses. The wildlife agency is put in the role of sole defender of wildlife vs people and practices. They are called upon to defend water quality, scenic beauty, openspace recreation, often in the absence of a legislative mandate.

When conflicts in land use cannot be resolved and no provisions for priorities are established by statute, then they must be resolved through technologic or political adjustments. Mitigation is such an adjustment.

It should come as no surprise, however, to professional wildlife managers to learn that even with funds recently made available through mitigation processes that wildlife is still on the losing end. A recent report by the General Accounting Office states that the federal wildlife agencies in Interior and Commerce have either not known about the continuing losses of wildlife habitat or have done nothing to halt them. Lack of coordination of efforts, lax administration, cursory office studies, inadequate reviews and absence of recommendations were some of the charges brought by GAO against the agencies. They, in turn, usually blame the deficiencies on inadequate funding and staffing, a charge rebuffed by GAO.

This report is not the place to review the failure of the Coordination Act in its various revisions but rather to state the fact of its failure so as to clarify some of the problems to which we are addressing our efforts. There is simply not enough flexibility in the process of buying lands and easements, funding developments, conducting before and after studies and coordinating efforts of the state with two or more

federal agencies charged with multiple responsibilities. Rapid turnover in federal personnel militates against the continuous efforts needed to manage resources properly. Contract researchers also lack the familiarity with the area that comes with continuous effort. State Game Departments usually lack the funds needed to do the extensive surveys before and after inundation at each new site. They do, however, possess the personnel or administrative vehicle for handling added staff on such assignments. We hereby recommend that efforts be made to assign study funds to the state agency as a contractor and that more trust be placed in the findings resulting from such efforts.

III. MITIGATION PROPOSALS

A review of correspondence, reports, and statements made during interviews leads to several generalizations on areas of agreement and of disagreement regarding the suggested mitigation proposals.

The fish and wildlife agencies have consistently stressed the losses of wildlife that have occurred as the result of the construction of four dams along the lower Snake River. They have pointed out the resulting loss of wildlife and of wildlife oriented recreational opportunities, whether it be by hunters or by non-consumptive users of the area--hikers, boaters, bird watchers, etc. They also feel that these loss estimates have been generally conservative.

The Corps of Engineers, while admitting the fact of loss, seemed disturbed by the generalized statements of destruction and wanted these losses "quantified and described in greater detail." The Corps felt that very little data had been presented to them for evaluation by their personnel. They would like to know if the estimates are reasonable and if the proposed solutions are practical responses.

In the brief period that we worked on this assignment it was obvious that a) far more material on fish and wildlife existed than was made available to the Corps, and b) that biological data collections can never match those generated by engineering activities due to the difference in the nature of the problems and the available methodology to determine best estimates. Two-party exchanges seldom function freely and efficiently and we feel that many of the delays and complications are inherent in the system as presently operated with split responsibilities and conflicting mandates.

III. (A.) STATEMENT OF ESTIMATES OF LOSSES, AND EVALUATION:

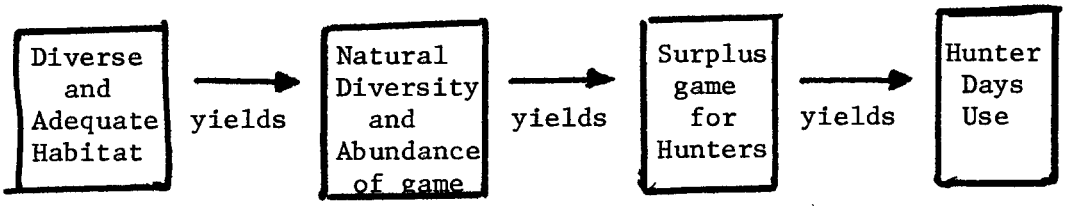
Losses of wildlife occur continuously in natural environments but if natality exceeds mortality, populations will increase at a variable rate. Because of the secretiveness and mobility of animals dispersed over space and time, and due to the lack of funds and trained personnel to do more intensive work, population data frequently is held suspect by the public who view game avocationally. The findings are also challenged by other scientists and engineers who deal with more easily quantifiable subject matter. In the absence of data prior to inundation it is very difficult to extrapolate from post-inundation data with any degree of accuracy. But if it must be done, as has been requested in the mitigation reports, then this becomes the primary responsibility of the fish and wildlife agencies.

Washington game biologists have used several management techniques generally acceptable to wildlife managers in preparing their estimates of losses--i.e., statewide harvest averages for deer in varying quality habitat, check station data, card questionnaires, field surveys before and after, if possible, or by comparison with similar areas elsewhere (i.e., Wells project). Hunting mortality can be calculated with fair accuracy but mortality or reduced natality induced by habitat changes such as inundation is far more difficult to assess.

Hunter-day use as an index of game abundance is a commonly used method and no workable substitute is available at present. Perhaps the relationships are more easily understood if we use a conceptual model.

Hunters are afield in anticipation of success and generally success is enhanced if the hunter selects an area inhabited by game animals,

preferably lots of them. This condition inevitably leads to more hunters or to more days afield per hunter or both. Thus it should be more frequently acknowledged that hunter days formerly spent pursuing game species reflected a total habitat quality that in its diversity also produced unquantified amounts of non-game species. It would appear as follows:



Then it also follows that improvement of habitat--i.e.--more vegetative cover, a greater variety of plants, more ecologic niches, and improved year around water supplies would be expected to improve conditions for game and non-game animals alike. Specific recommendations for enhancing conditions for individual species should result from the studies recommended in the preliminary mitigation reports of the cooperators.

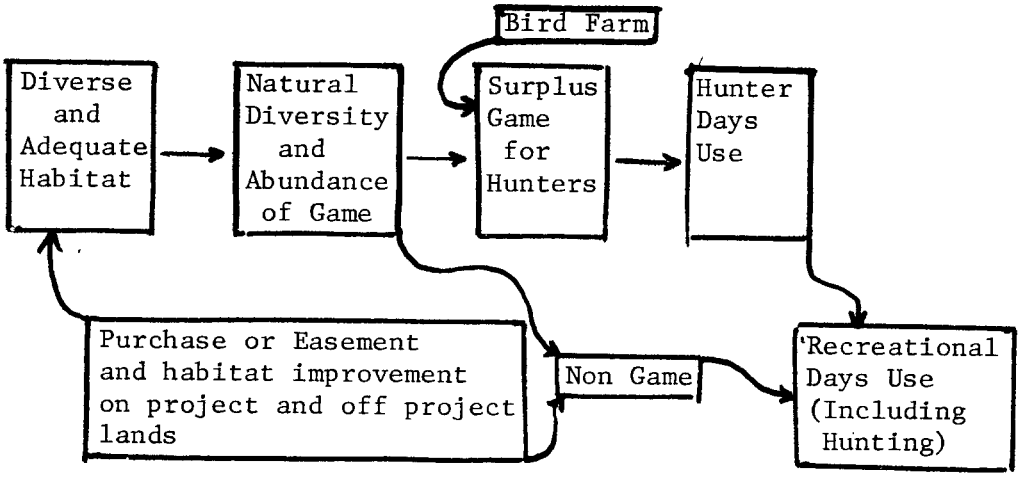
Evaluating losses in man/days use involves benefit/cost ratios that often appear to be too high. The State prefers to use the units of habitat needed to replace the amount of game necessary to duplicate the man/days use (pre-project). This may also involve enormous costs of reestablishment. The State feels that an attempt should be made to replace the resource "in kind" and that an increase in man/days use will follow. Since they didn't destroy the resource it should not be their responsibility to rebuild it. Hence cost considerations should be left to the responsible agency, based on the recommendations of qualified

biologists in the B.S.F.& W. and State Department of Game.

The State feels that immediate replacement is needed for the loss of recreation, which involves a broad spectrum of wildlife. In the special report summary prepared by Ohligher and Mains (July 1973, Pg. 54) this view is supported. "Full compensation of project-caused losses to wildlife require that these displaced animals be replaced in numbers and kind or that man's use level of these resources be maintained with a satisfactory alternative."

Replacement in numbers and kind is a stated goal but parts of this objective will be more difficult to achieve and will take more time. The State feels that a bird farm should be constructed to produce pheasants that will provide this immediate replacement. They point to the generally accepted practice of fish hatcheries and artificial stocking as a precedent.

The model now looks like this:



The Bureau of Sport Fisheries and Wildlife performed the calculations for man-days use based on raw data supplied by the Washington Department of Game. The State agency approaches the problem by

stressing the average population for each species, its potential yield, and its relative importance in the future. The B.S.F.& W., faced with limited funds and personnel, preferred to use the more general index of man-days use, determined from data supplied from the State. We believe they both tell the same story.

The 1964-1966 surveys conducted by the State in the project area were combined with statewide surveys of hunter success, population yield, and local surveys to achieve density per acre figures. From this they calculated gains or losses from pre-to-post project conditions. (For statistical accuracy, refer to the testimony of Dr. Scott Overton, Oregon State University, as reported in the P.U.D. transcripts of the Wells Project.)

Selecting a proper sample size is a difficult problem with mobile wildlife species, especially in arid country bisected by rivers and streams supporting riparian vegetation. The flooding of the river bottom and the massive rock rip-rapping accompanying railroad construction introduces further variables. Wildlife in peripheral areas are dependent seasonally on riparian areas and construction and flooding disrupt these complex ecological relationships. Important winter habitat may be eliminated by micro-climatic changes just as surely as by inundation.

The lost riparian habitat type probably cannot be compensated for by manipulation of project lands to produce key big game browse species, for example, with much hope for enduring self-sustaining success. Consequently, all species dependent upon that type can be acknowledged as permanently diminished. Wildlife just does not move uphill as the

waters rise.

Perhaps the most difficult assignment facing game biologists was in preparing estimates of the losses of wildlife that probably occurred due to inundation of the four reservoir areas. We have explored this at length with Wendell Oliver of the Washington Department of Game and have taken the liberty of enclosing his letter of April 11, 1974, detailing how the figures were arrived at. We don't know if his data is correct or not--so we can only assume the correctness of the data and then test the calculations and conclusions.

The selection of the lower two projects for comparison was unfortunate in that they were generally judged to be the poorer sites for game. Since they were being compared with harvest data pooled for all four sites it raises some question about the validity of the comparisons. In this case the error is on the conservative side.

Little is to be gained from further challenge of the methods by which the loss estimates were obtained. The degree of loss will never be accurately known and our recommendation is to accept the calculations as presented by the wildlife agencies in good faith. It is not possible nor should it even be attempted to make total counts of game species and total mortality losses to all causes for game management purposes. The indices of game abundance used by most game departments are more useful and less costly techniques whose refinements would rapidly escalate expenditure of both time and effort for very little return.

III. (B.) NON-GAME CENSUS RESULTS

A preliminary report filed with the Washington Department of Game by C.M. Chambers details the results of a wildlife census conducted by Chambers in riparian vegetation along Little Goose Reservoir and Lower Granite Project Site. These sites were selected because they had previously held the highest game population (peaking at Little Goose and declining downstream) and were thus expected to have supported correspondingly high numbers and varieties of non-game, specifically birds.

Three census routes were selected in each area with the hope that some clues might be obtained as to the relative effects of reservoir construction as reflected in animal diversity and abundance. Riparian draws tributary to the Little Goose Reservoir were sampled to test the theory that wildlife "move up the hillside" in response to inundation of their habitat.

A comparison of the three census areas at the two sites is as follows (my summary):

	Little Goose area			Lower Granite area		
	#1	#2	#3	#1	#2	#3
No. of Species	4	0	3	9	21	22
No. of Individuals	9	0	10	23	61	71

The results confirm what biologists have learned in other studies at other sites--a diverse habitat with a variety of ecologic niches can be expected to produce abundant wildlife and great variety. In this case the riparian vegetation provides this ideal habitat for many more kinds and numbers of wildlife than does a disturbed site. Averaging the three census

routes for each study site yields 2.3 species at Little Goose vs 17.3 species for Lower Granite. The average number of individuals counted on each of the census areas was 6.3 and 51.6 respectively. The evidence from this small study is overwhelmingly in favor of the undisturbed site as a more favorable habitat even though it may not have been the better of the two sites before disturbance.

