Columbia Basin System Planning

SALMON and STEELHEAD PRODUCTION PLAN

SNAKE RIVER SUBBASIN
(Mainstem from Mouth to Hells Canyon Dam)

September 1, 1990

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Columbia Basin System Planning

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Table of Contents

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INTRODUCTION

The Northwest Power Planning Council's Columbia River Basin Fish and Wildlife Program calls for long-term planning for salmon and steelhead production. In 1987, the council directed the region's fish and wildlife agencies, and Indian tribes to develop a systemwide plan consisting of 31 integrated subbasin plans for major river drainages in the Columbia Basin. The main goal of this planning process was to develop options or strategies for doubling salmon and steelhead production in the Columbia River. The strategies in the subbasin plans were to follow seven policies listed in the council's Columbia River Basin Fish and Wildlife Program (Appendix A), as well as several guidelines or policies developed by the basin's fisheries agencies and tribes.

This plan is one of the 31 subbasin plans that comprise the system planning effort. All 31 subbasin plans have been developed under the auspices of the Columbia Basin Fish and Wildlife Authority, with formal public input, and involvement from technical groups representative of the various management entities in each subbasin. The basin's agencies and tribes have used these subbasin plans to develop the Integrated System Plan, submitted to the Power Planning Council in late 1990. The system plan will guide the adoption of future salmon and steelhead enhancement projects under the Northwest Power Planning Council's Columbia Basin Fish and Wildlife Program.

In addition to providing the basis for salmon and steelhead production strategies in the system plan, the subbasin plans attempt to document current and potential production. The plans also summarize the agencies' and tribes' management goals and objectives; document current management efforts; identify problems and opportunities associated with increasing salmon and steelhead numbers; and present preferred and alternative management strategies.

The subbasin plans are dynamic plans. The agencies and tribes have designed the management strategies to produce information that will allow managers to adapt strategies in the future, ensuring that basic resource and management objectives are best addressed. Furthermore, the Northwest Power Planning Council has called for a long-term monitoring and evaluation program to ensure projects or strategies implemented through the system planning process are methodically reviewed and updated.

It is important to note that nothing in this plan shall be construed as altering, limiting, or affecting the jurisdiction, authority, rights or responsibilities of the United States, individual states, or Indian tribes with respect to fish, wildlife, land and water management.

PART I. DESCRIPTION OF SUBBASIN

Location and General Environment

The Snake River in Washington state begins at RM 177.1 at the Washington/Oregon border and flows northwesterly along the border of Washington and Idaho to RM 139.1. At this point the Snake River is completely within Washington state. It flows southwesterly to its confluence with the Columbia River at RM 324.2 (EPA Reach 17060). The Washington state portion of the Snake River Subbasin encompasses about 4,351 square miles. The drainage includes all parts of Asotin, Garfield, Columbia, Walla, Franklin and Whitman counties (USDA 1984).

The upper portion of the Snake River forms the state line between Idaho and Washington and Oregon for its 108 miles from Lewiston, Idaho (RM 139.1) to Hells Canyon Dam (RM 247), the upper limit of accessible river to anadromous fish. In this stretch of river, the Snake drains 29,740 square miles. Major tributaries include the Salmon, Clearwater, Grande Ronde, Imnaha, and Tucannon rivers and Asotin Creek. Excluding those drainages for which separate subbasin plans are being written (Salmon, Clearwater, Grande Ronde, Imnaha, and Tucannon rivers), the Snake River watershed totals 1,070 square miles in this area (EPA Reaches 17060101 and 17060103).

Much of the basin in the lower river area is mountainous forest in the Blue Mountains. Main tributaries, which include the Tucannon River and Asotin Creek, have their headwaters in the Blue Mountains. The highest points in these mountains exceed 6,400 feet. The forested area is transected with numerous steep canyons. Intermixed with the forested area are large areas of rangeland. Rangeland areas extend along canyon slopes throughout much of the basin. Ridges are generally cultivated.

The Snake River flows through a canyon that varies in depth from about 5,500 feet in the Hells Canyon area to about 705 feet in the Lewiston area, to about 100 feet near its confluence with the Columbia River. The upper part of the subbasin is characterized by an elevated mountainous mass cut by the deep canyons of the Snake and Salmon rivers. Included in this area is Hells Canyon, the deepest gorge in North America. To the north is a gently undulating plateau of 3,000 feet to 5,000 feet in elevation and underlain by Columbia River basalt flows. Elevations range from 9,393 feet (mean sea level) at the top of He Devil Mountain to 705 feet (msl) at Lewiston.

The climate in the subbasin is strongly affected by the Cascade Mountains. Moisture bearing winds from the Pacific are blocked by the Cascades, resulting in a climate that is continental and dry. Microclimates do occur as differences in temperature and precipitation vary according to elevation. Precipitation is evenly distributed from fall to spring; summers are dry. Lewiston annually averages about 13 inches of precipitation. Mean annual temperatures in Lewiston range from 74 degrees Fahrenheit in July to 32 F in January (NWS 1982). Higher elevations receive more precipitation (up to 50 inches) and experience lower temperatures (down to a 14 F average in January). Above 5,000 feet (msl), more than 70 percent of the annual precipitation is in the form of snow (USFS 1984).

Soils in the Snake Subbasin are of two types. At higher elevations, the cold soils are formed in materials from diorite, quartz, monzonite, granite, gneiss, schist, and in volcanic ash overlying basalt. Lower elevation soils were formed mainly in basalt with a thin loess cover and, in smaller areas, of granite. Plateaus and south-facing slopes in this unit have mesic soil temperature and most north slopes are frigid. Soils are mainly mollisols, aridisols, and inceptisols (Soil Conservation Service, pers. commun.).

Vegetation in the subbasin varies according to elevation. At lower elevations bunchgrasses dominate the flora. At higher elevations, above 4,000 feet (msl), a mixed coniferous forest of ponderosa pine, Douglas fir, and grand fir predominate.

Riparian conditions are fair to good. Early grazing practices have left some areas denuded and, in other areas, historic plant species have been replaced by less desirable species.

Water Resources

Major tributary streams in the lower Snake area include the Grande Ronde, Tucannon, and Palouse rivers. Numerous small tributaries include Asotin, Alpowa, Deadman, and Alkalai Flat creeks. In the upper Snake, the major tributary streams are the Salmon, Clearwater, Grande Ronde and Imnaha rivers.

Water conditions are good to excellent for anadromous fish in the upper Snake Subbasin. Water quality is more than adequate to support spawning and rearing of salmon and steelhead (Table 1). Peak flows occur from April to June (Table 2).

No major withdrawals of surface water occur in Idaho. Water uses in the lower Snake River (Washington state area) include irrigation, municipal and industrial (primarily Lewiston, Clarkston) navigation and power generation.

Table 1. Water quality information for the Snake River. Values are median values. Measurements for minerals, nutrients, and trace elements are available. (Idaho Department of Health and Welfare, personal communication)

LOCATION	SEASON*	pH	TEMP F	DO mg/l	SPECIFIC CONDUCTANCE (MICROMHOS)	TURBIDITY (FTU)	YEARS OF SAMPLE
HWY 12 BRIDGE	SUMMER*	8.4	69.8	8.3	235	6.0	75,76
JOHNSON BAR	FALL	7.9	65.7	8.8	400	16.0	75
	SPRING	7.7	39.2	12.0	495	4.5	76
	SUMMER	7.4	62.8	10.2	---	---	76

*FALL-SEPTEMBER, OCTOBER, NOVEMBER; WINTER-DECEMBER, JANUARY, FEBRUARY; SPRING-MARCH, APRIL, MAY; SUMMER-JUNE, JULY, AUGUST

Table 2. Mean flows in the Snake River, 1928 to 1933. (Idaho Department of Water Resources, per.comm.)

Mean monthly discharge (1,000 ac-ft)

LOCATION	RIVER MILE	J	F	M	A	M	J	J	A	S	O	N	D	TOTAL
CLARKSTON	132.9	2572.5	2475.4	3207.2	4610.0	6715.8	6061.4	2516.5	1330.2	1487.1	1544.0	1936.5	2352.2	36808.8
ANATONE	167.2	1774.6	1738.0	2163.0	3161.6	4328.0	4156.5	1835.8	1038.0	1109.4	1241.2	1390.9	1623.5	25460.6
HELLS CAN. DAM	247.0	1316.4	1251.9	1461.5	1818.3	1658.9	1328.7	784.6	635.1	788.0	862.5	989.5	1158.7	14054.1

The major impact on water usage in the Washington subbasin involves the construction and operation of the four lower Snake River dams, constructed by the U.S. Army Corps of Engineers -- Ice Harbor (RM 9.7), Lower Monumental (RM 41.6), Little Goose (RM 70.3), and Lower Granite (RM 107.5). Lock and dam projects were authorized to provide slackwater navigation, irrigation, and hydroelectric power generation. The Lower Granite project was also expected to provide flood protection for the Lewiston/Clarkston area. Ice Harbor, Lower Monumental, Little Goose, and Lower Granite Lock and Dam projects were completed in 1962, 1969, 1970 and 1975, respectively (USDCI 1972).

The projects are similar in design and operation. Developments include concrete dams with power plants, navigation locks, and fish passage facilities. Pertinent engineering and operation data for the lower Snake dams are presented in Table 3.

Table 3. Pertinent engineering and operation data, lower Snake River projects.

Project	Elevation (feet)	Capacity (acre-feet)	Surface Area (acres)	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 non-flood period.

Land Use

Major land use management in the subbasin is for wilderness and agriculture with some logging in the tributaries. Agriculture uses include rangeland and cropland used for growing wheat, peas, and lentils. The major residential area is Lewiston and Clarkston with a metropolitan population of about 30,000 people.

About 17 percent of the land in the Washington Snake River Subbasin is forest, managed largely by the U.S. Forest Service. The headwaters of the Tucannon River and Asotin Creek originate in the Umatilla National Forest. Except for designated wilderness areas of the Wenaha/Tucannon Wilderness Area, U.S. Forest Service lands are managed for multiple use, principally for timber production and summer livestock grazing. The Wenaha/Tucannon Wilderness Area was created in 1978. It is located in the northern Blue Mountains in southeastern Washington and Oregon and encompasses an area of 177,465 acres. This wilderness area is managed for low impact recreation. It is heavily used during elk hunting seasons. Restricted amounts of cattle grazing are allowed.

About 38 percent of the Washington subbasin is rangeland. Over one-half is located along the mainstem of the Snake River, another 20 percent in the Tucannon River watershed, and the remainder in other watersheds. Steepness of slopes along with stoniness and shallow soils generally make rangeland areas unsuited to cultivation. Rangeland provides important forage for livestock and is vital to various wildlife species. It also influences water quality and quantity, and enhances aesthetics.

About 40 percent of the Washington subbasin is used for cropland. Most is used for the production of winter wheat. Other crops grown include spring wheat, spring barley, winter barley, dry edible peas, green peas, bluegrass seed, and alfalfa hay.

Primary land ownership in the upper Snake Subbasin changes between the upper and lower reaches. The vast majority of land in the upper portion of the subbasin (above RM 208) is under Forest Service jurisdiction (Wallowa-Whitman, Nez Perce, and Payette national forests). The lower reach is mostly private with interspersed tracts of Bureau of Land Management (BLM) and state lands.

The upper 39 miles of the subbasin is still in a relatively undeveloped state. This area contains most of the Hells Canyon National Recreation Area, which encompasses 652,488 acres, of which 194,132 acres are designated as wilderness. This stretch is part of the 67.5 miles of the Snake River that is part of the Wild and Scenic River system.

PART II. HABITAT PROTECTION NEEDS

History and Status of Habitat

The geology, topography, soils, climate and precipitation of the subbasin are broadly described in Part I. All of these factors significantly affect fish production in the subbasin. The high elevation Blue Mountains and elevated mountains of the upper Snake Basin intercept moisture-laden air masses moving inland from the Pacific Ocean and ultimately yield the majority of subbasin streamflows. Annual precipitation in the middle and lower reaches of the subbasin is low. Annual streamflows are very dependent upon the annual high-elevation snowpack and, to a lesser extent, summer thunderstorms. Spring runoff and low summer flows are critical times for fish production.