It is our feeling that if adequate studies had been conducted before and after construction at each site, similar evidence would have been obtained. But since it wasn't, extrapolation, bits of evidence such as this, and comparisons with projects elsewhere, (i.e., the Wells Project) will have to suffice. The mass of evidence in the literature, on the ground and from intuitive reflection leads us to believe that the wildlife losses were probably underestimated.

Wildlife under stress react by moving, dying or adapting. If adjacent habitats are inadequate or fully occupied, a movement into the area by new individuals creates further stresses and losses. Adaptations, if they develop at all, generally occur over very long time spans and cannot be relied upon as a solution to the problem at hand. Loss of productivity following dislocations and stresses is a very difficult figure to assess and must be extrapolated from empirical evidence.

III. (C.) ECONOMIC AND PLANNING CONSIDERATIONS

In examining the nature of the problems that appear to exist between the parties to the dispute, it appears to us that an additional problem also exists. The Army Corps of Engineers defines the loss solely in habitat terms, in other words as strictly a biological and physical loss. The State of Washington Department of Game on the other hand, while recognizing the biological and physical loss, defines the problem in terms of human wants, needs, and satisfactions. It appears to us that in recognizing this difference as being real and paramount lies the solution to adequate and effective mitigation. The physical and biological loss is largely in terms of riparian habitat: counting both sides of the river, about 300 miles of such habitat. Given the riprap requirements, much of this loss is irreversible and adjacent developments do not mitigate for riparian loss. A lesser amount of available and reasonable public access for hunting and wildlife or wildlands recreation has similarly been lost or adversely affected. The loss can be stated in terms of numbers of birds and mammals and within a range reasonable men can agree upon. We state these losses as approximating the following based on the reports we have examined:

	Numbers of	Use or hunter/day/year
Deer		9,000-12,500
Fur bearers	2,000	
Geese		800-1,200
Pheasants, Chukar, Quail		25,000-30,000
Non-game birds and mammals	3,100 acres	25,000-100,000

What then can be done to mitigate these losses? Monetary values can't be placed on intangible benefits but the costs of providing intangible benefits can be computed.

Dollar values per hunter-day measure the amount users would be willing to pay, if payment were required, to avail themselves of the wildlife resource. Therefore, opportunity costs represent the minimum value placed on wildlife. Very little research has been done to determine dollar values per non-hunter day but judging by recent trends it may prove to be considerable.

We may not be able to calculate these values but we can estimate what it costs to provide replacements, such as hunter/use days as reflected in the bag.

Partial mitigation can be accomplished by substantial enhancement of lands acquired for the project by the Corps or on lands adjacent to project lands. Such measures should include habitat development on lands dedicated permanently to wildlife management. While habitat development is also an essential aspect of developed recreational areas, such development--in our judgment--should not be considered mitigation of wildlife losses. In our judgment the development of "interim use" lands that are not dedicated to permanent wildlife habitat management should be done by the Corps but should not be considered as a part of mitigation. Only enhancement that can be considered as reasonably permanent (estimated life of the project) should be considered as mitigation for the losses incurred. That the Corps will enhance all project lands dedicated to other uses is taken for granted;

after all, that is what quality recreation-resource development and quality public land management is all about. It is a continuing responsibility of all public land managers.

We do recognize that the project has probably enhanced one wildlife aspect and use. Substantial increases in recreation-boater use does include more people enjoying the wildlife--particularly birds--that are in the canyon. We also note that such use as it increases tends, in addition, to have an adverse effect on wildlife numbers and diversity compared to pre-project development.

While in our judgment all of the proposed mitigation activities should be accomplished to the maximum extent possible, it is also our collective judgment that something substantially less than fifty (50) percent of mitigation can be accomplished by these measures on project lands and on those lands immediately adjacent.

Where does this then leave us? A means to provide the equivalent of more than 20,000 hunter days annually for the life of the project is a reasonable solution.

To recapitulate: The Corps should begin immediately to carry out on all project lands wildlife habitat improvement measures as a portion of mitigation. Together with the Game Department an agreed to action program of such developments should commence.

Planning for such measures of greater magnitude as, for example, development of new "live streams", a bird farm, and similar measures should commence immediately and be action programs by the Spring of 1975.

Planning an action program with the Game Department and the Area Conservationist of the SCS to provide for habitat development, a bird

stocking program and for hunter or public access should begin immediately. An action program should be completed by June 30, 1975. The program of habitat development, acquiring of easements and public access should begin within the following year, and be completed by September 1977.

During this time frame and following to about 1980 the biological studies appropriate and agreed to by the parties involved should be undertaken. This work should be jointly planned and contracted for and cannot be done adequately without a continuing commitment to fund, and unless a complete plan of action is planned in advance.

Provision should also be made to compensate for inflation that appreciably reduces the financial resources available during the typically protracted negotiation and study periods.

III. (D.) PROJECT LANDS

The first mitigation priority for the Corps is in the development of project lands, probably less than half of which have any potential for wildlife. Of the potential wildlife sites on the project, there are further problems with the uncertainties of "interim use" decisions, harassment by construction activities and river traffic, and marginal potential for achieving an increase in wildlife productivity without expensive and ephemeral habitat treatments. All acres are not created equal. The quality and potential of river bottom habitat has probably been consistently underestimated by biologists and almost certainly by engineers.

Obviously any project lands identified by biologists as having potential for wildlife should be developed as soon as possible using funds available now. Lands with potential but an uncertain future (i.e., "interim use" restriction) should not be charged to the mitigation account. Neither should development of habitat for non-game species adjacent to or on recreation areas be charged to wildlife mitigation.

Goose islands and grazing pastures are the most suitable developments for certain project lands. The State should not be expected to put expensive developments on questionable acreages such as Mile 25 just because the acres are available. The potential is nil and should not be included in the development plans.

Perhaps a more productive management decision would be to prevent needless destruction during construction activities. This can still be achieved during the final stages of construction at Lower Granite.

On suitable lands not jeopardized by "interim use" provisions and undue human harassment, standard rehabilitation techniques such as

plowing, planting, fertilizing, watering and fencing can be applied. The Corps has the machinery and manpower and should, in cooperation with State biologists, be able to agree on a plan of management.

Administrative studies on project developments should be carried out for future evaluations as part of general operating costs.

III. (E.) OFF-PROJECT LANDS

The most realistic approach contained in the report lies in the development of off-project lands which have a known potential for wildlife--particularly those areas in the growing monoculture of wheat farming typical of some of the tributaries to the Snake River. Here opportunities exist to reclaim both riparian and valuable upland and habitat diversity.

There are two proposals designed to compensate for the loss of upland game species by obtaining easements from private property owners. In one instance the proposal is to complement the construction and placement of watering devices and in another to allow access to 14,260 acres of land surrounding 660 acres of acquired fee land proposed for the preservation of upland game bird habitat.

In the case of acquiring easements for hunting purposes, it is a practice of questionable value unless land use can also be appropriately affected. Access to depleted range lands or vast areas of summer fallow can only be of questionable value. Some control on land use intensity or over major changes in land use should be granted with these easements.

The main problem here is to get the approval and funds to proceed with negotiations with landowners, appraisals, and finally purchase. Rather than tie the off-project costs to a dollar figure, which is rapidly being whittled away by inflation and speculation, the agreement should be based on a fixed acreage. It is urgent that action be taken on project and off-project lands simultaneously. This condition applies to both fee purchase and easements, both of which should be correlated with similar negotiations for fisheries mitigation.

Land owner willingness to sell is not viewed as a problem by the State, despite the spirited opposition that arose at the Dayton and Colfax hearings last summer. We have stressed the urgency for immediate steps toward purchase and easement based on the continuing destruction of terrestrial and aquatic habitat by private owners adjacent to the project (i.e., Lower Tucannon River - April-May, 1974).

III. (F.) STUDIES

To compensate for wildlife losses, a number of studies were proposed. These included developing a comprehensive plan for habitat improvement on project lands, formulation of a plan for waterfowl habitat replacement and a survey of adjacent lands to identify sites with potential for habitat improvement projects. In all cases these studies are financed at approximately $20,000 per year. We are sure the authors now recognize that these were extremely conservative cost estimates, and a more realistic figure to place a biologist in the field for a single season is more nearly $25,000 to $30,000 per year.

Perhaps the only recommendation we can make here is to get on with the studies as soon as possible.

III. (G.) HABITAT DEVELOPMENT

In addition to the proposed short and long term studies, a number of habitat developments are proposed. Many of these proposals are valid, but their critique is perhaps inappropriate until the suggested studies are completed and the specifics are available for evaluation. There does seem to be, however, a tendency to attempt to manipulate vegetation, particularly in the on-project proposals. While most of the proposals, particularly as they pertain to revegetation, seem to be concerned with animal ecology and the appropriate forage plant species, there does seem to be a tendency to ignore plant ecology and the dictates of soil, slope, exposure and other factors relevant to the needs of individual plant species. Attempts to manipulate vegetation without proper site alteration will probably result in a gradual return to the plant species originally replaced. Jackrabbits, beaver and deer will eliminate new plantings unless protected by adequate fencing, another costly and dubious prospect.

It follows that if wildlife losses occurred as a result of habitat destruction, then habitat restoration or development should reverse the process. Unfortunately, it isn't that simple. Generally the chance for success is directly proportional to the quality of the land being developed. Good money and efforts should not be squandered on poor sites, regardless of ownership.

An estimate by a Walla Walla nurseryman for development of Mile 25 and New York Bar was set at $4 million. This points up the virtue of maintaining existing habitats rather than attempting to replace them artificially.

III. (H.) BIRD FARM

It is finally recommended that a bird farm be constructed to produce 20,000 birds per year to be planted on project and acquired lands. This is a questionable practice, particularly when viewed in terms of its continual maintenance costs and the permanent benefits accruing to the species as a result of this practice.

Several suggestions have been proposed--a new hatchery could be built with mitigation funds, and would replace the old, inefficient farms at Kennewick and Walla Walla. The site could be on federal land at McNary or on lands provided by Washington Department of Game. The operation and maintenance costs could be negotiated. One choice might be a 20-40 year period as a test of the ability of the Department to restore habitat on designated wildlife lands with gradual phasing out of the bird farm. Another possibility would be to purchase quality birds from a private source for release for "X" years.

Whitman County used to be the top pheasant producing area in the State--can it be restored? It isn't likely that the future recreational hunting demands will ever be met on steadily deteriorating habitat on adjacent private lands.

Planting pheasants to provide for immediate replacement of lost recreational opportunity may be a reasonable alternative if coordinated with measures to repair habitat along stream courses and through purchases, easements within the general vicinity of the project. Cooperation with the Soil Conservation Service may well provide the necessary vehicle of replacement of riparian habitat, conversion of steep palouse slopes to brush and grass, and providing for and developing public access.

IV. SUGGESTIONS FOR CORRELATING FISHERIES AND TERRESTRIAL MITIGATION

In many cases the consideration of fishery resources and game resources are related. For example watershed maintenance and riparian vegetation improvement will enhance fish, game and non-game species. They are also related in that available financial resources must be committed in a manner that returns the greatest permanent benefit to all species involved and subsequently to the human utilization of those species. Opportunities do exist for projects with these multiple benefits. Consequently financial commitments considered must be viewed in the perspective of their impact on both the primary objective and associated benefits that should accrue to related species. A fish hatchery for example offers no benefits to related species while watershed rehabilitation does.

To compensate for fisheries losses, the following features were suggested for anadromous fish species: a hatchery and associated trapping and holding facilities to rear the progeny of 2,290 adult female fall Chinook salmon, a hatchery and associated trapping and holding facilities to rear the progeny of 2,145 adult female spring and summer Chinook salmon, a hatchery and associated trapping and holding facilities to rear the progeny of 3,390 adult female steelhead trout.

All these facilities have been suggested in addition to the work already accomplished at the dams in question involving both upstream and downstream fish passage facilities. Since these anadromous species complete their life cycle in the Pacific Ocean, it seems quite reasonable and logical that augmenting anadromous fish stocks naturally produced in a now somewhat degraded tributary system can easily be accommodated

throughout the remainder of their life history.

Construction of these facilities should be authorized and commenced immediately and they should not be contingent upon reaching final agreement on all fish and wildlife compensation necessitated by the Lower Snake River Project.

Resident fish species also have been severely altered by the project in question. In order to compensate and mitigate for the incurred losses, it has been suggested that these rainbow trout be planted on a put-and-take basis in Asotin Creek and Touchet, Walla Walla and Tucannon Rivers in an attempt to compensate for the loss of 67,500 stream-angler days.

Before construction of the trout hatchery, it is strongly recommended that the practice of put-and-take planting in the streams suggested for that program be critically evaluated. This probably can be accomplished using current hatchery capacity. The impact on both resident trout and anadromous steelhead must be understood before planting catchable rainbows is commenced.

This particular request seems to run contrary to the objectives of (a) maintaining a steelhead fishery, and (b) increasing the existing angler-day opportunity. As mentioned previously, considerable effort has gone into passing steelhead trout over dams to eventually reach some of the tributaries identified for the put-and-take rainbow program. In these tributaries the steelhead will spawn and their young will remain for a considerable time prior to smolting and migrating back to the ocean. During this period they will be dependent upon the carrying capacity of the parent stream, subject to its limitations and in

competition for food, cover and space.

It is also assumed that at the present time there is some form of resident trout population in the streams identified. The planting of 93,000 pounds of legal or catchable-size rainbow trout raises the question of the environmental impact on the resident fish and the immature steelheads occupying these same streams. Several studies recently completed have demonstrated that the planting of large numbers of hatchery fish actually has the effect of depressing existing resident fish populations. If this condition does exist, the risk would certainly be taken that the expenditure identified to boost angler-days would actually be providing less angler opportunity for resident fish and seriously impairing the rearing capacity of the streams for steelhead trout.

Improved carrying capacity of the streams in question probably can only be improved through improving stream habitat, and funds expended for compensating the lost angler-days should be directed toward a program of habitat improvement rather than a program that superimposes an artificially high population of hatchery trout into a habitat whose carrying capacity is static or possibly declining due to adverse land use practices.

A final mitigation recommendation for fisheries losses is the acquisition of 150 linear miles of stream of known high quality steelhead fishing. This is an excellent recommendation and should be expanded to include stream habitat improvement measures such as streambank fencing and general watershed improvements.

V. POSSIBLE ALTERNATIVES

In reviewing the bulk of material available, several alternatives come to mind that should be investigated as part of the recommended studies.

(1) The continuous blanket riprap identified as a major problem in the project area seems unnecessary and should be unnecessary with reasonable alternative. Assuming riprap is basically for protection against wave action, narrow breaks, particularly in the vicinity of the mouths of side canyons, would seem to be an attainable goal.

If these breaks could be made, and perhaps accompanied by a lateral ditch in appropriate areas, water for big game and other wildlife could be made accessible. If protection from wave action is still absolutely essential at these areas, perhaps structures such as log booms could be strung across the mouth of the break in the riprap and afford sufficient protection. If the riprap is located in places where the river current is still perceptible enough to be a problem, it would seem that riprapping would be unnecessary on the deposition side of the river's curvature. An accommodation could be made in these places for breaks or gaps in the blanket riprap.

(2) The question of providing water in now arid side canyons has been widely discussed. The potential of lifting water from the impoundments and either providing a substantial sustained flow or providing a minimal trickle flow are worth exploring. In order to capture the imagination of the engineers, a research proposal should be made that includes at least the following features:

(a) the potential of lifting water, its dependability, and its

total production using wind-supplied energy;

(b) the impact of an interruptible flow on vegetation in an arid canyon environment;

(c) an evaluation of the impact of an interruptible flow on an arid canyon's wildlife population; and

(d) the dependability of irrigation water lifted x feet using wind-supplied energy.

In no case should this proposal be converted to a dependency on hydro or fossil fuel energy.

(3) The Corps of Engineers could initiate a hydraulic evaluation of the Tucannon River with emphasis toward channel stability as related to channel length and vegetative bank cover. Purpose of the study would be to restore a hydrologic equilibrium as nearly as possible through obtaining an appropriate channel length to accommodate the gradient between the headwater and mouth of the Tucannon River. The ultimate purpose of this evaluation is to restore an optimum aquatic habitat for the rearing of steelhead and resident trout species.

(4) A trust fund be established perhaps using the financial resources identified for the trout hatchery and bird farm for the purpose of altering land use patterns to the benefit of upland game and watershed quality. Some of the methods could be:

(a) to obtain conservation easements,

(b) make available financial incentives for landowners to increase their brushy areas in wheat-growing regions.

(c) financial incentives to allow riparian vegetation to recover

where currently overgrazed, and

(d) direct payments to encourage landowners to abandon the practice of diversified ranching now combining marginal livestock operations along with grain farming with an insufficient range land resource.

If the trout hatchery and bird farm ideas were abandoned, a fund of about $4 million in capital costs plus additional financial resources made available out of the operating and maintenance payments that would be required for the aforementioned facilities could be established. The interest payments to such a fund could be utilized to initiate a cooperative program with appropriate landowners. In the event that the program failed to live up to expectations, the capital resources would still be intact to attempt another alternative such as outright acquisition of critical habitat areas.

In considering the mitigation, and perhaps some of the suggested alternatives, it should be stressed that immediate commencement of mutually agreeable projects is appropriate. There is no need to wait for agreement on all proposals before initial funds are committed.

SPECIAL REPORT TO THE U. S. ARMY CORPS OF ENGINEERS ON TWO REPORTS CONCERNING PROPOSED COMPENSATION FOR FOR LOSSES OF FISH CAUSED BY ICE HARBOR, LOWER MONUMENTAL, LITTLE GOOSE, AND LOWER GRANITE LOCKS AND DAM PROJECTS, WASHINGTON AND IDAHO

Submitted to: Department of the Army
Walla Walla District
Corps of Engineers
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APPENDIX D

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PREFACE

This report is an analysis of the two reports, A Special Report on the Lower Snake River Dams, Ice Harbor, Lower Monumental, Little Goose, and Lower Granite, Washington and Idaho, U. S. Department of Commerce, National Marine Fisheries Service, U. S. Department of Interior, Fish and Wildlife Service Bureau of Sport Fisheries and Wildlife, September 1972[1] and Special Lower Snake River Report for Compensation for Fish and Wildlife Losses Caused by Ice Harbor, Lower Monumental, Little Goose, and Lower Granite Locks and Dam Projects, Washington and Idaho, U. S. Corps of Engineers, Walla Walla, 1973[2].

Subsequent to the agreement to evaluate the above two reports, a third report was made available by the U. S. Corps of Engineers. This report is untitled and can be assumed to be an in-house analysis of the two reports mentioned above. Although not reviewed per se, it was used as a resource document.[3]

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[1] Hereafter referred to as the Agencies' Report

[2] Hereafter referred to as the Corps' Report

[3] Hereafter referred to as the Corps' Supplemental Report

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* * *

INTRODUCTION

Ice Harbor, Lower Monumental, Little Goose, and Lower Granite Lock and Dam projects were authorized by Public Law 14, 79th Congress, and were approved March 2, 1945. They were designed to provide slackwater navigation, irrigation, and hydroelectric power generation with the Lower Granite project to provide additional flood protection for the Lewiston-Clark area. Ice Harbor, Lower Monumental, and Little Goose lock and dam projects were completed in 1962, 1969, and 1970 respectively, and the upstream Lower Granite project is scheduled for completion in 1975 (Fig. 1).

The projects are similar in design and operation, and the designs include power plants, navigation locks, recreation areas, and fish passage facilities. The filling of the impoundments involves some railroad relocation and in the Lewiston-Clarkston area, levees with pumping plants will be necessary.

Pool elevations of the projects will vary according to seasonal runoff and with usage, and fluctuations up to several feet daily can be expected. Tailwater fluctuations for power peaking operations may range up to 5 ft in the case of the Ice Harbor project (Table 1), but may range up to 35 ft under flood flows, depending on timing and volume of reservoir releases.

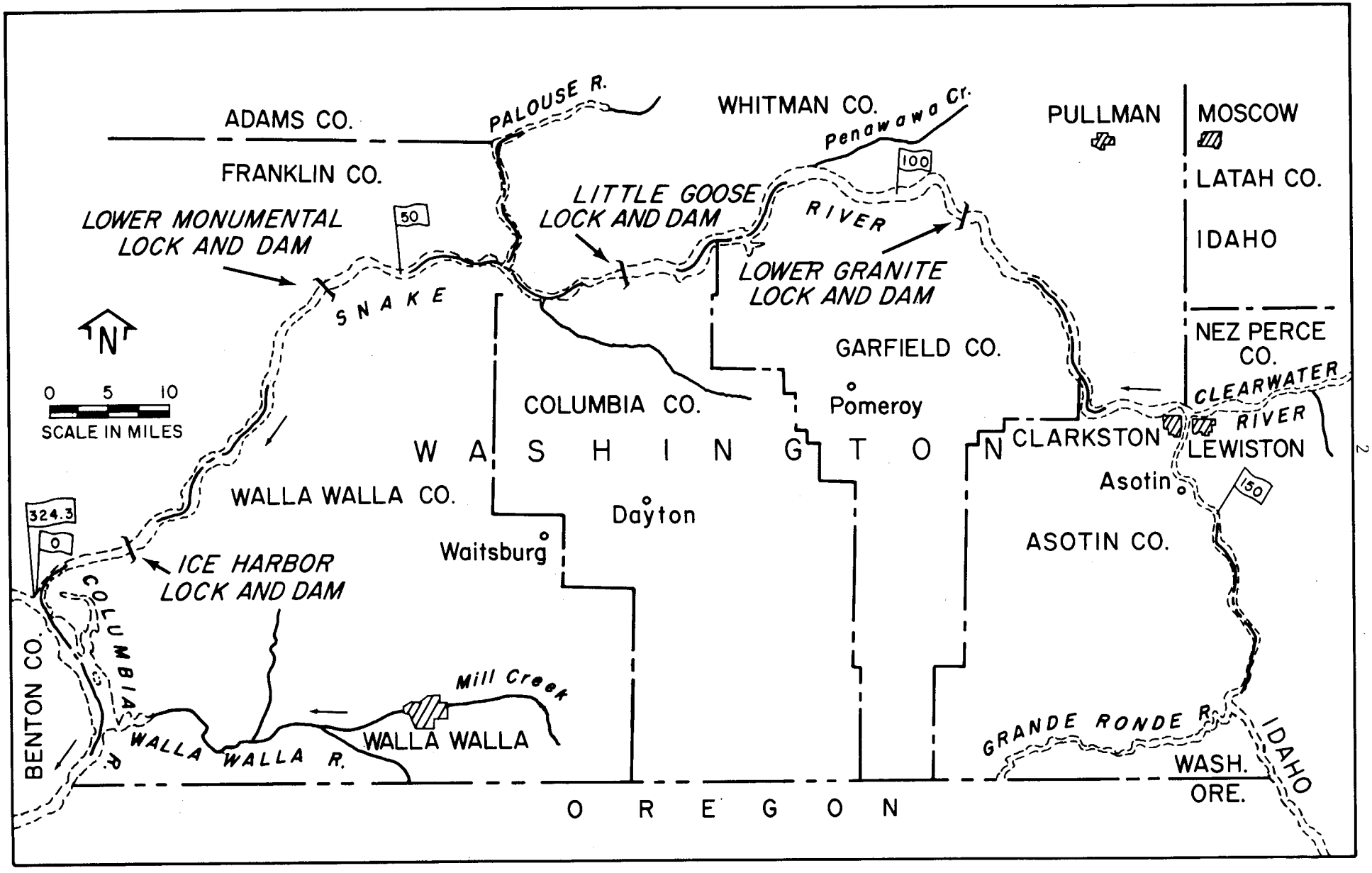

FIG. 1. Lower Snake River projects (from the Corps' Report)