During summer months, streamflows are generally low and have elevated temperatures due to natural summer conditions. Dams in the mainstem Snake have played a role in increasing summertime temperatures.

The most critical function of the mainstem Snake River is that it provides access to the sea for juvenile salmonids and for returning adults. Juvenile salmon and steelhead undergo increased mortality passing through the four Snake River hydroelectric dams during downstream migration. This increased mortality is caused by three factors: 1) changes in water pressure and gas saturation between the top of the dam and the base of the dam, 2) the impact of the turbine blades as fish pass through the dam, and 3) exposure to predators at the base of the dam, particularly if the fish become stunned during dam passage.

Constraints and Opportunities for Protection

Institutional Considerations

The federal, state, and local agencies listed in Part I of this plan regulate land and water use activities in the subbasin. Fish production in the subbasin must compete with other uses, primarily power generation, irrigation, grazing, farming, and timber production. The quality of fish habitat in streams that pass through private lands is often determined by the land management activities of that landowner. On land managed by agencies, habitat quality for fish production is in part determined by the activities that are permitted on the land.

Fish managers must coordinate with regulatory agencies to promote the protection of fish habitat. Habitat protection is a most important management activity and should receive high priority.

Legal Considerations

Since the adoption of the 1917 Water Code, the state of Washington has allocated water based on the Prior Appropriations Doctrine. In many cases, the amount of water allocated has resulted in many overappropriations and the reduction in corresponding anadromous fish runs. Instream flow protection started with Chapter 75.20 RCW (1949), with Department of Fisheries and Department of Wildlife recommendations for low flow conditions and stream closures to further appropriations of water. Since 1969, beginning with passage of the Minimum Water Flows and Levels Law (RCW 90.22), the state law has acknowledged a greater need to protect instream flows for fisheries and other instream values through developing basinwide flow protection programs. In addition, the 1917 Water Code provided that water permits would not be granted that could prove "detrimental to the public welfare." (RCW 90.03.290).

Both the Minimum Water Flows and Levels Law and the Water Resources Act of 1971 (RCW 90.54) direct the Department of Ecology to set minimum or base flows that protect and preserve fish and other instream resources. Because minimum or base flow regulations do not affect existing water rights, reductions in anadromous fish runs in overappropriated streams will continue to be a problem. The Water Resources Act specifically lists fish and wildlife maintenance and enhancement as a beneficial use. It further directs the Department of Ecology (DOE) to enhance the quality of the natural environment where possible.

The state statutes, however, do not define the extent of instream resource protection, leaving to the Ecology Department the task of determining adequate protection levels for instream flows. This has caused increasing controversy in recent years and resulted in an attempt by the Ecology Department to define the level of flow that was to be provided for fish in the state's streams. The Department of Ecology's 1987 effort to set a standard of "optimum" flows for fish was challenged by out-of-stream water users via the Washington Legislature in 1988. The 1988 Legislature put a moratorium (which has now been lifted) on the DOE's recommended standard and established a Joint Legislative Committee on Water Resources Policy to address Washington's water future. To date, the committee has yet to define the level of protection that will be afforded fish resources.

Lacking any legislative direction on instream flow protection levels, water continues to be allocated from state streams under past practices. All water right applications are reviewed by the Department of Fisheries (WDF) and the Department of Wildlife (WDW), under RCW 75.20, prior to issuance by the Department of Ecology. The Ecology Department considers WDW and

WDF comments before making a decision regarding the issuance of a permit for withdrawal. WDF and WDW comments are recommendations only, and can be accepted or ignored by the DOE. Current Ecology Department practice is to issue water permits if water, above that recommended to be retained instream, is available for allocation. Virtually all domestic use requests are approved as are many non-domestic requests. The impacts of specific withdrawals on fish resources is often unclear, however, the cumulative impact of the new withdrawals is less instream water and negative impacts on fish populations.

The majority of Washington's streams do not have minimum flows established. Yet the Department of Ecology continues to issue permits for diversion and water withdrawal. It is unlikely that the current system will change until the Joint Legislative Committee on Water Resources Policy defines state policy in this area. The committee's decision could have a major impact on the future of the state's fisheries resources.

The fisheries agencies have requested that for most streams, instream flows be protected at levels that would maintain existing fish production, including the full range of variations that occurs naturally due to environmental conditions. For some streams, like the Yakima River, the fisheries agencies request flows to levels that would achieve potential production. This potential production would be determined by analyzing what could reasonably and practically be expected to return to the stream in the future.

In those streams that have already been overappropriated, establishment of instream flows may limit losses of fish resources to that which has already occurred. In many of these streams, restoration of instream flows is requisite for increasing or re-establishing fish runs.

In support of the continuing investments by the Northwest Power Planning Council's Columbia River Basin Fish and Wildlife Program, the following recommendations are made relative to instream flows and fisheries resources:

1) No new out-of-stream appropriations of any kind should be issued unless appropriate instream flow levels are established for the stream to be impacted either through comment on the water right application or through the adoption of an instream flow regulation.

2) There should not be any exceptions to the minimum flow levels, including domestic use.

3) Minimum flows should be impacted only if concurrence is obtained from the state and federal fish resource agencies and tribes and adequate mitigation is provided.

4) Minimum instream flow levels should be adequate to protect existing and potential (where appropriate) fish production.

5) State law should be changed so that saved, purchased or donated water can be dedicated to instream flows.

Critical Data Gaps

- o Little is known about salmonid habitat usage in the pool areas between Ice Harbor Dam and Lower Granite Dam.
- o Little is known about fish production associated with the mainstem above Lower Granite Dam.

Habitat Protection Objectives and Strategies

Objectives

1. Restore stocks of fish historically produced in the Snake River mainstem.
2. Achieve optimum fish production from existing habitat.
3. Contribute to Northwest Power Planning Council's doubling goal.
4. Restore historic fisheries (tribal and non-tribal) within subbasin.
5. Contribute to Columbia River and ocean tribal and non-tribal fisheries.
6. Protect indigenous genetic resources of salmonid stocks.
7. Comport with tribal treaty-reserved rights to fish.
8. Comport with Pacific Salmon Treaty and United States vs. Oregon production agreements, the Lower Snake River Compensation Plan, and with other applicable laws and regulations.
9. Prevent further loss of habitat and enhance existing habitat.

10. Provide improved passage conditions for migrating juvenile fish in the mainstem Snake.

11. Establish minimum streamflow for migration, spawning and rearing habitat in the mainstem.

12. Protect riparian zones from degradation by domestic livestock, forestry and agricultural practices, and by urban, and commercial development.

13. Protect fish habitat from point and non-point source pollution, including sediments.

Strategies

1. Implement measures in Section 403 of the Columbia River Basin Fish and Wildlife Program, and construct adequate fish bypass screens at Lower Monumental and Ice Harbor dams.

   At the Northwest Power Planning Council's request, the Corps of Engineers completed a comprehensive report on smolt transportation in 1986. The council also called on the Bonneville Power Administration to fund the testing and evaluation of alternative bypass conduit systems. In addition, the council adopted a 90 percent fish guidance efficiency standard as a design criterion for devices that deflect fish away from turbine intakes. For further information, refer to Part III.

2. Review and develop data and criteria for minimum flow requirements in mainstem Snake.

3. Develop a riparian protection plan. A more comprehensive, subbasinwide, riparian protection strategy is needed. This strategy should be a joint effort of all local, county, state, tribal, and federal governmental units within the subbasin.

   Existing law and regulations are available to address point source pollutants. However, non-point sources of pollution are not as effectively regulated. Local county conservation districts have programs to reduce sediment yield from farmed land. A joint effort of all local, county, state, tribal, and federal governmental units should develop a subbasinwide erosion and sediment-control strategy.

4. Identify potential impacts of mainstem dredging operations and develop guidelines for disposal of dredge spoils.

PART III. CONSTRAINTS AND OPPORTUNITIES FOR ESTABLISHING PRODUCTION OBJECTIVES

Institutional Considerations

Agencies and organizations involved in land and water management in the mainstem Snake Subbasin are listed below.

Federal Land and Water Managers

Department of Agriculture
- United States Forest Service (Umatilla, Wallowa-Whitman, Nez Perce, Payette)
- Soil Conservation Service

Department of the Interior
- United States Geological Service

Federal Energy Regulatory Commission
U.S. Army Corp of Engineers
Bureau of Land Management
National Park Service
Bonneville Power Administration
Northwest Power Planning Council

State Land and Water Managers

Washington Department of Fisheries
Washington Department of Wildlife
Washington Department of Natural Resources
Washington Department of Ecology
Oregon Department of Fish and Wildlife
Idaho Department of Fish and Game

County Land and Water Managers

Columbia County
Garfield County
Franklin County
Whitman County
Asotin County
Walla Walla County
Idaho counties
Oregon counties

Tribal Land and Water Managers

Columbia River Inter-Tribal Fish Commission
Confederated Tribes of the Umatilla Indian Reservation
Nez Perce Tribe
Shoshone-Bannock Tribes of Fort Hall

Fish and wildlife interests and managers in the mainstem Snake Subbasin are listed below.

National Marine Fisheries Service
U.S. Fish and Wildlife Service
Confederated Tribes of the Umatilla Indian Reservation
Nez Perce Tribe
Shoshone-Bannock Tribes of Fort Hall
Oregon Department of Fish and Wildlife
Idaho Department of Fish and Game
Washington Department of Fisheries
Washington Department of Wildlife

Each of the land and water management agencies has regulatory authority over some aspect of land or water use, or is responsible for overall management of specific land areas. Each has its own policies, procedures and management directives associated with its area of responsibility. None of these agencies, by itself, acts as manager of the entire watershed or regulates all the activities occurring in it.

The tribes and state agencies have regulatory authority over fisheries and fish production in the subbasin, but none have ultimate control in regulating land or water use activities that may adversely affect the fishery resource. The only way comprehensive management of the watershed can be achieved is through the coordinated involvement and cooperation of the fishery, land and water managers.

Legal Considerations

The Fish and Wildlife Coordination Act [PL 85-264, 85th Congress, August 12, 1985] requires the head of a construction agency responsible for losses of fish and wildlife through construction of a project to compensate for those losses to the fullest extent possible. The four lower Snake River dams (Ice Harbor, Lower Monumental, Little Goose, and Lower Granite), constructed by the Corps of Engineers, impact natural migration of anadromous fish and various aspects of their spawning and rearing habitat. To fulfill the requirements of the Fish and Wildlife Coordination Act, a plan was developed to compensate for the impacts of the four dams as a unit, rather than a dam-by-dam basis (Lower Snake River Compensation Plan).

Congress authorized the Lower Snake River Fish and Wildlife Plan in 1976. Currently, hatchery programs throughout the Snake River drainage built under the Lower Snake River Compensation Plan are still in developmental stages. The production and release programs will be monitored and evaluated; adjustments will be made in rearing and release strategies as needed to ensure that mitigation requirements are met and that the long-term objectives of the Lower Snake River Compensation Plan are achieved.

Lower Snake River Compensation programs in Oregon and Idaho are covered in the Grande Ronde, Clearwater, and Salmon River subbasin plans. Part of Washington's compensation under the Lower Snake River Compensation Plan is covered in the Tucannon River Subbasin Plan; however, all fall chinook and some steelhead production in Washington are related to the mainstem Snake River and will be covered in this subbasin plan.

On May 31, 1984, the Idaho Power Company and the U.S. Army Corps of Engineers agreed to increase the fall chinook salmon adult trapping, holding, and spawning capacity at the Lyons Ferry Salmon Hatchery, located on the lower Snake River. The purpose of this agreement was to mitigate for impairment to the fall chinook salmon run in the Snake River between Hells Canyon Dam and Lower Granite Dam that resulted from the construction, operation, and maintenance of Idaho Power's Hells Canyon Dam complex.