Table 1. Pertinent engineering and operation data,

Lower Snake River projects (from the Agencies' Report, p. 6)

Project	Elevation (feet) msl	Capacity (acre-feet)	Surface area (acres)	Stream inundated (river miles)
Ice Harbor				
Normal pool	440	417,000	9,200	35.0
Tailwater	337-342*			
Lower Monumental				
Normal pool	540	377,000	6,590	29.0
Tailwater	374-441*			
Little Goose				
Normal pool	638	565,000	10,025	37.2
Tailwater	357-541*			
Lower Granite				
Normal pool	738	485,000	8,900	39.0
Tailwater	633-639*			
Totals		1,844,000	34,715	140.2

* Tailwater range for non-flood period

PROJECT IMPACTS ON ANADROMOUS AND RESIDENT FISHES AND THE STATUS OF REQUESTS FOR COMPENSATION

The Snake River system is one of the more productive rivers in the United States, and historically has contributed substantially to the anadromous and resident populations of the Columbia River complex. The contribution of chinook salmon, Oncorhynchus tshawytscha, to the commercial and sport fisheries of the Columbia River is major, while the steelhead trout, Salmo gairdneri, contributes significantly to the support of an extensive sport fishery throughout the lower Columbia and Snake Rivers. The fall run of chinook salmon contributes to both the river and ocean commercial and sport fisheries, while the spring and summer run chinook salmon are harvested principally in the river; their contribution to the ocean fishery is presently unknown.

Principal resident game fish other than the salmonids are the small-mouth and large-mouth bass, white sturgeon, and channel catfish. Of lesser importance to the resident fishery are rainbow trout, Dolly Varden, brown bullhead, mountain whitefish, white crappie, and bluegill. Non-game fish include carp, squawfish, suckers, chiselmouth, and shiners.

The Agencies' Report claims that, prior to project construction, about 5,000 fall chinook spawned in the Snake River below the mouth of the Clearwater River, although accurate counts of the actual numbers of fish spawning in this stretch of river have not been made because of the turbidity of the free-running river. Some information is available from early estimates of spawning ground requirements.

Prior to construction of the project, the lower Snake River supported the largest summer-run steelhead fishery in the state of Washington. The project has changed many of the rapids and pool areas to large, deep impoundments and previous methods of fishing for these large trout are no longer effective, except in the tailrace areas immediately below the dams. An estimate has been made that about 130,000 angler-days annually could have been expended on steelhead fishing over the next 100 years if the project had not been built.

Similarly, the Washington State Department of Game estimated that approximately 250,000 days annually would be spent fishing for the resident fish within the area affected by the projects.

The major effects that the construction of the four dams would have would be the conversion of a free-flowing stream to a reservoir-type habitat, the inundation of the mainstem spawning, and the addition of four obstacles with accompanying hazards to the upstream and downstream migrants. The change from a stream to reservoir condition also alters the character of the sport fishery for the anadromous and resident fish in the project area.

Prior U. S. Fish and Wildlife Service reports on Ice Harbor, Lower Monumental, and Little Goose projects recommended measures to minimize fishery losses on an individual project basis, and according to the Agencies:

> "Such measures were largely limited to upstream fish passage facilities at the dams, spawning channel development, and artificial propagation of anadromous species. Fish passage

facilities have been the only features provided. According to the Corps of Engineers, these facilities were constructed at a cost of $38,844,000. Research is being conducted to develop measures to provide improved conditions for juvenile fish migration at the Lower Snake River dams. The initial measures for minimizing losses to anadromous and resident fisheries were based on insufficient information and were not adequate to maintain these fisheries. Therefore, to maintain the runs of anadromous fish in the Snake River system, and to offset losses to the sport fishery for anadromous and resident species, measures recommended in the early reports must be augmented and accomplished according to the agencies."

The compensation requested by the Agencies is based upon three principal types of impact: (1) losses of downstream migrants at the four projects; (2) a loss of a resident river fishery of high caliber; and (3) the inundation of spawning grounds for fall chinook salmon. Acknowledgment is made of the fact that the collection of the downstream migrants by the use of traveling screens and subsequent transportation by trucks, has definite possibilities of relieving the problems; however, the engineering and biological problems have not been completely solved, and the results are still variable according to species. Thus, the compensation requested assumes a constant loss at each dam.

The requests and justifications for compensation for losses do not include losses due to nitrogen supersaturation, but assume that the problem will be resolved in a reasonably short period of time. Progress in correcting this problem has been very encouraging.

OUTLINE OF THE AGENCIES' METHOD OF DETERMINING AND JUSTIFYING THE REQUESTED COMPENSATION

The Agencies' method of determining the compensation for losses caused by the four Lower Snake River dams consists of the following steps:

1. The Agencies developed a philosophy of compensation for the management of the potential of watersheds (or major sections of the river) rather than by mitigation for losses on a project-to-project basis. For the Lower Snake River, this approach requires an estimate of the potential production of spring chinook, summer chinook, and steelhead trout for the entire watershed.

2. The methods used in determing the potential of the watershed were:

   a. determination of the maximum run size for each species that passed over McNary Dam between 1954 and 1967, and
   b. determination of the maximum percentage of McNary fish that passed over Ice Harbor Dam between 1962 and 1967, and
   c. computation of the number of each species to be maintained as Snake River stocks by multiplying the maximum number passing over McNary and the maximum percentage counted over Ice Harbor (a and b, above).

3. In order to justify the use of maximum McNary counts, they (the Agencies) compared the total runs returning to the Columbia River since Bonneville (1938) with the calculated optimum sustainable runs.

4. The optimum sustainable runs were calculated by:

   a. using optimum escapements determined in the 1950's, and

   b. multiplying the optimum escapements by the return/spawner for the pre-McNary period. During this process, they also developed the return/spawner in the post-McNary years (1957 to 1967) and pointed out the drastic drop in production. They maintained, by inference, that since the calculated optimal runs for the entire river were similar to the maximum runs for the entire river, the use of maximum runs for the Snake were justifiable as optimal.

5. The losses to the fishery (i.e., to the fishermen) were determined by comparing the calculated optimum sustainable yield with the yield that could be expected to be sustained under existing conditions. These figures were used to point out the loss to the fishermen in recent years and under existing conditions, and <u>were not used directly</u> in the calculations for compensation.

6. Compensation for losses of downstream migrant salmon and steelhead trout attributed to the four Lower Snake River dams was estimated by;

   a. assuming a loss of 15% of the downstream migrants of each species at each dam, for a cumulative total effect of 48% for the four dams; and

   b. multiplying the expected run for each species at Ice Harbor by 0.48; then

c. determining the size of hatchery required to replace the losses (derived in 6-b).

7. Using the estimated costs of capital outlay and the maintenance and operation costs of the hatcheries and the benefits accrued from the fish produced, the cost-benefit ratio of the compensation was developed.

8. Compensation for the loss of the fishery for resident fishes other than salmon was computed on the basis of a reduced availability of the more desired species and the contention that reservoir fishing is not equivalent in quality to river fishing.

Prior to project construction, high quality stream fishing existed for bass, sturgeon, and channel catfish. With the impoundments, this fishery has been adversely affected directly by inundation and indirectly by fluctuations of the reservoirs which have reduced the spawning and rearing success of bass and some of the other species. The Agencies estimated that the average annual man-day use of this area during project life would have been 250,000 angler-days, but with the project, the use would become restricted to the species more adaptable to warmer waters. This use is forecast at 205,000 angler-days, for a loss of 45,000 angler-days annually.

The Agencies request for compensation is in the form of a

supplemental stocking of catchable-size rainbow trout in tributary streams in areas such as Asotin Creek, Grande Ronde, Tucannon, Touchet, and the Walla Walla Rivers. This would require the construction of facilities capable of producing 85,000 lbs of rainbow trout annually. In addition, the Agencies also consider the factor of the quality of the river fishery in comparison to reservoir fishing, and they use the ratio (which apparently has been established) that 2 days of river fishing is equivalent to 3 days of reservoir fishing, as far as benefits to the state are concerned. This would raise the quantity of trout necessary for compensation to 93,000 lbs.

9. Compensation for the losses to the fishery of steelhead trout within project influence was in the form of replacement in kind and numbers, as well as the acquisition of access to streams supporting good steelhead fishing.

The steelhead trout support an extensive sport fishery throughout the entire Columbia River system and an incidental commercial fishery on the Columbia River. As with the spring and summer chinook, the escapement over Bonneville Dam has remained relatively constant but, as with the salmon, the commercial fishery has been drastically reduced (Fig. 2). According to the Agencies, the sport fishery for steelhead trout has increased during recent times and they projected the 52,000 angler-days annually occurring in the lower Snake River project area before

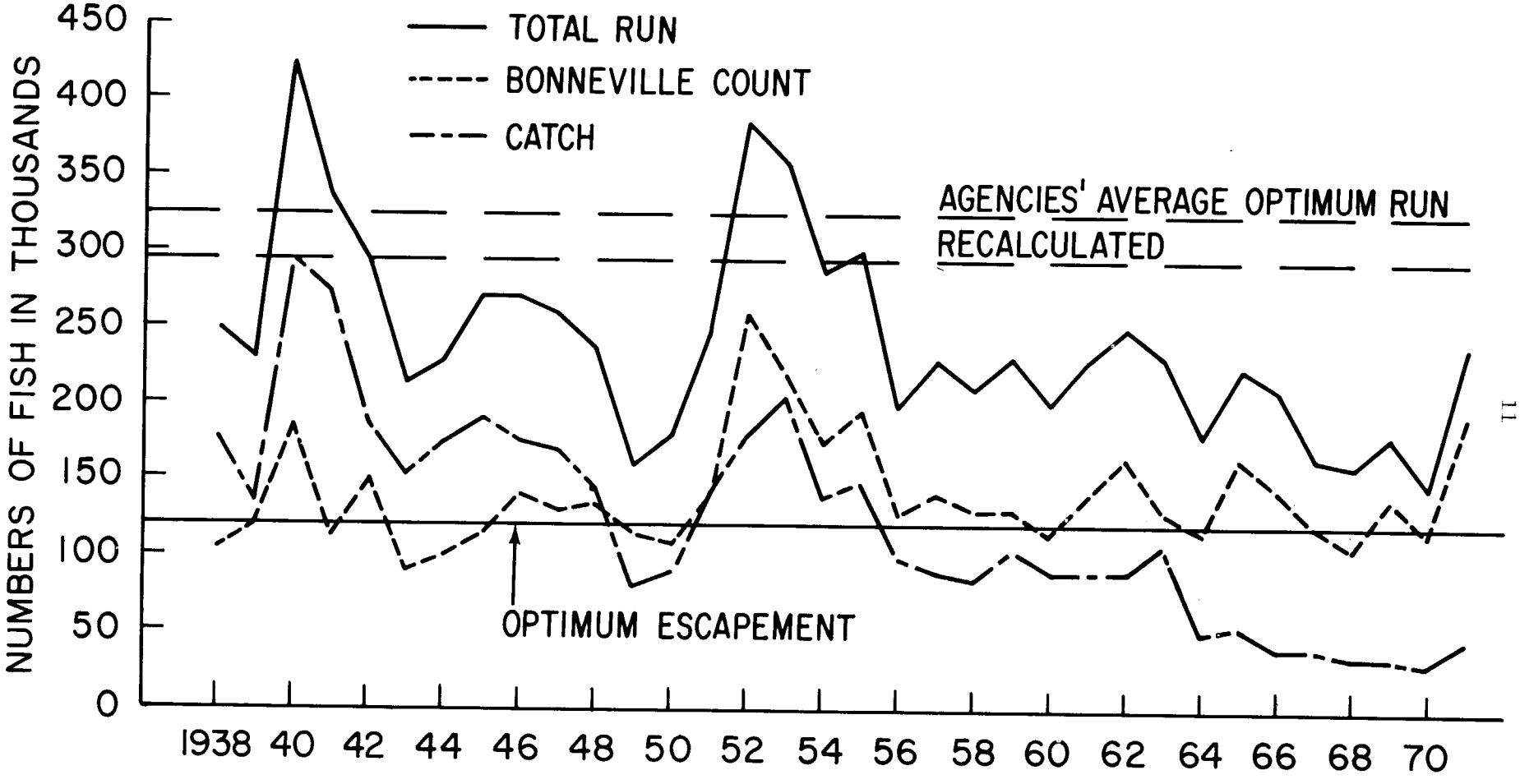

FIG. 2. Status of steelhead trout runs, 1936 - 1971, showing the Agencies' and the recalculated (the author's) values for the optimum sustainable run (modified from the Agencies' Report).

construction to grow to an estimated 130,000 angler-days annually during the 100-year project life--if the projects were not built.