As a result of this agreement, Idaho Power Company agreed to pay for 9.7 percent of the actual construction costs for the hatchery facilities related to the fall chinook salmon program, and 8.7 percent of the actual construction costs for the fish ladder. Upon payment of these construction costs, Idaho Power Company was assured 1.3 million eyed eggs from Snake River stock fall chinook salmon annually. This provision was to be done when the Lyons Ferry Hatchery obtained 80 percent of its annual egg quota of 12 million eggs. Thereafter, the Idaho Power Company is entitled to receive 9.7 percent of all fall chinook salmon eyed eggs, up to a maximum of 1.3 million eggs. The Idaho Power Company is then under agreement to provide incubation and rearing for the eggs at the Idaho Power Company's Oxbow Hatchery.

In another significant mitigation measure, the Northwest Power Planning Council called for the construction of bypass facilities on the four dams. To protect migrating fish prior to completion of these facilities, the council adopted a plan that called for dam operators to spill sufficient water at the dams to guarantee a specified level of fish survival. Until mechanical bypass systems are installed, the council requires that the level of spill be sufficient to guarantee at least 90 percent fish survival at specified projects for the middle 80 percent of the spring and summer migrations. Spill operators are to begin when the first 10 percent of the spring migrants have passed a dam and are to protect 80 percent of the spring and summer migration. An annual spill plan is to be coordinated between the Corps of Engineers and the fish and wildlife agencies and tribes.

Various other legal considerations affect Idaho anadromous salmonids. Important legislation includes the Water Resources Development Act of 1976, Pacific Northwest Electric Power Planning and Conservation Act of 1980, and Salmon and Steelhead Conservation and Enhancement Act of 1980.

Four main laws shape the state of Idaho's policies toward the Snake River: 1) the state of Idaho commissions the Idaho Department of Fish and Game to manage the fish and wildlife of the state; 2) the Stream Channel Protection Act of 1971 regulates proposed stream channel alterations; 3) in the early 1970s the State Environmental Health Protection Act was passed, setting the basis for water quality standards; and 4) a law was recently legislated to establish a comprehensive state water plan and authorize a state "protected rivers" system.

Several Idaho Indian tribes have traditionally fished within the subbasin. By virtue of the treaties with the Nez Perce Tribe in 1855 and the Shoshone-Bannock Tribes in 1868 (Fort Bridger Treaty), the tribes are guaranteed the right to fish on any unoccupied federal lands. Several court cases have established the scope and extent of these treaties and the subsequent rights possessed by the tribal members. The extent of the Shoshone-Paiute Tribes' fishing rights remain unresolved pending anthropological and legal research and evaluation.

Federal agencies owning land within the subbasin are presently, or will soon be, working under their respective management plans. Forest management plans have been finalized for the Nez Perce and Payette national forests, however, both are under appeal. The Bureau of Land Management is currently operating under its Chief Joseph Land Management Plan.

The Idaho Department of Fish and Game (IDFG) is presently working under, or in conjunction with, three plans concerned with anadromous fish. The department's current five-year Anadromous Fisheries Management Plan ends in 1990. Earlier mitigation efforts resulted in two other plans -- the Lower Snake River Fish and Wildlife Compensation Plan and the settlement agreement with Idaho Power Company.

No fish species in the subbasin are currently listed as endangered by the Environment Protection Agency. However, the Idaho Fish and Game classifies sockeye (*Oncorhynchus nerka*) as endangered, summer and fall chinook (*Oncorhynchus tshawytscha*) as threatened, and spring chinook and steelhead (*Oncorhynchus mykiss*) as species of special concern. The Bureau of Land Management and lists chinook, sockeye, and steelhead as sensitive species. The Northern Region of the Forest Service has officially classified as sensitive all anadromous species.

Management of anadromous salmonids in the Snake River has been and will be influenced by the outcome of several cases and negotiations. The Snake River adjudication will determine private, tribal, state, and federal reserve water rights within the Snake River and its tributaries. The Northwest Power Planning Council's "protected areas" includes a large number of stream reaches in the Snake River drainage. The Pacific Salmon Treaty Act of 1985 provides for coastwide management of salmon by the United States and Canada to rebuild natural stocks of chinook and other species, and considers steelhead compensation needs in salmon fisheries. This treaty and United States vs. Washington determined harvest allocation principles and processes for anadromous fish in coastal areas of the United States and Canada. United States vs. Oregon (Columbia River Fish Management Plan) is intended to deal with similar issues in the Columbia River. The Magnuson Act (Fishery Conservation and Management Act of 1976) provides for domestic U.S. harvest management processes in national waters of the Pacific Ocean through the Pacific Fisheries Management Council.

The Snake River has been the subject of many federal acts. As mentioned, the Snake River is part of the national Wild and Scenic River system. Public Law 94-199, passed in 1975, established the Hells Canyon National Recreation Area.

PART IV. ANADROMOUS FISH PRODUCTION PLANS

SPRING CHINOOK SALMON

Fisheries Resource

Natural Production

One southeast Washington tributary stream, Asotin Creek, has a spring chinook population. Washington Department of Fisheries biologists have conducted surveys in Asotin Creek since 1984 and determined an average annual escapement of nine redds. Counts were conducted intermittently by other agencies in the last 30 years with redd counts ranging from five redds to 75 redds. Total smolt capacity in the Smolt Density Model is 81,771 smolts. Currently, Washington Fisheries Department biologists have found densities of less than one juvenile chinook per 100 square meters. Quality of habitat in Asotin Creek is limited by high summer water temperatures and lack of cover. Fencing is needed in many areas to control livestock.

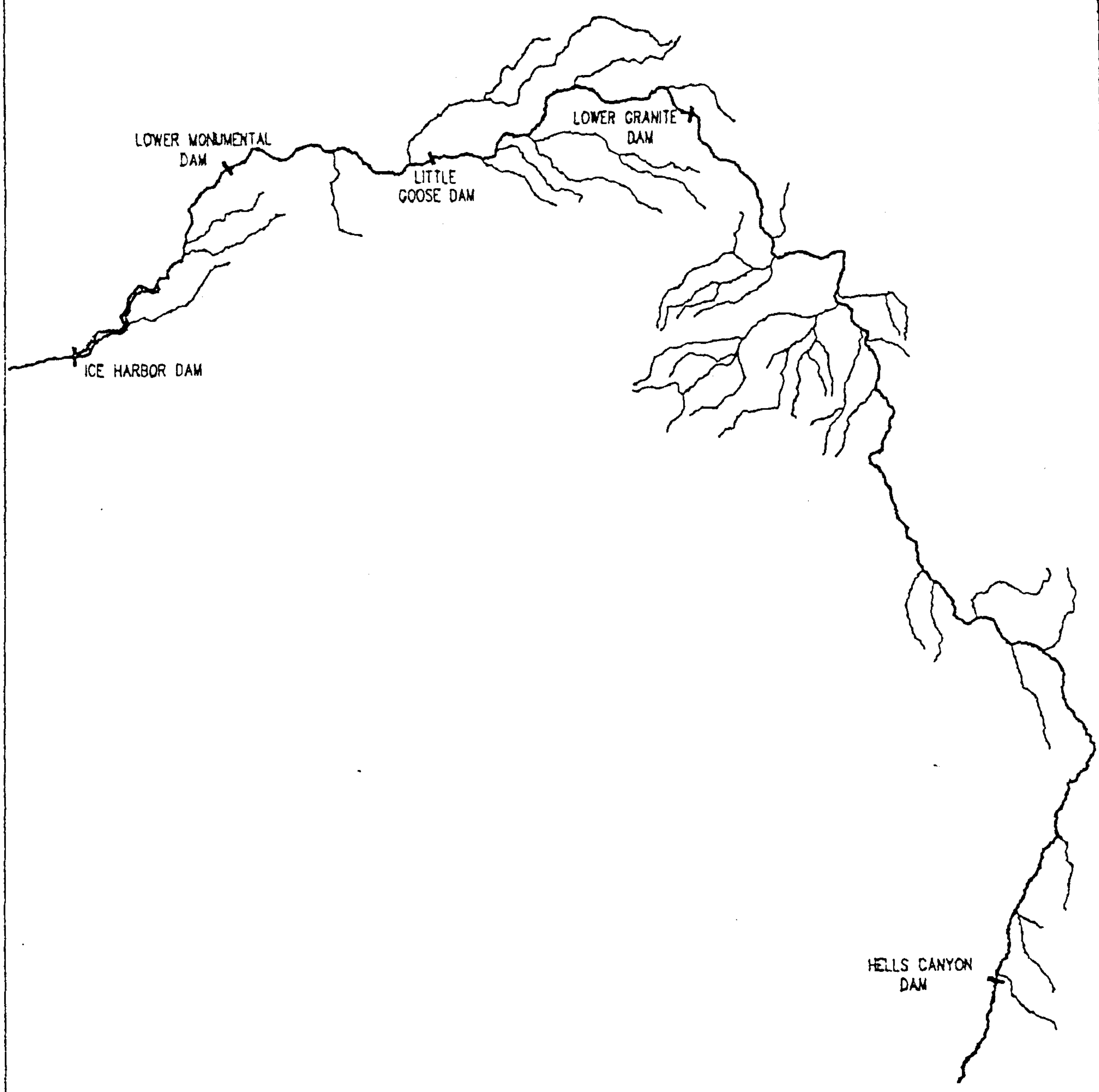
Other streams above Lower Granite Dam known to provide some spawning and rearing for spring chinook are Granite and Sheep creeks.

In addition to being a migration route for adult and juvenile spring chinook, the mainstem Snake River provides important rearing and staging habitat for spring chinook produced in the major subbasins of the Salmon, Clearwater, Grande Ronde, Tucannon, and Imnaha rivers. The amount of rearing provided in the mainstem for these fish is unknown.

Hatchery Production

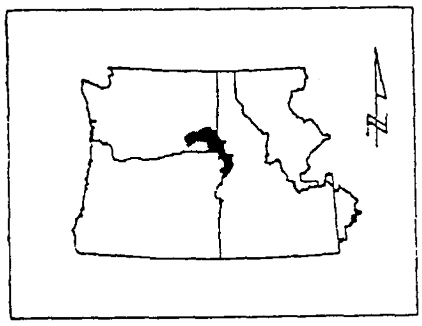
Oxbow Hatchery is a steelhead and spring chinook salmon facility owned and funded by the Idaho Power Company and operated under contract by the Idaho Department of Fish and Game. Oxbow is located on the Oregon shore of the Snake River, at River Mile 270 (602 miles from the Pacific Ocean), about one half mile downstream from Idaho Power's Oxbow Power Plant (Burton 1988). Adult fish held and spawned at Oxbow are collected at the Hells Canyon Trap. The trap is situated approximately 23 miles downstream of Oxbow on the Oregon side of the Snake River adjacent to the tailrace of Hells Canyon Dam. Water for the hatchery is supplied from Hells Canyon Reservoir. Two pumps supply a maximum of 24 cubic feet per second (cfs) to holding ponds and raceways.

SNAKE RIVER



ICE HARBOR DAM TO

HELLS CANYON DAM



GIS GEOGRAPHIC INFORMATION SYSTEM

BONNEVILLE POWER ADMINISTRATION

Oxbow Hatchery, begun as an experimental facility in 1961, has been in production since 1962. Currently, the primary purpose of this facility and the Hells Canyon Trap is to trap and hold sufficient numbers of returning adult steelhead and spring chinook to fulfill Idaho Power's anadromous fish mitigation requirements.

According to the settlement agreement approved by the Federal Energy Regulatory Commission, the Hells Canyon Trap and Oxbow Hatchery must, to the extent possible, provide sufficient numbers of adult spring chinook to produce 1 million smolts. The adult spring chinook are transported to Idaho Power's Rapid River Hatchery for spawning. Rearing of resultant progeny are then trucked back to the Snake River for release. Spring chinook returns have ranged from zero to 547 fish from 1980 through 1987 (Table 4). Average fork length for 1986 through 1987 was 30 inches; this is primarily a 2-ocean run. Average fecundity has varied, and was 4,400 eggs per female in 1987. Smolt releases are given in Table 5. Percent returns have ranged from 0.1 percent to 0.2 percent for the 1983 through 1985 release groups (Table 5).

Table 4. Summary of rack returns to the Oxbow trapping facility since 1980.

Year	Total Return To Rack	Number Released	# Trucked To Rapid River	Females Spawned
1980	8 1/	8 1/		
1981	5 2/	5 2/		
1982	0			
1983	16	0	12	1
1984	0			
1985	760	4	733	268
1986	395	2	362	---
1987	547	0	536	177

1/ Jack fall chinook released into river.
2/ Three jack fall chinook, one fall chinook female, one jack spring chinook.

Table 5. Hells Canyon spring chinook age distribution and percent return.

Rel. year	Number Released/1	3-Yr Old	4-Yr Old	5-Yr Old	Total	% Return
1983	250,000	ND	454 /2	62	516	0.2
1984	500,850	61 /2	317	156	534	0.1
1985	437,860	14	387	391 /3	792	0.2
1986	140,000	4	39 /3			
1987	444,700	11 /3				

/1 Taken from Rapid River records.
/2 36 fish not measured in 1985.
/3 As of 6/23/88.

The brood stock for the spring chinook program is fish that originally inhabited waters above Hells Canyon Dam such as the Powder and Weiser rivers. These fish were also transferred to Idaho Power Company's Rapid River and Pahsimeroi hatcheries in the Salmon River Subbasin.

Production constraints include the fact that the Oxbow facility at this time is not designed to be a cold water culture station. Also, an additional source of water other than river water for egg incubation is desirable. However, a source does not appear available at this time.

Specific Considerations

- Spring chinook production on the mainstem Snake River Subbasin is located above four mainstem Columbia River dams and four Snake River dams.
- Habitat carrying capacity has not been adequately identified.
- Specific escapement goals have not been established.
- Current management practices do not allow for directed harvest of spring chinook since all fish are needed for escapement.
- Low flow and high water temperatures in the summer and fall adversely impact survival.
- In Asotin Creek, returns are extremely low, with counts ranging from five redds to 75 redds.

o Oxbow Hatchery is a mitigation facility for Idaho Power that holds adult spring chinook trapped at Hells Canyon Dam. There is an annual release goal of 1 million smolts, reared at Rapid River Hatchery. Releases in recent years have ranged from 250,000 fish to 500,000 fish. Adult returns have ranged from zero to 547 fish.

Objectives

Biological Objectives

1. Reestablish the spring chinook run into suitable tributaries of the Snake River.

2. Increase returns to Asotin Creek.

   Concurrent with mainstem passage improvements, returns to Oxbow should provide opportunities for brood stock expansion and eventual outplanting into tributaries.

3. To the extent possible, protect indigenous genetic resources of spring chinook. More specific information is needed to better identify tributaries for potential reintroduction of spring chinook.

Utilization Objective

At this time no specific directed harvest opportunities have been identified. Besides reestablishing the run, the ultimate goal is to restore historic tribal and non-tribal fisheries within the subbasin.

Alternative Strategies

Modeling results for each strategy are presented in Table 6 as fish produced at "maximum sustainable yield" (MSY). The sustainable yield of a fish population refers to that portion of the population that exceeds the number of fish required to spawn and maintain the population over time. Sustainable yield can be "maximized," termed MSY, for each stock at a specific harvest level. The MSY is estimated using a formula (Beverton-Holt function) that analyzes a broad range of harvest rates. Subbasin planners have used MSY as a tool to standardize results so that decision makers can compare stocks and strategies.

In MSY management, managers set a spawning escapement level and the remaining fish (yield) could theoretically be harvested. In practice, a portion of the yield may be reserved as a buffer or to aid rebuilding. Thus, managers may raise the escapement level to meet a biological objective at the expense of a higher utilization objective.

The amount of buffer appropriate for each stock is a management question not addressed in the subbasin plans. For this reason, the utilization objective, which usually refers to harvest, may not be directly comparable to the MSY shown in Table 6. At a minimum, a strategy should produce an estimated MSY equal to or greater than the utilization objective. A MSY substantially larger than the subbasin utilization objective may be needed to meet subbasin biological objectives.

Planners did not estimate costs of the following strategies.

STRATEGY 1: Natural Production, Level 1.

Asotin Creek was identified as the primary tributary where spring chinook production occurs. Although Granite and Sheep creeks provide some spawning and rearing, the extent is unknown and considered small.

Strategy 1 focuses on improving the habitat within the Asotin Creek drainage. Such activities as fencing, revegetation, placement of large organic materials, and stream channel improvements would benefit survival of spawning adults and rearing within this creek. In the model, an assumption was made that these types of improvements would result in 5 percent increases in survival rates for both the pre-spawning and egg-to-smolt parameters.

ACTIONS: 1, 2

1. Improve habitat of Asotin Creek. This would involve fencing and revegetation programs. Specific activities and locations need to be identified.

2. Screen diversions on the mainstem Snake River. Swan et al. (1986) located and inspected water withdrawal sites on the Columbia and Snake rivers to determine adequacy of intake screening. A total of 225 sites were inspected in 1979 and 1980. Results showed that the majority of intake pipes (70 percent) lack proper screening. Subsequent inspection a year later, after notification of the intake inadequacies, revealed that 30 percent still lacked proper screening and/or design. One particular withdrawal, located on the Snake River near the confluence of the Columbia, has remained unscreened for 45 years. Known as the Burbank Diversion in South Columbia Basin Irrigation District,

this intake has a maximum withdrawal of 39 cfs, with an average of 20 cfs. In 1964, Washington Department of Fisheries and Washington Department of Game did indicate that this intake did not need screening; however, under present considerations, it is advisable to screen this structure. Impacts to spring chinook are not known.

STRATEGY 2: Natural Production, Level 2 (not modeled).

This strategy focuses on increasing the habitat base through expansion of production areas. At this time no specific areas have been identified.

ACTIONS: 3

3. Allow natural spring chinook runs to re-establish in the smaller subbasin tributaries and mainstem concurrent with increases in major subbasins such as Salmon, Clearwater, Grande Ronde, Tucannon rivers. Management directed at these major subbasins within the Snake River Subbasin will dictate the rate at which spring chinook re-establishment will take place.

STRATEGY 3: Supplementation (not modeled).

This strategy would involve identifying selected tributaries for outplanting of spring chinook, most likely a stock originating from Oxbow Hatchery. At this time, no areas of supplementation have been noted, though it is thought to be a potential strategy.

ACTIONS: 4

4. Supplement natural production in the mainstem and minor tributary streams through the outplanting of hatchery fish.

STRATEGY 4: Hatchery Production.

Action 5 does not presently identify any specific increases as a result of facility expansion. According to the FERC agreement, 1 million smolts are identified as the mitigation level. However, recent releases have been within the range of 250,000 to 500,000 smolts.

The model was calibrated using a 500,000 smolt release into the Snake River. Pre-implementation estimated a MSY run size of 795 fish. Post-implementation estimated it at 939 fish, or a 1.11 increase over pre-implementation (Table 6).

ACTIONS: 1, 5

1. -

5. Construct or expand an existing hatchery in the subbasin to produce some as yet undetermined numbers of spring chinook.

Recommended Strategy

Planners recommend Strategy 1, which calls for natural production increases through habitat improvements in Asotin Creek, and screening of mainstem Snake River diversions.

Table 6. System Planning Model results for spring chinook in the Snake River Subbasin. Baseline value is for pre-mainstem implementation, all other values are post-implementation.

Utilization Objective:
No specific directed harvest opportunities have been identified at this time. Ultimate objective is to restore historic tribal and non-tribal fisheries within the subbasin.

Biological Objective:
1. Re-establish runs into suitable tributaries. 2. Increase returns to Asotin Creek. 3. To the extent possible, protect indigenous genetic resources.

Strategy[1]	Maximum[2] Sustainable Yield (MSY)	Total[3] Spawning Return	Total[4] Return to Subbasin	Out of[5] Subbasin Harvest	Contribution[6] To Council's Goal (Index)
Baseline	795 -N	614	1,553	476	0(1.00)
All Nat	950 -N	637	1,735	533	401(1.12)
1*	864 -N	627	1,636	502	185(1.05)
2-N/M					
3-N/M					
4	939 -N	622	1,717	527	363(1.11)

*Recommended strategy.
N/M denotes a strategy that was not modeled.

[1]Strategy descriptions:

For comparison, an "all natural" strategy was modeled. It represents only the natural production (non-hatchery) components of the proposed strategies plus current management (which may include hatchery production). The all natural strategy may be equivalent to one of the alternative strategies below.

1. Improve habitat in Asotin Creek and screen diversions in mainstem Snake River. Post Mainstem Implementation.
2. Allow runs to re-establish in other creeks through habitat projects. Post Mainstem Implementation.
3. Supplement tributary creeks. Post Mainstem Implementation.
4. Expand hatchery facilities. Post Mainstem Implementation.

[2]MSY is the number of fish in excess to those required to spawn and maintain the population size (see text). These yields should equal or exceed the utilization objective. C = the model projections where the sustainable yield is maximized for the natural and hatchery components combined and the natural spawning component exceeds 500 fish. N = the model projection where sustainable yield is maximized for the naturally spawning component and is shown when the combined MSY rate results in a natural spawning escapement of less than 500 fish.

[3]Total return to subbasin minus MSY minus pre-spawning mortality equals total spawning return.

[4]Total return to the mouth of the subbasin.

[5]Includes ocean, estuary, and mainstem Columbia harvest.

[6]The increase in the total return to the mouth of the Columbia plus prior ocean harvest (as defined by the Northwest Power Council's Fish and Wildlife Program), from the baseline scenario. The index () is the strategy's total production divided by the baseline's total production.

FALL CHINOOK SALMON

Fisheries Resource

Natural Production

History and Status

Fall chinook salmon are indigenous to the Snake River Subbasin. Fall chinook were historically distributed throughout the mainstem and also in the lower part of the major tributaries. Habitat degradation, harvest, and hydroelectric development have all contributed to the declining runs. Dam counts presented in Table 7 indicate the population trends entering the Snake River since 1964.

Prior to 1964, dam counts to estimate Snake River returns were only available in the mainstem Columbia at McNary Dam and downstream facilities. These dam counts were used in the development of the Lower Snake River Compensation Plan.

From 1954 through 1974, the highest count of fall chinook at McNary Dam was 97,500 fish. Of these fish, an estimated 33.5 percent (32,700 chinook) entered the Snake River based on comparisons with Ice Harbor Dam counts. Spawning habitat for approximately 5,000 of these adults was directly lost by the inundation of the Snake River from the Clearwater confluence to Ice Harbor Dam. The downstream migrant progeny of the remaining 27,700 fish were estimated to undergo 48 percent mortality during their passage over the Snake River dams. Thus, of the 32,700 fall chinook calculated to have entered the Snake River prior to impoundment, potential production from 18,300 adults was estimated to have been lost. Refer to the Lower Snake River Compensation Plan Special Report (COE 1975) for further discussion of this agreement.

Fish and wildlife agencies from Washington, Oregon, and Idaho and the Idaho Power Company have made aerial searches for fall chinook spawning activity in the Hells Canyon reach of the Snake River. The first recorded surveys were made in 1969 (after completion of Hells Canyon Dam in 1967). Biologists observed 283 adults and 388 redds. In 1974 (after completion of Little Goose Dam in 1970), two adults and 16 redds were observed. Surveys were again made in 1975 and 1976 (after completion of Lower Granite Dam in 1975). Biologists recorded 11 adults and 10 redds in 1975, and six adults and 13 redds in 1976. In 1987, 13 adults and 66 redds were observed.

Table 7. Adult and jack counts of fall chinook at four Snake River dams, 1964-1987 (Jensen, 1988).