In a procedure similar to that developed for the salmon, the Agencies determined the size of the run to be maintained in the Snake River to be 114,800 steelhead trout (Table 2). Then, to compensate for the estimated loss of 48% to a run of this size due to project causes, it was recommended that hatchery facilities be provided accordingly.

In addition, a sport fishery for steelhead trout has also developed to substantial proportions within the project area. Prior to project development, this fishery was an open river fishery and subsequently, the reservoir conditions have caused the fishermen to become decreasingly effective. With the completion of Lower Granite, approximately 140 miles of stream which was once available to the fishery will essentially be eliminated. The Agencies estimated that this loss is equivalent to the 130,000 angler-days mentioned above.

The Agencies state that there is no known way to compensate for this loss within the project area, so they recommend that either access to tributary streams of high quality be provided on a permanent basis, or that public fishing areas be established by direct acquisition of approximately 150 miles of land averaging

Table 2. Estimated distribution of salmon and steelhead trout runs to Snake River system in percentage and number (revised from the Corps' Report, Table 2)

River Segment	Fall chinook Maximum Count McNary Dam 97,500 (1958) Distribution		Spring-Summer chinook Maximum Count McNary Dam 222,100 (1957) Distribution		Steelhead Maximum Count McNary Dam 172,600 (1962-63) Distribution	
	Percentage	No. of Fish	Percentage	No. of Fish	Percentage	No. of Fish
Snake River:						
Lwr. Monumental-China Gardens (mainstem spawning)	26.5	8,526				
Tucannon River					4.0	4,600
Clearwater River	0.5	161	2.0	2,400	3.0	3,400
Asotin Creek			0.5	600	37.5	43,200
Grande Ronde River					1.5	1,700
Snake River: China Gardens-High Mountain Sheep	5.5	1,770	10.0	12,200	14.0	15,900
Salmon River						
Imnaha River	0.5	161	79.5	97,200	30.5	35,200
Snake River:			5.5	6,700	3.5	4,000
High Mountain Sheep-Appaloosa	1.5	483				
Appaloosa-Pleasant Valley	5.5	1,770				
Pleasant Valley-Hells Canyon	33.0	10,617				
Hells Canyon Dam Fish Facilities	27.0	8,687	2.0	2,500	5.0	5,700
Small tributaries						
Imnaha River-Hells Canyon Dam	____	____	0.5	600	1.0	1,100
	100.0	32,175 [1/]	100.0	122,200 [2/]	100.0	114,800 [3/]

[1/] McNary Dam maximum count 97,500 x 33% = 32,175 (rounded to nearest 100) (68% is the highest percentage of McNary counts over Ice Harbor 1962-67; however, this count has room for doubt so 33%, next highest percentage, was used).

[2/] McNary Dam maximum count 222,100 x 55% = 122,200 (rounded to nearest 100) (55% is the highest percentage of McNary counts over Ice Harbor 1962-67).

[3/] McNary Dam maximum count 172,600 x 66.5% = 114,800 (rounded to nearest 100) (66.5% is the highest percentage of McNary counts over Ice Harber/fish year 1962-67 adjusted to include estimates of fish migrations during months when no counts were made).

100 ft in width adjacent to certain selected streams. Although they recommend in the report that the lands be acquired through a willing seller concept, their basic objective is to insure, on a permanent basis, access to streams of high quality fishing.

DISCUSSION

1. Analysis of the Concept of Compensation for the Management of the Potential of the Snake River Watershed

The fact that the four Lower Snake River dams were authorized for construction and completion within a relatively short period of time and are scheduled to operate as a system, virtually compels the natural resources of the area to be managed as a unit. Needed are: (a) definition of the boundaries of the watersheds under question, and (b) agreement upon the potential of the watersheds for production of the various species of fishes.

As so often is the case, there are insufficient data to give precise estimates as to the numbers of fish that were produced by the area prior to project development, and the Agencies argue with considerable validity that the size of the existing stocks (which can be considered as depressed) should not be used as a baseline to develop the parameters for compensation. The fact that the current runs are maintained at a near-constant level by increasing restrictions upon the fishery (Figs. 2, 4, and 5) reflect the depressed and, according to the Agencies, unacceptable condition of the runs.

2. The Methods Used in Determining the Potential of the Watershed

The determination of the run size for each species by using the counts over McNary Dam and then multiplying them by the percentage that pass over Ice Harbor is mathematically simple, and sound. The two questions one may have about the procedure are the selection of the counts over McNary and the percentage of these that can be expected to continue over Ice Harbor (see 3, following).

3. The Justification for the Use of the Maximum McNary Counts and the Percentages Used of McNary Fish Passing Over Ice Harbor

The Agencies used the McNary counts from 1954 through 1972 to determine the maximum number of salmon and steelhead trout passing over McNary Dam (Table 3). They then determined the percentage of chinook salmon and steelhead trout counted at McNary Dam that passed over Ice Harbor in the 11-year period from 1962 through 1972 (Table 4). For their calculations of numbers destined for the Snake, the only percentages considered were those for the 6-year period from 1962 through 1967. The percentages used were either the second-highest percentage, or else some compromise between the first and second.

In recent years, the percentage of McNary fish passing over Ice Harbor has shown a tendency to increase; therefore, for all but the fall chinook, the percentages used were reasonably close to the average for the 11-year period. For the fall chinook, the second-highest percentage was used, and this decision was made subsequent to the

Table 3. Number of chinook salmon and steelhead trout counted at McNary Dam, 1954-1972 - from the Corps' Supplemental Report (w/additions)

Year	Spring and Summer chinook salmon	Fall chinook salmon	Steelhead trout
1954	113,079	13,476	75,059
1955	92,489	16,426	85,575
1956	103,052	11,290	42,554
1957	222,149	70,607	105,728
1958	128,564	97,528	87,890
1959	115,760	55,730	110,475
1960	129,430	47,337	96,895
1961	113,796	41,200	103,743
1962	108,640	44,116	163,181
1963	97,096	57,363	113,646
1964	109,341	58,593	100,742
1965	74,581	76,326	118,960
1966	108,022	75,119	145,130
1967	122,666	73,087	77,700
1968	127,731	72,757	112,522
1969	134,032	79,375	76,681
1970	107,338	61,554	69,759
1971	101,730	69,718	109,630
1972	119,514	49,307	93,820
Totals -	2,229,010	1,070,909	1,889,690
Averages -	117,316	56,364	99,457

Table 4. Number and percentage of chinook salmon and steelhead trout counted at McNary Dam passing Ice Harbor Dam (revised from Corps' Supplemental Report)

	Year	Spring & Summer Chinook			Fall Chinook			Steelhead		
		McNary number	Ice Harbor number	%	McNary number	Ice Harbor number	%	McNary number	Ice Harbor number	%
	1962	108,640	64,252	59.1	44,116	30,049	68.1	163,181	115,796	71.0
	1963	97,096	47,653	49.1	57,363	13,537	23.6	113,646	74,539	65.6
	1964	109,341	49,273	45.1	58,593	11,097	18.0	100,742	58,860	58.4
	1965	74,581	26,879	36.0	76,326	12,345	16.2	118,960	62,873	52.9
	1966	148,022	60,864	41.1	75,119	15,018	20.0	145,130	65,798	45.3
	1967	122,666	65,908	53.7	73,087	19,022	26.0	77,700	44,205	56.9
Average	1962-67	110,057	52,472	47.4	64,101	16,844	28.8	119,893	70,345	58.4
	1968	127,731	74,304	58.2	72,757	24,377	33.5	112,522	82,383	73.2
	1969	134,032	83,001	61.9	79,375	17,507	22.1	76,681	63,889	83.3
	1970	107,338	67,313	62.7	61,554	10,385	16.9	69,759	53,870	77.2
	1971	101,730	59,244	58.2	69,718	11,004	15.8	109,630	67,029	61.1
	1972	119,514	73,196	61.2	49,307	10,430	24.4	93,820	63,593	67.7
Average	1968-72	118,069	71,412	60.4	66,542	14,741	22.5	92,482	66,153	72.5
Average	1962-72	113,726	61,081	53.7	65,210	15,888	24.4	107,434	68,440	63.7

release of both the Agencies' and the Corps' Reports. Instead of using the maximum percentage of 68.1, the second-highest (33.5) was used. The estimated numbers and distribution of fall chinook in the Snake River system, along with the spring and summer chinook and steelhead trout distribution, are shown in Table 2, which is a revision of the Corps' Report Table 2.

The percentages used of McNary fish passing over Ice Harbor appear to be justified.

4. Analysis of the Use of the Maximum Counts Over McNary Dam

The Agencies used two approaches for justifying the use of the maximum runs over McNary:

(a) by comparing the calculated optimum sustained run in the entire Columbia River system with the maximum runs experienced in the river system and, by inference, stating that since these were reasonably similar, the maximum over McNary is also similar to the optimum, and

(b) by showing that the maximum counts in recent years, with a minimal fishery, are of the same general sizes as those of previous years when a substantial fishery was supported, they contend that the escapement should not be any less.

Although both of these concepts have considerable basis in fact, the latter approach is simpler, and much easier to justify.

The pre- and post-McNary brood years were examined to detect any changes in sizes of runs or any changes in productivity (return/spawner). The measure of productivity for the two periods was compared. The Dalles brood years from 1942 to 1952 were considered pre-McNary and The Dalles brood years 1957 to 1967 were defined as post-McNary. The return/spawner was determined for the two periods by taking the average run size for the 11-year period in each case and dividing by the average escapement for the respective periods (Table 5). The return/spawner for the spring chinook dropped from 3.57 to 2.07, the summer chinooks from 2.77 to 1.15, and the summer steelhead from 2.72 to 1.54.

At this point, the Agencies state (page 5, Appendix A, Agencies' Report) that "the ocean catches for runs considered here are generally minor and are therefore not included. Ocean catches of Columbia River steelhead and sockeye are insignificant, and scale studies of ocean-caught chinook indicate that the vast majority of these are fall chinook." This infers that the drop in production is directly related to changes in environment. The reduction in the return/spawner in recent years is rather dramatic, and the Agencies point out that in the post-McNary period, the value for summer chinook dropped to 1.15, recognizing that when the value drops below 1.0, the run is not reproducing itself. They also

Table 5. Basic Columbia River salmon and steelhead data for estimation of the production rates (return/spawner) for the 11 brood years preceding the completion of McNary Dam and the 11 brood years after the completion of The Dalles Dam.