	ICE HARBOR		LOWER MONUMENTAL		LITTLE GOOSE		LOWER GRANITE	
YEAR	ADULTS	JACKS	ADULTS	JACKS	ADULTS	JACKS	ADULTS	JACKS
1964	9,100	2,000						
1965	8,200	4,200						
1966	12,800	2,200						
1967	14,000	5,000						
1968	19,500	4,900						
1969	13,600	3,900	6,200	1,400				
1970	9,000	1,400	5,300	2,000	4,500	1,800		
1971	9,300	1,700	7,800	2,400	4,700	1,400		
1972	7,500	1,900	4,100	1,100	1,800	530		
1973	6,700	1,600	3,800	1,700	2,400	760		
1974	2,400	410	2,200	860	900	380		
1975	1,900	620	1,800	1,300	900	710	1,000	1,200
1976	1,100	360	1,100	1,000	430	630	470	830
1977a	1,200	540	870	1,100	420	840	600	1,300
1978	1,100	500	500	520	490	780	640	850
1979	1,200	810	620	660	550	640	500	940
1980	1,200	590	570	340	500	200	450	330
1981	770	1,300	490	1,100	420	970	340	1,400
1982	1,600	1,900	930	1,400	b	---	720	1,500
1983	1,800	960	800	720	b	---	540	980
1984	1,700	800	620	610	b	---	640	730
1985	2,000	7,100	980	4,800	b	---	690	1,500
1986	3,100	2,700	1,700	3,200	b	---	780	1,800
1987	6,800	1,600	3,300	1,200	b	---	950	390

a/ Starting in 1977, fall chinook were removed at Ice Harbor dam for the egg bank program and do not appear at upstream dams.

b/ After 1981, counts at Little Goose Dam were not diffentiated by species.

Biologists have attempted aerial surveys in other years as well, but have generally been unsuccessful due to poor water conditions (high flow and turbidity) and weather.

Life History and Population Characteristics

Adults were known to enter the Snake River from late August through November with peak dates in September (Pirtle 1957). Current adult return timing for the 1987 brood is presented in Table 8. This includes fish trapped at Ice Harbor Dam and the first voluntary adult returns to Lyons Ferry Hatchery.

Table 8. Collection and spawning summary for 1987 fall chinook salmon brood stock at Lyons Ferry Fish Hatchery. a/

Week ending	Arrivals		Mortality			Spawned		Estimated egg take
	adult/	jacks	M /	F /	J	M /	F	
09/05/87	87							
09/12	174							
09/19	408							
09/26	747							
10/03	542	3	2					
10/10	400	3	1					
10/17	136	2	3					
10/24	89	6	11	1		3		13,500
10/31	78	6	17	1	10	18		81,000
11/07	196	9	31			82		328,500
11/14	55		46	46	2	10	192	841,500
11/21	114		111	120	14	58	506	2,223,000
11/28	160		180	36	3	155	377	1,647,000
12/05	28		220	42	3	223	296	1,314,000
12/12	24		92	15	4	118	92	414,000
12/19		3		18	3	69	19	63,000
Total	3241	28	704	327	28	643	1585	6,925,500

a/ Classification of adults and jacks at time of arrival was based on size only. Coded-wire tag and scale impression data revised escapement to 2,842 adults and 1,015 jacks.

Downstream migration of fall chinook began in March, peaked in mid-April (about one month prior to the normal maximum daily Snake River discharge) and was completed by the end of June. Migration appeared to have been initiated by an increase in flow and water temperatures. Modal size for age-0 downstream migrants was 42 mm, with a range of 30 mm to 55 mm (Mains and Smith 1955).

Survival rates and habitat carrying capacity is unknown. See Table 7 for run size.

As for genetics, conclusions from electrophoretic data are (Seidel et al. 1988):

- No evidence of genetic difference between fish returning to the Snake River and Lyons Ferry Hatchery and those derived from the Snake River/Lyons Ferry egg-bank program at Kalama Falls hatchery and returning to that hatchery.

- Clear evidence of significant genetic differences between the Priest Rapids Hatchery Stock (mainstem Columbia River Hanford Reach) and the Snake River/Lyons Ferry Hatchery stock.

Supplementation History

An egg-bank program for Snake River fall chinook was started in 1977. The purpose of the program was to ensure that the Snake River fall chinook stock would still be available when the Lower Snake River Compensation Plan hatchery program was completed. Juveniles from adults collected at Ice Harbor Dam from the 1977 through the 1983 brood were released at both Kalama Falls (below Bonneville Dam) and mainstem Snake River (above Lower Granite Dam). Starting in 1984, adults captured at Ice Harbor Dam and eggs from adults returning to Kalama Falls were transported to Lyons Ferry Hatchery. The Kalama Falls egg-bank program was quite successful, since it doubled the number of eggs available for the initial start up years for the Lyons Ferry Hatchery. Egg-bank releases in the mainstem Snake River above Lower Granite Dam are listed in Table 9.

Fish Production Constraints

The most critical function of the mainstem Snake River is that it provides access to the sea for juvenile salmonids and for returning adults. Juvenile and adult fish undergo increased mortality passing through the four Snake River hydroelectric dams during migration periods. Inundated reaches eliminated extensive spawning areas.

Table 9. Snake River Smolt Release Above Lower Granite Dam (1978-1984 broods)

HATCHERY	BROOD YEAR	NUMBER RELEASED	SIZE OF RELEASE NO/POUND	DATE OF RELEASE	RELEASE LOCATION
HAGERMAN	1978	53,000	84	MAY 20,1979	BARGE LOWER GRANITE
HAGERMAN		46,000	92	MAY 21, 1979	ASOTIN
HAGERMAN		40,000	137	JUNE 7, 1979	BARGE LOWER GRANITE
HAGERMAN	1979	47,550	38	MAY 22, 1980	ASOTIN
HAGERMAN		59,850	44	MAY 27, 1980	ASOTIN
HAGERMAN		57,713	59	JUNE 5, 1980	LOWER GRANITE
HAGERMAN		60,750	58	JUNE 3, 1980	ASOTIN
HAGERMAN	1980	60,233	34	MAY 26, 1981	LOWER GRANITE
HAGERMAN		61,134	51	MAY 28,1981	LOWER GRANITE
HAGERMAN		59,924	80	JUNE 2, 1981	4 MI ABOVE LOWER GRANITE
HAGERMAN	1981	28,045	30	MAY 15, 1982	MOUTH GRAND RONDE
HAGERMAN		82,907	38	JUNE 3, 1982	4 MI. ABOVE LOWER GRANITE
HAGERMAN		80,721	37	JUNE 3, 1982	ASOTIN
HAGERMAN		215,667	47	JUNE 7, 1982	AOSTIN
HAGERMAN		70,272	48	JUNE 22, 1982	HELLS CANYON DAM
HAGERMAN		64,123	89	JUNE 22, 1982	MOUTH GRANDE RONDE
HAGERMAN		157,636	98	JUNE 24, 1982	AOSTIN
HAGERMAN	1981	10,000	50	JULY 5, 1982	AOSTIN
HAGERMAN	1982	78,900	44	JUNE 16, 1982	MOUTH GRANDE RONDE
HAGERMAN	1983	38,380	53	JUNE 5, 1983	MOUTH GRANDE RONDE
HAGERMAN		61,146	53	JUNE 5, 1984	MOUTH GRANDE RONDE
HAGERMAN		119,458	84	JUNE 13, 1984	MOUTH GRANDE RONDE
HAGERMAN		208,207	83	JUNE 13, 1984	MOUTH GRANDE RONDE
HAGERMAN	1984	71,902	52	JUNE 4, 1985	AOSTIN
HAGERMAN		10,372	52	JUNE 4, 1985	AOSTIN
HAGERMAN		45,988	44	JUNE 4, 1985	MOUTH GRANDE RONDE

During summer months, streamflows are generally low and have elevated temperatures due to natural summer conditions. Dams in the mainstem Snake have played a role in increasing summertime temperatures.

Hatchery Production

The Lyons Ferry Hatchery is located at the confluence of the Palouse River with the lower Snake River at RM 56.2. Design capacity is 101,800 pounds (9,162,000 subyearling smolts at 90 fish per pound) of fall chinook salmon and 8,800 pounds (132,000 yearling smolts at 15 fish per pound) of spring chinook salmon (Table 10).

Table 10. Fall and spring chinook salmon production objectives for Lyons Ferry and Tucannon fish hatcheries.

Return Facility	Stock	Number produced	Pounds produced	Adult returns	Rate (%)
Lyons Ferry	Fall	9,162,000	101,800	18,300	0.20
Tucannon	Spring	132,000	8,800	1,152	0.87

The Lyons Ferry facility has a single-pass well water system through the incubators, two adult holding ponds, and 28 raceways. Fall chinook salmon are hatched and reared at the Lyons Ferry facility and either released on station or barged downstream and released. Adult fall chinook salmon return to the fish ladder at the Lyons Ferry facility for brood stock; 1987 was the first year of adult (4-year-olds and older) returns to the hatchery.

The Lyons Ferry Fish Hatchery has been developing its brood stock since the facility was completed in 1984. Snake River fall chinook brood stock are currently obtained from two sources, 1) returns to Lyons Ferry ladder and 2) adults trapped at Ice Harbor Dam for transport to Lyons Ferry. The third source, transport of eyed eggs from Kalama Falls Fish Hatchery, was done as part of the Snake River Egg Bank Program, and was completed in 1986.

Duration of 1987 fall chinook salmon spawning was from October 20 through December 14 (Table 8), compared to October 22 through December 16 in 1986. Peak of spawning was November 17, compared to November 19 in 1986, and November 16 in 1985. Egg-take was 5,957,976 eggs with a mortality rate of 3.82 percent, compared with egg mortality rates of 3.98 percent in 1986 and 3.99 percent in 1985.

Numbers of fall chinook salmon returning to the Lyons Ferry Fish Hatchery ladder are increasing each year because on-station releases under way since 1985 are returning as adults. As of 1987, voluntary returns to the hatchery have been the primary source of brood stock (Table 11). A total of 1,654 adults and 543 jacks (fish under 61 cm fork length) returned to Lyons Ferry Fish Hatchery in 1987. First adult arrival to the rack was on September 18; last arrival was on December 12, six weeks longer than the duration of returns in 1986 (October 6 to November 14).

Since 1977, returning adult fall chinook salmon have been trapped at Ice Harbor Dam and transported to Dworshak National Fish Hatchery and Tucannon Fish Hatchery in conjunction with the Snake River Fall Chinook Egg Bank Program (Bjornn and Ringe 1988). Since its completion in 1984, Lyons Ferry Fish Hatchery has been receiving the transported fall chinook (Table 12). Over the 11-year period, numbers of fish transported have averaged 561 adults (range, 212 to 1,613 fish) and 56 jacks (range, zero to 150 fish). In 1987, 1,613 adults and 46 marked jacks were trapped and hauled to Lyons Ferry Fish Hatchery, representing 24 percent of the total run of fall chinook salmon adults past Ice Harbor Dam for that year (Table 11). Actual trap efficiency for the period of operation, however, was 32 percent.

Table 11. Contribution of fall chinook salmon adult returns to Lyons Ferry Fish Hatchery from Ice Harbor Dam, Kalama Falls Fish Hatchery, the Lyons Ferry Fish Hatchery ladder, and the total count past Ice Harbor Dam from 1984 through 1987.

Year	Source	Adults	Jacks	Adults	Jacks
1984	Lyons Ferry FH	0	0	1410	642/1
	Ice Harbor Dam	663	97		
	Kalama Falls FH	220	10		
1985	Lyons Ferry FH	6	4070/2	2046	7119
	Ice Harbor Dam	589	90		
	Kalama Falls FH	952	2		
1986	Lyons Ferry FH	245	1125	3152	2665
	Ice Harbor Dam	212	23		
	Kalama Falls FH	576	1		
1987	Lyons Ferry FH	1654	543	6812	1619
	Ice Harbor Dam	1613	47		
	Kalama Falls FH	0	0/3		

/1 Classification of adults and jacks is based upon size only.

/2 The first release from Lyons Ferry Fish Hatchery was in 1985 (1983 brood). Therefore, first returns of hatchery-reared stock to Lyons Ferry Fish Hatchery were 2-year-old jacks in 1985.

/3 There were no returns of Snake River stock fall chinook salmon to Kalama Falls Fish Hatchery in 1987.

Table 12. Numbers of fall chinook salmon trapped at Ice Harbor Dam and hauled to Lyons Ferry Fish Hatchery, duration of trapping, and peak day of trapping from 1984 through 1987.