Period	Parameter	Salmon			
		Spring chinook	Summer chinook	Sockeye	Summer steelhead
Pre-McNary-The Dalles brood years (1942-1952)	Average escapement (1942-1952)	52,400	37,900	49,100	95,600
	Average run size (Salmon: 1946-1956) (Steelhead: 1947-1957)	187,300	105,100	195,900	259,600
	Return/spawner	3.57	2.77	3.99	2.72
Post-McNary-The Dalles 1/ brood years	Average escapement (1957-1967)	83,200	82,500	72,500	130,000
	Average run size (Salmon: 1961-1971) (Steelhead: 1962-1972)	172,500	94,500	100,400	200,800
	Return/spawner	2.07	1.15	1.38	1.54

1/ Production in these years was also influenced in varying degrees by other dams: Brownlee (1953)
Priest Rapids (1960)
Oxbow (1961)
Rocky Reach (1961
Ice Harbor (1962)
Wanapum (1963)
Wells (1967)
Hells Canyon (1967)
John Day (1968)
Lower Monumental (1969)
Little Goose (1970).

Source: Fish and Wildlife Agencies Supplemental Report Appendix B

point out that, currently, no direct fishery is permitted on the summer chinooks although, historically, it was the single most important run in the Columbia.

A basic principle of fisheries management is to regulate the runs by determining both maximum and optimum escapements. The maximum escapement obtained on a sustaining basis may not necessarily be optimum for management. On the other hand, the optimum escapement which produces the optimum sustaining yield does not necessarily give the greatest return/spawner.

According to the Agencies' Report, by the late 1950's a sufficient amount of data was available from the fisheries and the counts at Bonneville Dam to determine "on an excellent basis" the optimum escapement levels for the various runs. These are given as 80,000 each for spring and summer chinook, and 120,000 for summer steelhead (line 2, Table 6). The Agencies' Report then develops the optimum sustainable run (line 1, Table 6) by multiplying the optimum escapements by the return/spawner for the pre-McNary period. The Agencies maintain that these are the run sizes that could have been harvested on an "optimum sustainable yield", if the optimum escapement levels had been followed and if the series of dams starting with McNary had not been constructed. Optimum production is obtained by harvesting at the level that sustains the greatest difference between the run produced and the escapement required. These levels were not maintained for several reasons, including overfishing in the river, changes in environment,

Table 6. Computation of average yearly loss to Columbia River fisheries based on difference between optimum yield[1/] and current yield

Period	Parameter	Salmon			
		Spring chinook	Summer chinook	Sockeye	Summer Steelhead
Pre-McNary-The Dalles	Average optimum run	285,600	221,600	319,200	326,400
	Otpimum escapement	80,000	80,000	80,000	120,000
	Optimum sustainable yield (difference)	205,600	141,600	239,200	206,400
Current	Average run	172,500	94,500	100,400	200,800
	Average escapement > 1968-1972	115,400	74,800	68,700	129,800
	Average sustainable yield (difference)	57,100	19,700	31,700	71,000
Average yearly loss to fisheries (difference between yields)		148,500	121,900	207,500	135,400

[1/] Optimum yield is average yearly harvest that could have been taken by fisheries if McNary and subsequent dams had not been constructed.

Source: Fish and Wildlife Agencies Supplemental Report (Appendix B)

losses of downstream migration through inadequate screening of sources of water for irrigation, and unknown factors such as the ocean fisheries.

In typical spawner recruit curves, often called Ricker-type spawner recruit curves, the return/spawner is greater at the lower levels of escapement, and the optimum sustainable yield is determined by drawing a line asymptotic and parallel to the 45 degree line of equal replacement (Fig. 3). The return/spawner at this point of maximum sustained yield is always less than at any point on the curve below the optimum escapement. Thus, it is not technically correct (on the basis of the information presented) to multiply the optimum escapement (80,000 spring chinook, 80,000 summer chinook, and 120,000 summer steelhead) by the return/spawner of the pre-McNary era, which was developed for spring chinook on the basis of an average escapement of 52,400, for summer chinook at an average escapement of 37,900, and for summer steelhead at 95,600. Thus, the values of 3.57, 2.77, and 2.72 for returns/spawner, respectively, are too high for the calculation of the optimum runs.

It is not possible to estimate with reasonable accuracy the return/spawner at escapements of 80,000 with the data available--as a family of curves (Fig. 3) may pass through the two points that are known; i.e., the return/spawner for the pre-McNary era and the points at which the line may be parallel at escapements of 80,000 for fall and spring chinook, and 120,000 for steelhead. For example,

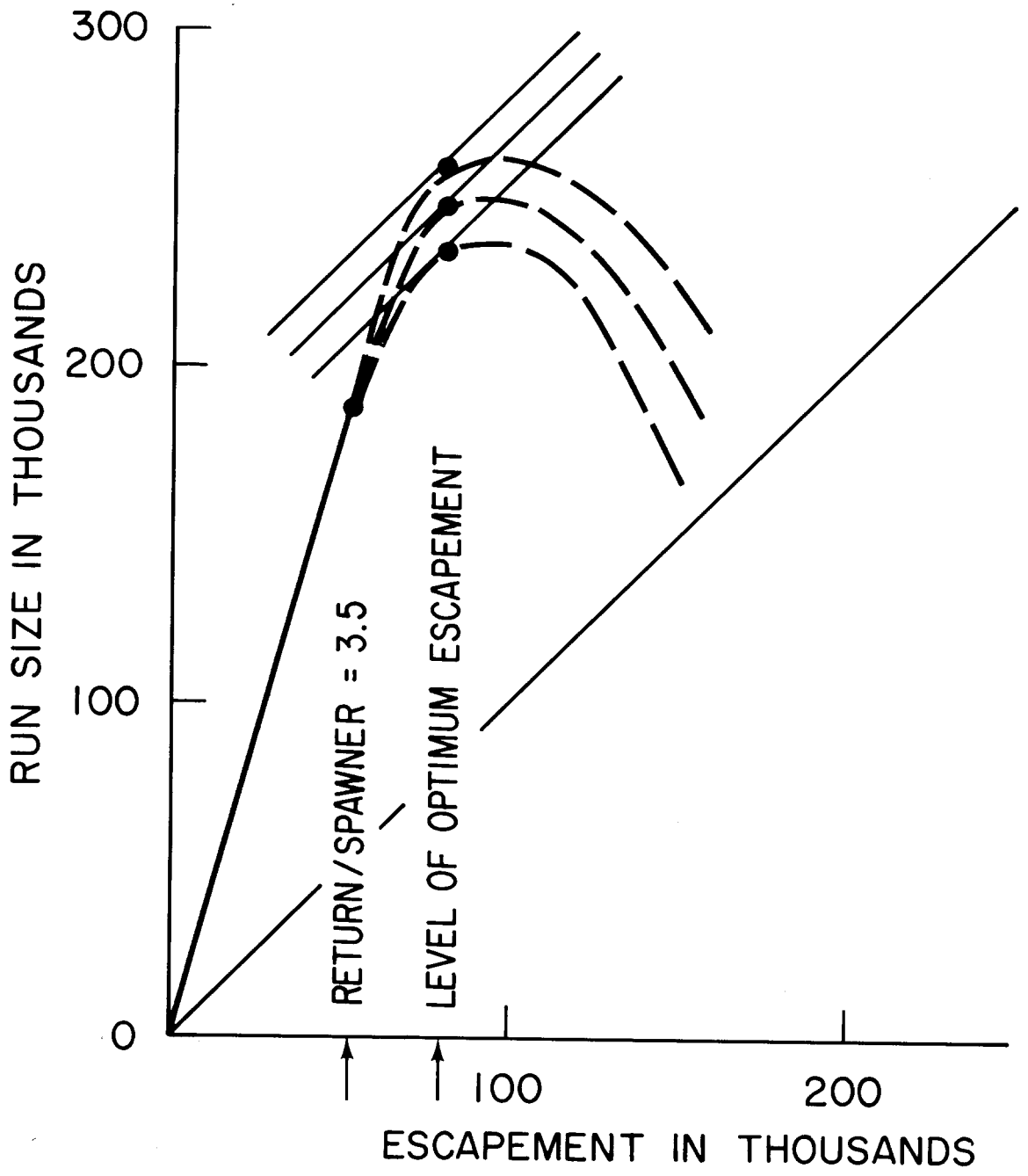

FIG. 3. Ricker-type spawner/recruit curve for spring chinook salmon showing some probable levels of optimum sustained yield given the return/spawner at an escapement of 53,000 and an optimum sustained yield of 80,000.

for the spring chinook, the optimum size of the run probably falls on the curve somewhere between 235,000 and 260,000 adults produced by an escapement of 80,000, so the return/spawner is probably between 2.93 and 3.25. Using the figure of 3.0, the optimum escapements and losses to the fishery for spring chinook salmon are shown in Table 7. Reconstructing the spawner-recruit curves for summer chinook and summer steelhead, the returns/spawner of 2.56 and 2.42 were derived, along with the recalculated losses to the fisheries (Table 7). Also, by using the average escapements for the years 1968 to 1972 (post-John Day) as shown in Table 6, the return/spawner of the late post-McNary period changed from the Agencies' estimate of 2.07 for spring chinook to 1.49, and from 1.15 to 1.26 for summer chinook, while the return/spawner for summer steelhead remained constant at 1.54. It is unlikely that these most recent changes in productivity in these later years (1968 to 1972) are real, unless spring chinook became particularly vulnerable by the developments in the river during that period while the conditions improved for summer chinook and remained constant for summer steelhead. This is unlikely. These values may fall within natural variation, but are more likely to reflect the status of the knowledge of the sizes of the runs, the sizes of the catch, and unknown losses between dams.

The procedure of comparing the optimum sustainable run with the maximum runs--which are quoted as 281,000 (in 1955) for spring chinook, 207,000 (in 1957) for summer chinook, and 383,000 (in 1952) for summer steelhead--is difficult to support. However, since the results are

Table 7. Recalculated computation of average yearly loss to Columbia River fisheries based on difference between optimum yield[1/] and current yield

Period	Parameter	Salmon			
		Spring chinook	Summer chinook	Sockeye	Summer Steelhead
Pre-McNary-The Dalles Brood years (1942-1952)	Average optimum run	240,-00	204,800	255,000	290,000
	Optimum escapement	80,000	80,000	80,000	120,000
	Optimum sustainable yield (difference)	160,000	124,000	185,000	170,000
	Return/spawner	3.0	2.56	3.19	2.42
Current	Average run	172,500	94,500	100,400	200,800
	Average escapement	115,400	74,800	68,700	129,800
	Average sustainable yield (difference)	57,100	19,700	31,700	71,000
	Return/spawner	1.49	1.26	1.46	1.54
Average yearly loss to fisheries		102,900	104,300	153,300	99,000
Agencies' calculated yearly loss		148,500	121,900	207,500	135,400
Difference		45,600	17,600	54,200	36,400
Percentage		31%	14%		27%

[1/] Optimum yield is average yearly harvest that could have been taken by fisheries if McNary and subsequent dams had not been constructed.

not directly applicable to the sizes of hatcheries requested for compensation, the significance is felt primarily upon the development of the losses to the fisheries. Furthermore, the returns/spawner are so low (assuredly < 3.5) that there is no significance in attempting to refine for compensatory purposes.

When both the Agencies' and the recalculated (the author's) optimum sustainable runs are compared with the maximum runs of recent history (Figs. 2, 4, and 5), some questionable results are evident for the salmon; however, the expected returns for steelhead are more reasonable. For the salmon, particularly the summer chinook, the calculated return/spawner appears still to be too high. As the optimum sustained escapement calculated by the Agencies cannot be considered too high (i.e., overescapement), the productivity of the runs (return/spawner) may be even lower than anticipated for the 1950's.