Year	Number trapped adults	Number trapped jacks	Duration of trapping	Peak trapping day date	Peak trapping day number
1984	663	97	1 Sep.-5 Oct.	11 Sep.	57
1985	589	90	31 Aug.-30 Sep.	9 Sep.	68
1986	212	23	4 Sep.-3 Oct.	18 Sep.	24
1987	1,613	47	2 Sep.-11 Oct.	26 Sep.	97

Prior to completion of the Lyons Ferry Fish Hatchery, a portion of the Snake River stock fall chinook salmon adults were collected and reared at the Washington Department of Fisheries Kalama Falls Fish Hatchery on the lower Columbia River as part of the Snake River Fall Chinook Egg Bank Program. When the Lyons Ferry facility was completed, eyed eggs were transported from Kalama Falls Fish Hatchery to Lyons Ferry for rearing and subsequent release. Hatchery staff transported 219,800 1984 brood eggs, 1,182,000 1985 brood eggs, and 749,355 1986 brood eggs from Kalama Falls Fish Hatchery (Table 11). There were no returns of Snake River stock fall chinook to Kalama Falls in 1987. Snake River stock fall chinook have not been released from Kalama Falls since spring 1984; all releases since that time have originated at Lyons Ferry.

In 1987, there were returns to the Lyons Ferry rack from five separate treatment (release) groups, 1) the 1983 brood yearling (age 1+) on-station release, 2) the 1984 brood yearling on-station release, 3) the 1984 brood subyearling (age 0) on-station release, and 4) the 1985 brood yearling on-station and 5) transport groups. Each release group was differentially marked with coded-wire tags (Table 13).

To date, 1.21 percent of the 1983 brood has returned to Lyons Ferry as 2-, 3-, and 4-year-olds (Table 14). Currently, 13,399 tagged fish from this release group were caught in various fisheries, for a 4 percent contribution. The overall survival rate (fishery contribution and returns to the Lower Snake River Compensation Plan project area) is 5.23 percent. To date, 0.05 percent and 0.06 percent of the 1984 brood subyearling on-station releases have returned to Lyons Ferry and contributed to various fisheries, respectively; the overall survival rate is 0.22

percent. Both release groups have returned as 2- and 3-year-olds. These estimates are preliminary, and will be revised when coded-wire tag recoveries from all year classes are available.

All release groups from the 1983, 1984 and 1985 broods were represented in returns to the Lyons Ferry Fish Hatchery in 1987 (Table 15). The 1983 brood yearling release comprised the majority of the escapement in 1985, 1986, and 1987. Actual age distributions of returning fall chinook salmon to Lyons Ferry based upon scale and coded-wire tag analyses indicate the predominance of the strong 1983 year class (Table 16).

Table 13. Numbers released and proportion marked (coded-wire tag) for Lyons Ferry fall chinook salmon, compared by brood year and release group.

Brood year Release group	Number marked	Number unmarked	Mark rate	Total released
1983				
yearling on-station	334,442	315,858	0.51	650,300
1984				
subyearling on-station	234,985	304,407	0.44	539,392
yearling on-station	258,355	223,595	0.54	481,950
1985				
subyearling on-station	246,625	1,295,543	0.19	1,542,162
subyearling transport	245,561	1,831	0.99	247,392
yearling on-station	152,479	77,934	0.66	230,413
yearling transport	156,036	470	1.00	156,506
1986				
subyearling on-station	251,646	86,139	0.74	337,785
subyearling transport	255,998	80,264	0.76	336,262

Table 14. Preliminary coded-wire tag recoveries from contribution to various fisheries, returns to the Lyons Ferry Hatchery rack, and fish trapped at Lower Granite Dam for 1983, 1984, and 1985 broods Lyons Ferry fall chinook salmon. Results are compared by type of release and year of recovery.

Brood year release group	Year recovered	Fishery contribution	Hatchery returns	Lower Granite Dam
1983				
yearling	1985	157	1,929	51
on-station	1986	2,839	663	40
	1987	10,403	1,444	1 1/
1984				
subyearling	1986	88	34	56
on-station	1987	328	108	1
Total		416	146	57
1985				
subyearling on-station	1987	0	18	17
subyearling transport	1987	0	6	0
yearling on-station	1987	0	131	15
yearling transport	1987	0	110	3

1/ Only jacks (less than 55 cm fork length were collected at Lower Granite Dam, providing an accurate estimate for returns as 2- or 3-year-olds only.

Table 15. Number (and percent) of coded-wire tag recoveries by treatment (release) group and return year at Lyons Ferry Fish Hatchery.

Brood year release group	Number marked	Coded-wire tags recovered 1985	1986	1987	Total
1983					
yearling on-station	334,442	1,891 (0.57)	663 (0.20)	1,444 (0.43)	3,998 (1.20)
1984					
subyearling on-station	234,985	- -	34 (0.01)	108 (0.05)	142 (0.06)
yearling on-station	258,355	- -	48 (0.02)	89 (0.03)	137 (0.05)
1985					
subyearling on-station	246,625	- -	- -	18 (0.01)	18 (0.01)
subyearling transport	245,561	- -	- -	6 (0.01)	6 (0.01)
yearling on-station	152,479	- -	- -	131 (0.09)	131 (0.09)
yearling transport	156,036	- -	- -	101 (0.07)	101 (0.07)

Table 16. Comparison of age composition (and percent of total) of fall chinook salmon brood stock since Lyons Ferry Fish Hatchery began operation in 1984. Numbers include both voluntary returns to the hatchery and fish trapped at Ice Harbor Dam.

Brood	Year Total	Age-2	Age-3	Age-4	Age-5
1984	0 (0)	278 (37)	401 (54)	67 (9)	746 (100)
1985	4,147 (87)	71 (2)	442 (9)	95 (2)	4,755 (100)
1986	157 (10)	1,344 (83)	63 (4)	41 (3)	1,605 (100)
1987	563 (14)	453 (12)	2,823 (73)	18 (1)	3,857 (100)

Average fecundity of Snake River stock fall chinook salmon since inception of the egg-bank program in 1977 is 4,297 eggs per female (Table 17).

The ratio of females to males in 1987 was 1.43-to-1, compared to 0.48-to-1 in 1986, and 1.79-to-1 in 1985. The average female-to-male ratio since 1977 is 1.33-to-1 (Table 18).

Table 17. Comparison of fecundity, egg size, and sex ratios of Snake River fall chinook salmon from 1977 through 1987.

Return year	Fecundity	Egg size (number/lb.)	Sex ratio (female:male)
1977	4,533	- -	1.55:1.00
1978	3,936	- -	1.05:1.00
1979	4,526	- -	1.60:1.00
1980	4,302	- -	2.83:1.00
1981	4,339	- -	1.49:1.00
1982	4,282	- -	0.32:1.00
1983	4,271	- -	0.73:1.00
1984	4,191	- -	2.09:1.00
1985	4,622	1,312	1.79:1.00
1986	4,386	1,720	0.48:1.00
1987	3,874	1,539	1.43:1.00

Table 18. Age composition by sex of adult fall chinook salmon sampled at Lyons Ferry Fish Hatchery, 1987.

Sex	Age				Total
	2	3	4	5	
Male	325	214	634	3	1,176
Female	3	50	1,012	8	1,073
Total	328	264	1,646	11[a]	2,249

[a] Sixty-one scales regressed or were unreadable, precluding age determination.

Specific Considerations

- o Natural production of fall chinook once occurred throughout the Snake River mainstem and lower portions of tributaries. As a result of the dams, primary spawning areas are limited to the free-flowing section between Lower Granite and Hells Canyon dams. Returning adults must pass eight mainstem dams.

- o Natural spawning has been poorly documented, with surveys conducted sporadically. It is evident, however, that the returns are significantly reduced from pre-dam years.

- o According to the Snake River Compensation Plan, dams have reduced the fall chinook run size by 18,300 adults.

- o The Lower Snake River Compensation Plan calls for the annual release of 9,162,000 subyearling fall chinook smolts from Lyons Ferry Hatchery to compensate for the loss of 18,300, based on a return rate of 0.2 percent.

- o Habitat carrying capacity has not been adequately identified above Lower Granite Dam.

- o Specific escapement goals have not been established for areas above Lower Granite Dam, though it is believed that the system is underescaped.

- o Current management practices allow for harvest of Snake River stock in the mainstem Columbia River below the confluence of the Snake River. Harvest rate is determined by the status of the Hanford Reach stock fall chinook.

Critical Data Gaps

- o Salmonid habitat usage in the pool areas between Ice Harbor Dam and Lower Granite Dam is largely unknown.

- o Status of natural production in the mainstem above Lower Granite Dam is also largely unknown.

Objectives

Biological Objective

The objectives of the Lyons Ferry Fish Hatchery under the Lower Snake River Compensation Plan are to compensate for the losses of 18,300 fall chinook, Snake River stock.

An evaluation program was initiated in 1984 to monitor the success of the Lyons Ferry Hatchery in achieving Lower Snake River Compensation Plan goals and to identify any production adjustments required to accomplish these goals.

The Washington Department of Fisheries has identified two major goals in the Lyons Ferry Evaluation Program: 1) to ensure quality smolt releases, high downstream migrant survival, and sufficient contribution to the fishery with escapement to meet the Lower Snake River Compensation Plan compensation goals, and 2) to maintain genetic integrity of Snake River Basin chinook stocks.

Besides providing some level of harvest, the projected 18,300 mitigated fall chinook would provide, in order of priority:

1. Perpetuation of the 9.1 million fed fry release at Lyons Hatchery to be released at that facility.

2. One million fish for mitigation of the Hells Canyon Dam complex, to be released below Hells Canyon Dam. Release locations are undetermined.

3. An additional 4 million fish for restoration of fall chinook within the Grande Ronde.

4. Possible fed fry release for the Snake River above Lower Granite Dam. This objective will need further interagency coordination.

Utilization Objective

At this time there are no specific utilization objectives. A general objective would be to provide, at some level, stable fisheries that could support tribal and recreational harvest.

Alternative Strategies

Modeling results for each strategy are presented in Table 19 as fish produced at "maximum sustainable yield" (MSY). The sustainable yield of a fish population refers to that portion of the population that exceeds the number of fish required to spawn and maintain the population over time. Sustainable yield can be "maximized," termed MSY, for each stock at a specific harvest level. The MSY is estimated using a formula (Beverton-Holt function) that analyzes a broad range of harvest rates. Subbasin planners have used MSY as a tool to standardize results so that decision makers can compare stocks and strategies.

In MSY management, managers set a spawning escapement level and the remaining fish (yield) could theoretically be harvested. In practice, a portion of the yield may be reserved as a buffer or to aid rebuilding. Thus, managers may raise the escapement level to meet a biological objective at the expense of a higher utilization objective.

The amount of buffer appropriate for each stock is a management question not addressed in the subbasin plans. For this reason, the utilization objective, which usually refers to harvest, may not be directly comparable to the MSY shown in Table 19. At a minimum, a strategy should produce an estimated MSY equal to or greater than the utilization objective. A MSY substantially larger than the subbasin utilization objective may be needed to meet subbasin biological objectives.

Planners did not estimate costs for the following alternative strategies, except for hatchery production (Table 19a and Appendix C).

STRATEGY 1: Passage Improvement. This strategy focuses on identifying and correcting screening of outer withdrawal intakes located along the mainstem Snake. As stated in the spring chinook plan, Action 2, the Burbank Diversion is of particular concern. Through better monitoring programs, other diversions with inadequate screening may also be detected. Correction will provide increased survival rates of out migrating smolts of not only fall chinook, but spring chinook and steelhead.

ACTIONS: 1

1. Identify the screening status of water withdrawal intakes on the Snake River. (See Action 2 under spring chinook for further explanation.)

STRATEGY 2: Hatchery Production. Consistent with the Lower Snake River Compensation Plan, provide hatchery production levels that will achieve the release goals for the Lyons Ferry Hatchery, Oxbow Hatchery and potential Grande Ronde restoration.

ACTIONS: 1-3

1. -

2. According to the Lower Snake River Compensation Plan, provide annual releases at levels necessary to compensate for the loss of 18,300 fall chinook. In concert with this action, the program should participate in the following activities:

   A) Maintain records of adult returns to the Snake River Basin for each rearing program, categorized by stock and brood year. Data is collected at hatchery racks and spawning grounds by program staff.

   B) Document juvenile fish output for Lyons Ferry. Records will be compiled and summarized by numbers of fish produced at each facility and categorized by stock, size, weight, and planting location. Fish condition and survival rates to planting will be noted.

   C) Document contributions of each rearing program to the various fisheries through coded-wire tag returns. Pacific coast states, federal, and Canadian agencies cooperate in returning tags and catch data to the agency of origin. Managers will attempt to tag sufficient fish to represent each rearing program.

   D) An initial objective was to document downstream survival to National Marine Fisheries Service (NMFS) sampling points on the lower Columbia River for each rearing program. However, this type of sampling has been discontinued by the NMFS. Managers hope that cooperating agencies will continue monitoring survival of downstream migrants. As this type of information becomes available, program staff will retrieve and summarize data for the Lyons Ferry and Tucannon facilities. Survival rate comparisons for each rearing program will be made. This data could then be used to improve downstream migrant survival.

E) Quantify genetic variables that might be subject to alteration under hatchery production strategies. Using and maintaining native stocks is an important goal of the Lower Snake River Compensation Plan. Managers plan to identify and quantify as many genetic variables as possible in the Tucannon River spring chinook populations. These data include qualitative loci analysis through electrophoresis, and quantitative analysis of such factors as adult size, run timing, and disease susceptibility.

F) Determine the success of any off-station enhancement projects, and determine the impact of hatchery fish on wild stock. Data gathered from Action 2E (above) could allow managers to develop genetic marks (qualitative or quantitative) which could provide techniques for evaluating interactions of wild and hatchery fish in the Tucannon River system.

G) Evaluate and provide management recommendations for major hatchery operational practices.

- o Optimum size and time of release data will be determined for both spring and fall chinook. Existing size, time and return data for other Columbia River Basin programs will be reviewed to determine the experimental possibilities which would have the most likelihood of success. Continual experimentation may be necessary in some cases.

- o Selection and maintenance of brood stock will be done in conformance with Lower Snake River Compensation Plan goals. Criteria will be developed to program genetic management as determined by Action 2E (above).

- o Disease investigations or other special treatments on experimental hatchery practices often require mark-release-return groups to facilitate evaluation. Program staff will coordinate the development of experimental designs, direct the marking, and analyze the results.

H) Evaluate and provide management recommendations for Snake River fall chinook distribution programs basinwide. This does not apply to Spring Chinook program.

I) Coordinate research and management programs with hatchery capabilities. Advance notice to the hatchery for specific study groups of marking programs will allow a more efficient use of hatchery facilities and reduce handling and stress on the fish. Research and management programs will be reviewed to determine if the hatcheries will have the capabilities to meet program goals.

3. As identified in the objectives, provide additional production for mitigation level of Hells Canyon at 1 million fish and 4 million fish to the Grande Ronde.

A) Preliminary test rearing of fall chinook at Oxbow Hatchery using existing water supplies and equipment suggest that water temperatures may be limiting. Therefore, prior to implementation of expansion measures for full production, evaluate suitability of water volume, temperature, and quality. Conduct research to determine the availability of suitable quality groundwater if needed. Should expansion of the Oxbow facility to meet production goals be feasible, expansion would need to include, but may not be limited to, development of a well field, construction of raceways, feed storage and delivery systems, and a backup power source. Because of Idaho Power Company ownership and mitigative responsibilities, all actions should be undertaken in concert and cooperatively with Idaho Power Company.

B) Existing facilities at Oxbow Hatchery would be capable of meeting requirements for only egg hatching and early fry production for 1.3 million fall chinook eggs

C) Requirements for final rearing to meet a full production goal of 1 million smolts, as listed below, would include approximately six 10' x 3' x 100' raceways, which are currently not available. Raise 1 million age-0^{+} smolts (total weight: 11,500 lbs; size: 80-90 fish/lb; total length: 3.3").

D) Evaluate brood stock. Although it is assumed that eggs from Lyons Ferry will be available for additional fall chinook production, straying from other stocks may have impacted this brood source. Conduct baseline genetic monitoring of both Lyons Ferry and wild fall chinook crossing Lower Granite Dam to assess brood stock suitability.

STRATEGY 3: Natural Stock Supplementation. With the fulfillment of the hatchery release obligations, supplement natural production in the mainstem Snake through outplanting of hatchery reared fall chinook. Interagency coordination is needed before this strategy can be implemented. If implemented, coordinated spawning ground surveys would be necessary for evaluation.

ACTIONS: 4

4. Supplement natural production in the mainstem through outplanting of hatchery reared fall chinook.

Recommended Strategy

Planners recommend Strategy 2, continuing with the Lyons Ferry production program as established through the Lower Snake River Compensation Plan, providing additional production for mitigation level of Hells Canyon and fish to the Grande Ronde, and improving diversion screens.

Table 19. System Planning Model results for fall chinook in the mainstem Snake Subbasin. Baseline value is for pre-mainstem implementation, all other values are post-implementation.

Utilization Objective:
At this time there are no specific utilization objectives. A general objective would be to provide, at some level, stable fisheries that could support tribal and recreational harvest.

Biological Objective:
The objectives of the Lyons Ferry Fish Hatchery under the Lower Snake River Compensation Plan are to compensate for the losses of 18,300 fall chinook, Snake River stock.

Strategy[1]	Maximum Sustainable Yield (MSY)[2]	Total Spawning Return[3]	Total Return to Subbasin[4]	Out of Subbasin Harvest[5]	Contribution To Council's Goal (Index)[6]
Baseline	2,192 -C	1,351	3,914	20,825	0(1.00)
All Nat	3,867 -C	1,641	5,949	31,651	14,839(1.52)
1	NM				
2*	4,208 -C	1,695	6,376	33,920	17,949(1.63)
3	NM				

*Recommended strategy.
NM-not modeled.

[1]Strategy descriptions:

For comparison, an "all natural" strategy was modeled. It represents only the natural production (non-hatchery) components of the proposed strategies plus current management (which may include hatchery production). The all natural strategy may be equivalent to one of the alternative strategies below.

1. Passage improvements in addition to current hatchery production.
2. Supplementation of 1 million smolts from Oxbow Hatchery in addition to current hatchery production. Post Mainstem Implementation.
3. Natural stock supplementation.

[2]MSY is the number of fish in excess to those required to spawn and maintain the population size (see text). These yields should equal or exceed the utilization objective. C = the model projections where the sustainable yield is maximized for the natural and hatchery components combined and the natural spawning component exceeds 500 fish. N = the model projection where sustainable yield is maximized for the naturally spawning component and is shown when the combined MSY rate results in a natural spawning escapement of less than 500 fish.

[3]Total return to subbasin minus MSY minus pre-spawning mortality equals total spawning return.

[4]Total return to the mouth of the subbasin.

[5]Includes ocean, estuary, and mainstem Columbia harvest.

[6]The increase in the total return to the mouth of the Columbia plus prior ocean harvest (as defined by the Northwest Power Council's Fish and Wildlife Program), from the baseline scenario. The index () is the strategy's total production divided by the baseline's total production.

Table 19a. Estimated costs of alternative strategies for mainstem Snake fall chinook. Cost estimates represent new or additional costs to the 1987 Columbia River Basin Fish and Wildlife Program; they do not represent projects funded under other programs, such as the Lower Snake River Compensation Plan or a public utility district settlement agreement. (For itemized costs, see Appendix C.)

	Proposed Strategies		
	1	2*	3
Hatchery Costs			
Capital[1]	0	1,150,000	0
O&M/yr[2]	0	125,000	0
Other Costs			
Capital[3]	0	0	0
O&M/yr[4]	0	0	0
Total Costs			
Capital	0	1,150,000	0
O&M/yr	0	125,000	0

* Recommended strategy.

[1] Estimated capital costs of constructing a new, modern fish hatchery. In some subbasins, costs may be reduced by expanding existing facilities. For consistency, estimate is based on $23/pound of fish produced. Note that actual costs can vary greatly, especially depending on whether surface or well water is used and, if the latter, the number and depth of the wells.

[2] Estimated operation and maintenance costs per year directly associated with new hatchery production. Estimates are based on $2.50/pound of fish produced. For consistency, O&M costs are based on 50 years.

[3] Capital costs of projects (other than direct hatchery costs) proposed under a particular strategy, such as enhancing habitat, screening diversions, removing passage barriers, and installing net pens (see text for specific actions).

[4] Estimated operation and maintenance costs per year of projects other than those directly associated with new hatchery production. For consistency, O&M costs are based on 50 years.

SUMMER STEELHEAD

Fisheries Resource

Natural Production

History and Status

The Snake River once supported large numbers of steelhead. Dams, unscreened diversions, logging, mining, farming, grazing, and other activities degraded habitat (Raymond 1976). The U.S. Army Corps of Engineers (1975) concluded the Snake River provided 130,000 angler-days for steelhead and 250,000 angler-days for resident fish prior to the development of hydroelectric dams. The Snake River once provided the largest summer steelhead fishery in Washington. The Corps calculated 63.1 percent of Columbia River steelhead entered the Snake River for 1962 through 1974.

Currently, the Snake River (below Lower Granite Dam) primarily provides a transportation corridor while mainstem production is thought to be low. Construction of lower Snake River dams eliminated approximately 80 percent of the mainstem spawning and rearing habitat. Mainstem spawning presently occurs from RM 145 to parts of Alpowa Creek, and the lower reaches of the following Snake tributaries: Deadman, Meadow, Penawawa, Almota, Steptoe Canyon, Tenmile, and Couse creeks (Howell et al. 1985). The major subbasin production units addressed herein are Asotin and Alpowa creeks, Lyons Ferry Hatchery, and Oxbow Hatchery.

Life History and Population Characteristics

Summer steelhead are indigenous throughout the Snake River drainage. Thompson et al. (1958) identified two peak migration periods when steelhead entered the Snake River -- late September and early April to mid-May. Observations indicated the spring migration was composed primarily of males.

Asotin Creek steelhead probably migrate up the Columbia between July and September. Eldred (1961) indicated these fish do not enter Asotin Creek until mid-February, peaking in March and April (Gunsolus et al. 1953, Howell et al. 1985). Thompson et al. (1958) estimated that 910 steelhead migrated to Asotin Creek between 1954 and 1955, based on observations at the Lewiston and Asotin dams. Runs of wild steelhead to Asotin Creek averaged over 800 fish for 1954 through 1960 (Table 20).

Table 20. Steelhead trapped at the Asotin Creek diversion dam (Howell et al. 1985).

Year Trapped	Males	Females	Total	Corrected Total 1/
1954	---	---	371	408
1955	332	609	941	1,035
1956	533	1,140	1,673	1,840
1957	249	289	538	592
1958	153	357	510	561
1959	124	264	388	427
1960	326	467	793	872
1961	55	169	242 2/	266

1/ 20 percent estimated to jump dam, but 10 percent thought to fall back and pass through fishway again; hence, corrected total equals total plus 10 percent.

2/ 18 fish not sexed; counts are low due to theft of fish from trap.

Eldred (1961) noted Asotin Creek adults predominantly returned two years after release (Howell 1985). The male-to-female ratio averaged 0.54 for 1955-1961 (Howell et al. 1985). Howell et al. (1985) suggested spawning extended from April through May. Eighteen females were spawned in 1954 and averaged 3,615 eggs per fish (Kray 1959). Most Asotin Creek smolts likely outmigrate in late April and May as 170 mm to 200 mm 2-year-olds (Howell et al. 1985).

Schreck et al. (1986) found that the greatest genetic differences in Columbia River steelhead existed between eastern and western stocks (in relation to the Cascade Mountain Range). Cluster analysis resulted in lower Snake River stocks appearing in two of the three subgroups of the eastern stock separation.

Fish Production Constraints

Major natural production constraints result from the inundation caused by dams, which eliminated spawning and rearing areas (Table 21). The declines in fish runs can also be attributed to increased smolt mortalities from turbines, delayed passage, predation, and supersaturation. Ebel and Raymond (1976) calculated smolt emigration from the Salmon River to the Dalles

Dam to be 65 days, an increase of about 35 days from the pre-dam era. Travel time determined by Sims et al. (1978) during the 1977 low runoff took 57 days, with smolts arriving in mid-June rather than early May.

Hatchery Production

Lyons Ferry Hatchery

With the 1982 completion of Lyons Ferry Hatchery, large numbers of hatchery smolts were released in the lower Snake River. For 1984 through 1988, an average of 160,704 smolts were planted into the lower Snake while Asotin Creek received an average of 32,976 smolts for 1983 through 1988 (Table 22).