Perhaps the most likely conclusion one can draw from the entire analysis is: there are so many variables affecting productivity (i.e,, overfishing in the river, unknown influences of ocean fishing, changes in environment, losses due to hazards presented at dams--including passage through turbines and mortalities due to excess nitrogen--and differential survival of wildfish when hatchery fish are introduced into the stocks) that the theory of Maximum Sustained Yield (MSY) is not applicable. It may even be that "natural" variations are so great that an e capement which is held constant will produce variations that defy the application of the theory.

The obvious drop in productivity should be of great concern.

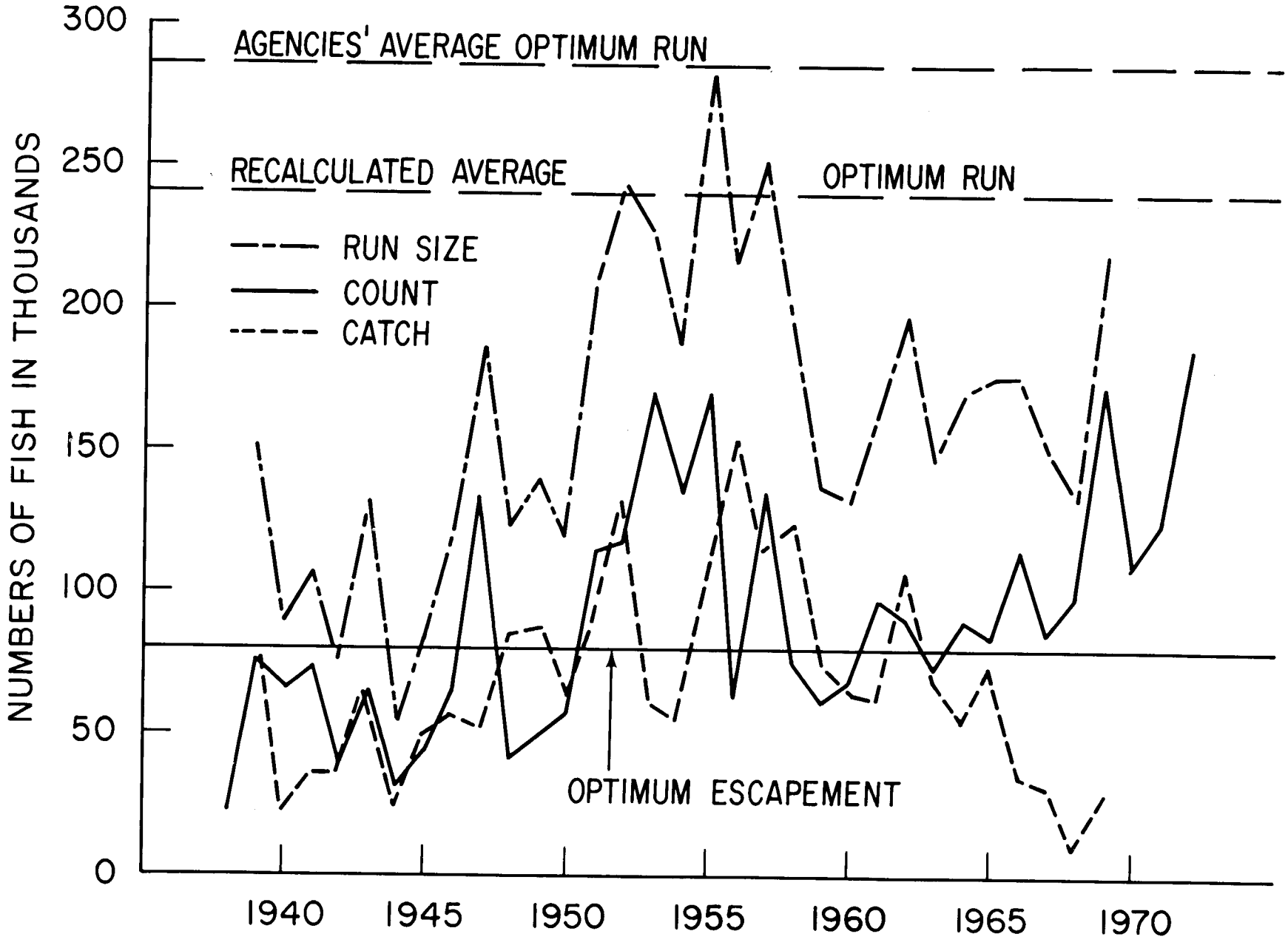

FIG. 4. Status of spring chinook salmon runs, January 1 to May 31, 1939 to 1972

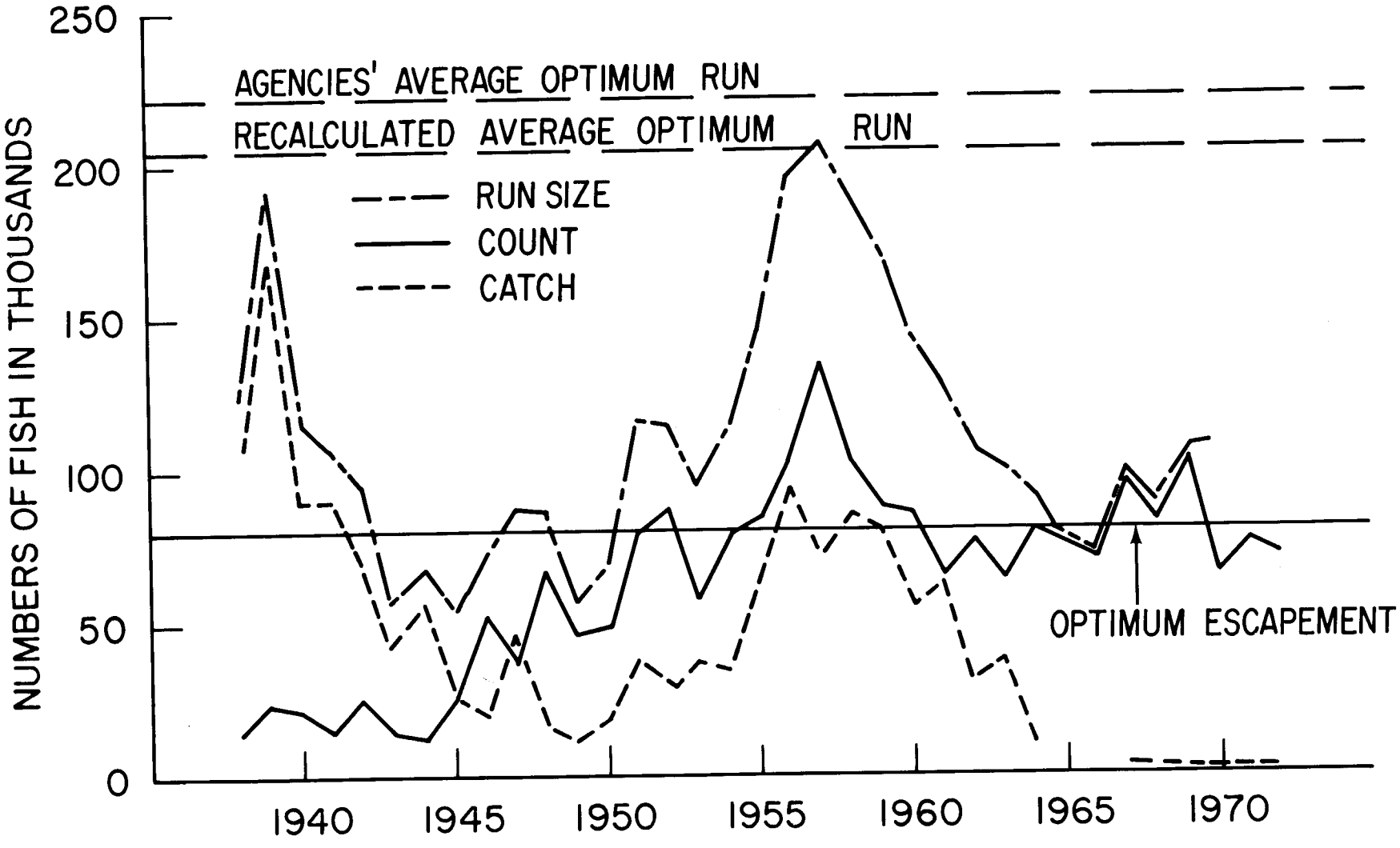

FIG. 5. Status of summer chinook salmon runs, June 1 to July 31, 1938 to 1972

5. Analysis of the Calculated Losses to the Fishery

As mentioned previously, the losses to the fishery were determined by comparing the calculated optimum sustained yield of the pre-McNary period with expected yield for the post-McNary period. As discussed in 4 (above), the calculated optimum sustained yield may be too high because of the use of the return/spawner which may be doubtful. With the recalculated return/spawner, the losses to the fishery were determined to be 31% lower (than the Agencies' figure) for spring chinook, 14% for summer chinook, and 27% for steelhead. Nevertheless, the losses are still substantial--over 300,000 fish annually.

6. Analysis of the Compensation for Losses to Downstream Migrants

There appears to be agreement among all parties that the estimate of a 15% mortality of the downstream migrants at each dam is reasonable, and possibly conservative. Thus, the expected mortality of 48% of the run as a result of the passage of downstream migrants over the four Snake River dams has been generally accepted. Acknowledgment is also made of the considerable effort expended by the Corps of Engineers and other agencies in the development of screening facilities at the projects so that the downstream migrants can be diverted, captured, and transported below the lowest project to some safer point of release. Although this appears to have considerable potential, the entire process including diversion, capture, and transportation has not been perfected to the point where it compensates for the anticipated 48% loss.

Thus, the 48% loss, sustained by a population which already is suffering a decrease in productivity, will cause an additional burden that the runs--particularly, summer chinook--apparently cannot bear.

Therefore, the request for maintenance of the runs at some level near those requested by the Agencies appears to be reasonable and well-founded.

At our present state of knowledge, stream improvement, capture and transportation of downstream migrants, the possible creation of new water resources (rivers) and other suggested means of compensation do not appear to have the merit and standing of fish hatcheries.

Therefore, if the principle of accepting the maximum runs--which appears to be reasonable--is accepted and the 48% mortality can be anticipated, the size of the hatcheries required to replace the loss can be estimated. The agencies anticipate losses equivalent to 20,700 adult fall chinook salmon, 58,700 spring- and summer-run chinook salmon, and 55,100 steelhead (Table 8).

Table 8. Estimated losses, and artificial propagation costs associated with anadromous and resident fish maintenance, following Lower Snake River project construction (Agencies' Report, partially revised table 4)

Species	Max run	Loss (adults)	Number (adults)	Hatchery		Collect., eyeing, trans.	
				Capital costs	Annual OM&R costs	Capital costs	Annual OM&R costs
Fall chinook	32,700	20,700 [1/]	5,294	2,623,000	$146,803	$562,488	$30,080
Spring & summer chinook	122,200	58,700 [2/]	3,800	$8,960,000	$502,000	$432,000	$50,000
Steelhead trout	114,800	55,100 [2/]	7,200	$18,140,000	$834,000	$819,000	$95,000
Rainbow trout			(85,000) [3/]	1,275,000 [4/]	96,000		
	Total costs			$30,998,000	1,578,803	$1,813,488	$175,080

Total capital costs: $37,011,488 [5/]

Total OM&R costs: $ 1,753,883

1/ Based on total replacement for 5,000 adults in inundated spawning area plus cumulative smolt loss of 48% at four dams.

2/ Based on 15% smolt loss for each of the four dams (48% cumulative loss)

3/ Number of pounds needed for liberation at three to the pound

4/ costs include collecting, eyeing, holding, and transportation, as well as hatchery requirements.

5/ based on $4,200,000 land acquisition and development costs for fishing access added to capital costs.

7. Analysis of the Benefit-Cost Ratios for Hatcheries

The benefit-cost ratios for the hatcheries are difficult to develop with reasonable accurace because of the unknowns concerning costs, values, and the questionable uses of catch-to-escapement ratios of 4:1 for chinook and 2:1 for steelhead. These are probably too high, and are borne out by the fact that the productivity (return/spawner) has been reduced to values considerably less than catches of 4:1 would allow. The best estimates for the benefit-cost ratios are given in Tables 9 through 13. A different method of computing the benefit-cost ratio was tried for chinook and steelhead, and the results were very similar (Table 14 for chinook).

Table 9: (Revised) Commercial landings and sport fishing use, with and without compensation[1] in Columbia River System and Pacific Ocean (anadromous species) and in Lower Snake River project area (resident species).

Areas and species	Commercial Fisheries: with compensation — Escapement	Landings — Pounds	Landings — Value	without compensation — Escapement	Landings — Pounds	Landings — Value	difference — Escapement	Landings — Pounds	Landings — Value	Sport Fisheries[4]: w/comp Ang days	w/o comp Ang days	diff Ang days
Columbia R. System, Ocean								?	?	?	?	?
Fall chinook[2]	32,700	1,668,000	917,000	14,400	734,000	404,000	18,300	934,000	513,000	163,500	72,000	91,500
Spring and summer chinook[2]	122,200	6,232,000	4,362,400	63,500	3,238,000	2,266,600	58,700	2,994,000	2,094,800	611,000	318,000	293,000
Steelhead[3]	114,800	692,000	208,000	59,700	360,000	108,000	55,100	332,000	100,000	763,000	397,000	366,000
Totals	269,700	7,900,000	5,487,400	137,600	4,332,000	2,778,600	132,100	?	3,159,550 ?	1,537,500 ?	787,000 ?	750,500 ?
L. Snake Project Area												
Resident										250,000	205,000	45,000

1/ Insofar as possible, "with compensation" is intended to reflect the pre-project condition.

2/ Calculations based on catch to escapement ratio of 4:1 (commercial catch 3:1 and sport catch 1:1) average weight per fish of 17 lbs; and commercial value of $0.55 per pound for fall chinook, $0.70 per pound for spring and summer chinook.

3/ Calculations based on catch to escapement ratio of 2:1 (commercial catch 0.67:1 and sport catch 1.33:1); average weight per fish of 9 lbs; and commercial value of $0.30 per pound.

4/ Angler-days for anadromous fish are based on catch to escapement ratios (footnotes 2 and 3) and an estimated 5 days of effort per fish (the value of an angler-day for anadromous fish is $6.00).
Angler-days for resident fish are based on creel studies of Washington Department of Game and the ratio of 3 reservoir angler-days to 2 stream angler-days.

From BSFW Report (Appendix A) as revised by correspondence.

Table 10. An economic analysis for fall chinook prepared on a 100-year project life as a basis for benefit-cost comparison.

Item	100-year life
Cost	
Initial construction	$2,750,000
Capital investment	152,000
Annual O & M	250,000
Total amortized annual cost	402,000
Benefit	
Commercial fishery value	
934,000 lbs at $0.55/lb	513,000
Sport fishery value	
91,500 angler-days at $6.00/day	549,000
Total annual benefits	$1,062,000
Benefit-cost ratio	2.64:1

Table 11. Economic analysis for spring and summer chinook salmon prepared on a 100-year project life as a basis for benefit-cost comparison

Item	100-year life
Cost	
Initial construction	$11,250,000
Capital investment	621,700
Annual O & M	900,000
Total amortized annual cost	1,521,700
Benefit	
Commercial fishery value	
2,994,000 lbs at $0.70/lb	2,095,800
Sport fishery value	
293,000 angler-days at $6.00/day	1,758,000
Total annual benefits	$3,853,800
Benefit-cost ratio	2.5:1

Table 12. An economic analysis for steelhead trout prepared on a 100-year project life as a basis for benefit-cost comparison

Item	100-year life
Cost	
Initial construction	$15,000,000
Capital investment	828,900
Annual O & M	1,000,000
Total amortized annual cost	1,828,900
Benefit	
Commercial fishery value	
332,000 lbs at $0.30/lb	99,600
Sport fishery value	
366,000 angler-days at $6.00/day	2,196,000
Total annual benefits	$2,295,000
Benefit-cost ratio	1.3:1

Table 13. An economic analysis of the Lower Snake River sport fishery prepared on a 100-year project life as a basis for benefit-cost comparison.

Item	100-year life
Cost	
Initial land cost	$2,000,000
Capital investment	110,500
Annual O & M	30,000
Total amortized annual cost	140,500
Benefit	
Sport fishery value	
130,000 angler-days at $6.00/day	780,000
Total annual benefits	780,000
Benefit-cost ratio	5.6:1

Table 14. Spring and summer chinook benefit-cost ratio

Year	Cost	Discounted cost[1]	Benefit	Discounted benefit[2]
0	11,871,000	11,871,000	0	0
1	900,000[3]	857,143	0	0
2	900,000[3]	816,327	3,853,800[4]	3,495,510
3	900,000[3]	777,873	3,853,800[4]	3,330,856
4	900,000[3]	740,741	3,853,800[4]	3,171,851
5	900,000[3]	704,225	3,853,800[4]	3,015,493
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
98	900,000	7,563	3,853,800	32,384
99	900,000	7,200	3,853,800	30,830
100	900,000	6,870	3,853,800	29,418
Totals		$28,527,536		67,802,371

Benefit-cost = 2.377

The method of calculating the benefit-cost ratio is from Benefit-Cost Aspects of Salmon Habitat Improvement in the Alaska Region, U.S.D.A. Forest Service, Alaska Region, February 1969.

[1] $\text{Cost}/(1 + i)^n$ where i is the discount rate of .05 on long-term government bonds and n is the number of years

[2] $\text{Benefit}/(1 + i)^n$

[3] Based on total capital costs for spring and summer chinook

Cost

Initial construction		$11,250,000
Capital investment		621,000
	Total -	11,871,000
Annual OM&R costs		900,000

[4] Benefit

Commercial fishery		2,095,800
Sport fishery		1,758,000
	Total -	3,853,800

8. Analysis of Compensation for Losses to Resident Fishes

The analysis of the losses of fishing in a free-running river compared to reservoir-type fishing is extremely difficult to make, because of the biases in evaluation of substituting one kind of fishery for another. In this case, the only form of compensation that is acceptable to the agencies is off-site mitigation in the form of planting of the more desirable species--such as rainbow trout--in either tributaries of the Snake, on other off-site locations, or even possibly the creation of new rivers by the Corps. This type of mitigation needs to be negotiated.

On-site enhancement is limited by the fluctuations of the reservoir, the problems of dealing with the railroads with their demands for assuring the integrity of the dikes and berms upon which the railroads are located, and the unwillingness of the agencies to accept the substitution of species.

9. The Compensation for Losses of Steelhead Fishing

The agencies appear firm in their request for access to rivers of high quality steelhead fishing by requesting assurance of access of approximately 150 miles of river to substitute for the area inundated. This can be accomplished by either direct purchase or some other form of negotiation that is legally binding for continued access during the life of the project.

A recommendation cannot be made at this time for the type of assurance of access, but outright purchase of all these properties should be a last resort...unless wildlife mitigation becomes a persuasive factor.

CONCLUSIONS

1. The concept of managing the entire watershed rather than by a project-to-project basis is a sound one, particularly when one agency, such as the Corps of Engineers, is responsible for the development of the resources of a major portion of the watershed. Such is the case for the Snake River.

2. The runs of spring chinook, summer chinook, and steelhead trout have degraded, from many causes, in recent years. Further degradation can be expected by the construction and operation of the four Lower Snake River dams.

3. The Agencies' method of computing losses to the fish runs of the Lower Snake River (i.e., the use of the cumulative loss of 48% of the downstream migrants) appears to be sound.

4. The use of the maximum size runs over McNary times the percentage of McNary fish that pass over Ice Harbor is justifiable.

5. The Agencies' use of calculated optimum sustainable runs for computing losses to the fishery may result in an overestimate, but not grossly so.

6. The numbers of fish to be replaced can be estimated at approximately 18,500 for fall chinook, 59,000 for spring and summer chinook (total), and 55,000 for steelhead trout.

7. The summer chinook are obviously in jeopardy, and a substantial effort to maintain this run is justifiable on the basis that enhancement can occur by proper hatchery management, by effective screening, and by habitat control.

8. Off-site mitigation for the loss of the resident fishery needs to be negotiated. This could include planting of trout in waters in the Lower Snake Area and also completely off-site.

9. Access for steelhead fishing in tributary streams needs to be assured.

10. The benefit-cost ratios are very difficult to evaluate as the catch-to-escapement ratios used for salmon (4:1) exceed the productivity of wildfish...and differential harvesting is not defined.

11. Management (including the harvest) after hatcheries are constructed will be exceedingly difficult, as the return/spawner for wildfish is currently about 3.0, while the anticipated return/spawner for hatchery fish is calculated to be as high as 14.0. Further degradation of wild stocks can occur when the hatchery fish comprise 48% of the Snake River run.

RECOMMENDATIONS

1. Because of the decline in the stock of summer-run chinook and the apparent drop in productivity approaching bare maintenance, support by the use of hatcheries is urgent. Compensation for the losses of spring chinook is also requested, so it is recommended that the spring chinook and summer chinook hatcheries be authorized and constructed simultaneously and, as soon as possible.

   It is further recommended that the hatchery sites be chosen carefully and great credence be given to the desirability of having a number of small hatcheries rather than one or two large facilities. These are almost essential in Idaho because of the distribution of the fish east and west of the Idaho Primitive Area. The transportation of fishes across state lines cannot be avoided entirely, but the problems of disease control, inspection, and authority can be minimized by construction of one or two hatcheries in the Grande Ronde River area in Oregon and additional sites and hatcheries should be considered for the state of Washington.

2. It is recommended that the integrity of the stocks be maintained as much as possible. In the attempt to maintain the integrity of the stocks, siting should be done carefully to consider environmental as well as genetic influences. It is suggested that an attempt be made to adapt the hatcheries to the environment rather than by creating new environments by temperature and water control. That is, once-through systems should be considered prior to recirculating

systems, both for biological and economic reasons.

3. It is recommended that a fall chinook hatchery also be constructed close to, preferably within, the Snake River area. Once again, this is an attempt to maintain the integrity of the local stocks which do migrate into Idaho at the present time.

4. As the planting of catchable trout is already practiced in the area, by the Washington State Department of Game, it is recommended that additional off-site planting be considered. Although no catchables are planted at the present time in the Clearwater River in Idaho, it is felt that this can soon become a viable fishery because of the cooling influence of Dworshak Dam.

5. It is recommended that off-site mitigation, possibly including artificial rivers and lakes, be considered, but this does not have a sense of urgency.

6. It is recommended that permanent access to rivers of high quality steelhead fishing be acquired. The access need not be in the form of outright purchase if permanency is assured. The management of the wildlife resources may be a deciding factor in determining the type of access provided.

7. It is recommended that the Corps consider negotiation with the Agencies for the maintenance of an optimum number of fish for the

entire Snake River Area, and if this number is maintained by improved screening, transportation, habitat control, etc., the Corps' obligations for maintenance and operation of the hatcheries be reduced at the Corps' option.

8. Special consideration should be given to the management of stocks which are 52% wild...with a return/spawner of 3...and 48% hatchery stocks with returns/spawner up to 14.

9. The implementation of the above recommendations continues to emphasize the burden upon the Agencies for wise fisheries management, so it is essential that the Corps and the Agencies integrate their programs ever more closely and that mutual assessment be continuous.

EOS:mlo