Lyons Ferry Hatchery is located on the Snake River (RM 56.2) below the confluence of the Palouse River. The hatchery is part of the Lower Snake River Compensation Plan, which was to compensate or replace lost natural production of salmon, steelhead, and resident fish due to hydroelectric projects on the lower Snake River (COE 1983; Schuck and Mendel 1987). The Lower Snake Hatchery Subcommittee of the Columbia Basin Fisheries Technical Committee estimated these losses, (Table 23) which amounted to 4,656 adult steelhead destined for Washington; resident fisheries for rainbow trout, smallmouth bass, sturgeon, channel catfish, crappie, and other species would be diminished by 67,500 angler days of recreation annually. Consequently, hatchery facilities were built to return 4,656 adults to the project area (ending at the point above Lower Granite Dam), and provide 93,000 pounds of legal size (three fish per pound) trout (Schuck and Mendel 1987).

Production facilities at Lyons Ferry include egg and starter troughs for 1,150,000 steelhead. Additionally, 100,000 trout eggs are hatched annually. Nineteen intermediate concrete raceways and three rearing ponds (80' X 1,150') with a surface area of 2.1 acres each are used for advanced rearing. The hatchery and rearing ponds are designed for single-pass water flow. Water is provided by eight deep wells capable of producing 103 cfs constant flow. Water temperatures fluctuate between 48 and 53 degrees Fahrenheit. A fish ladder, enclosed spawning building, and release structure are also present (Schuck and Mendel 1986).

Design capacity of the hatchery is 116,400 pounds of steelhead smolts at eight fish per pound, and 45,000 pounds of legal trout at three fish per pound (Schuck and Mendel 1987). Lyons Ferry has used Wells and Wallowa stocks along with developing its own stock. Use of Wells stock was discontinued in 1986. Wallowa stock use will continue contingent on Oregon Department of Fish and Wildlife and Washington Department of

Wildlife cooperation. Brood stock is collected at the hatchery during fall and early spring. The hatchery tends to intercept fish from throughout the Snake River Basin. Brood stock selection attempts to avoid B-run fish or obvious disease carriers. Eggs from IHN virus positive adults are destroyed.

Table 21. Summary of production constraints in the Snake River Subbasin and associated tributaries.

Location	Sedimentation Problems	Low Flow Problems	Water Quality	Migration Barriers
Snake River	X	X Related to spill hydroelec.	X elevated at temperatures	X Related passage at hydroelectric facilities
1/ Alpowa Creek (Mendel 1981)	X lack of rip. veg. and bank instability	X	X elevated temps. in late spring, summer, and fall	
2/ Asotin Creek (Mendel 1981)	(lack of rip. veg. and bank instability)			X potential with the beaver dams and Headgate Dam

1/ Alpowa Creek contains resident trout and a small spring run of steelhead. The stream is annually stocked with rainbow trout but low streamflows limit fishing to early spring. A few spring chinooks also may spawn in this stream. A large portion of the constraints associated with Alpowa Creek are related to livestock management. Additional problems include lack of instream cover caused by channel realignment and overgrazing; braided channels also exist (Mendel 1981).

2/ Asotin Creek contains a resident trout fishery and a small run of steelhead. The creek is stocked with rainbow trout each spring and summer. Chinook salmon also utilize this stream. Many constraints are related to livestock management along the creek. Additional problems include a lack of instream cover because of stream realignment and overgrazing; braided channels also exist (Mendel 1981).

Table 22. Releases of hatchery steelhead in the Snake River and Asotin Creek.

Year	Hatchery/Stock	Smolts	Release Site
1971	COLBASIN/WELLS	38,500	
1977	TUCANNON/SKAMANIA	21,756	
1980	TUCANNON/SKAMANIA	19,384	
1982	TUCANNON/WALLAWALL	16,960	
1982	LYONSFRY/WALLOWA	27,940	LYONSFRY
1983	LYONSFRY/WELLS	87,933	LYONSFRY
1983	LYONSFRY/WALLOWA	50,597	LYONSFRY
1983	LYONSFRY/WELLS	36,774	ASOTIN CR
1984	LYONSFRY/WELLS	80,563	LYONSFRY
1984	LYONSFRY/WALLOWA	57,815	LYONSFRY
1984	LYONSFRY/WALLOWA	33,005	ASOTIN CR
1985	LYONSFRY/WELLS	41,344	LITL GOOS
1985	LYONSFRY/WELLS	24,864	ICE HARBR
1985	LYONSFRY/WELLS	50,585	LYONSFRY
1985	LYONSFRY/WALLOWA	53,913	LYONSFRY
1985	LYONSFRY/WALLOWA	31,500	ASOTIN CR
1986	LYONSFRY/WELLS	59,556	LITL GOOS
1986	LYONSFRY/WELLS	36,033	ICE HARBR
1986	LYONSFRY/WELLS	61,281	LYONSFRY
1986	LYONSFRY/WALLOWA	40,480	LYONSFRY
1986	LYONSFRY/WALLOWA	44,650	ASOTIN CR
1987	LYONSFRY/WELLS	34,188	ICE HARBR
1987	LYONSFRY/WELLS	60,313	LYONSFRY
1987	LYONSFRY/LYONSFRY	50,843	LYONSFRY
1987	LYONSFRY/WALLOWA	51,017	LYONSFRY
1987	LYONSFRY/LYONSFRY	22,950	ASOTIN CR
1988	LYONSFRY/LYONSFRY	100,725	LYONSFRY
1988	LYONSFRY/WALLOWA	4,392	LYONSFRY
1988	LYONSFRY/WALLOWA	28,975	ASOTIN CR

Table 23. Allocation of hatchery capacity for the Lower Snake River Compensation Plan.

Species	Numbers of Adult Fish		
	Washington	Idaho	Oregon
Spring Chinook	1,152	40,432	9,072
Fall Chinook	18,300		
Summer Chinook		8,000	
Steelhead	4,656	39,264	11,184
TOTAL	24,108	87,696	20,256

During 1985 to 1986, 524 captured adults consisted of 76 percent females and 24 percent males. Personnel spawned 359 females (34.4 percent wild and 65.6 percent hatchery based on dorsal fin inspection). Other fish collected and sorted at the facility were comprised of 78 percent females and 22 percent males, 17.2 percent of which were wild fish (Schuck and Mendel 1987). One-ocean fish averaged 53.9 percent of returns while 2-ocean and 3-ocean fish averaged 45.8 percent and 0.7 percent, respectively (Schuck and Mendel 1987). This data is not stock specific.

Adults returning to Lower Granite Dam from 1982 through 1984 releases at the Grande Ronde River, Lyons Ferry Hatchery, Wallowa River, and the Tucannon River expressed 1-ocean mean lengths between 57.3 cm and 60.2 cm. Two-ocean mean lengths of Grande Ronde River, Lyons Ferry Hatchery (two tag groups), and Wallowa River releases from 1982 and 1983 were 69.6 cm (n=16), 76.2 cm (n=75), 71.7 cm (n=150), 70.7 cm (n=100), respectively. The combined mean length for all 1-ocean and 2-ocean adults was 58.6 cm and 72.0 cm, respectively (Schuck and Mendel 1987).

During 1985 to 1986, 359 females were spawned and yielded 4,075 to 4,450 eggs per female (Schuck and Mendel 1987). The 1988 spawning data revealed 5,152 and 5,575 eggs per 1.1- and 1.2-aged females, respectively (Table 24).

Table 24. Fecundity of Lyons Ferry Hatchery steelhead (M. Schuck, WDW, pers. commun.).

Ocean Age	Eggs/Female	Mean Length	N
1	5,152	61.1(cm)	15
2	5,575	72.9	22

Smolts are released about one year after hatching. Egg-to-smolt survival averaged 93.4 percent for Wells and Wallowa stocks for 1983 through 1985 (Schuck and Mendel, 1987). Smolt-to-adult survival of 1982 through 1984 releases ranged from 0.37 percent to 1.47 percent, with six of nine tagged groups exceeding 0.50 percent (Schuck and Mendel 1987).

An infectious hematopoietic necrosis (IHN) virus epizootic at the hatchery in 1989 resulted in several groups of fish being destroyed. This was the first serious disease outbreak. Small outbreaks of cold water disease have occurred. Predation only becomes a serious problem when rearing ponds are lowered (Schuck and Mendel 1987). Some concern exists regarding homing ability of adults to the hatchery (M. Schuck, WDW, pers. commun.).

Oxbow Hatchery

Oxbow Hatchery is a steelhead and spring chinook facility owned and funded by the Idaho Power Company and operated under contract by the Idaho Department of Fish and Game. Oxbow is located on the Oregon shore of the Snake River at RM 270 (602 miles from the Pacific Ocean), about one-half mile downstream from the Idaho Power Oxbow Power Plant (Burton 1988). Adult fish held and spawned at Oxbow are collected at the Hells Canyon Trap. The trap is situated approximately 23 miles downstream of Oxbow on the Oregon side of the Snake River adjacent to the tailrace of Hells Canyon Dam. Water for the hatchery is supplied from Hells Canyon Reservoir. Two pumps supply a maximum of 24 cfs to holding ponds and raceways.

Oxbow Hatchery began as an experimental facility in 1961 and has been in production since 1962. The primary purpose of this facility and the Hells Canyon Trap is to trap and hold sufficient numbers of returning adult steelhead and spring chinook to fulfill Idaho Power's anadromous fish mitigation requirements.

In accordance with the settlement agreement, the Hells Canyon and Oxbow facilities must provide sufficient numbers of steelhead to provide for the production of 200,000 pounds of smolts. Adult steelhead are held and spawned at Oxbow while eyed eggs are shipped to Idaho Power's Niagara Springs Hatchery where resultant fry are reared to smolts. Smolts are then trucked back to Hells Canyon. Although not a part of the mitigation agreement, recently up to 1 million fry have been raised at Oxbow for supplementation in the lower Salmon River. Limited information is available about this run of fish prior to 1980. Hatchery information for the years 1965 through 1968 indicate that fecundity ranged from 3,181 eggs to 3,212 eggs per female. Run sizes for this early period are shown in Table 25. Recent data indicates that this is an A-run steelhead; average total length for 1986 to 1987 run was 26.5 inches. Recent run sizes are shown in Table 26. Fecundity for 1983 through 1987 ranged from 3,964 to 5,138 eggs and averaged 4,534 eggs per female.

Table 25. Oxbow Hatchery/Hells Canyon Trap steelhead runs, 1963 through 1968.

1963-64	Released 413 steelhead above Brownlee
1965-66	Sept. 9 - Oct 4 = 1022 steelhead
	(2700 steelhead released)
	March 9 - May 22 = 797 steelhead
	4519 total run
	Hatchery/Trap Mortality = 20
1966-67	Sept. 6 - Dec.31 =4108 steelhead
	March - May = 846 steelhead
	4954 total run
	Hatchery/Trap Mortality = 818
1967-68	Sept. 20 - Nov.18=1026 steelhead
	March 18 - June 4= 583 steelhead
	1609 total run
	Hatchery/Trap Mortality = 152

Table 26. Oxbow steelhead.

YEAR	TOTAL RETURN TO RACK	NUMBER RELEASED	TOTAL PONDED	NUMBER FEMALES PONDED	FEMALE PRESPAWN MORTALITY	FEMALES SPAWNED
1980 a	339	0	339	192	56	136
1981	158	0	158	115	66	69
1982	205	40	165	89	21	68
1983	874	145	729			444
1984	1116	657	459	334	55	279
1985	1383	40	1343	825	150	700
1986	2438	1461 d	935	451	119 e	332
1987	3209 f	1863 g	1346	726	108	618
1988	2524 h	184	2340	1301	202 i	1065 i

a- year is trapping year: Fall, 1979 and spring, 1980
b- 143 release in Boise River for sport harvest
c- 350 fish release into Boise River,
   307 fish released into Hells Canyon Reservoir
d- 961 fish release into Boise River
   500 fish release into Hells Canyon Reservoir
e- includes fish lost through pond grate
f- 3 fall chinook also captured during fall trapping
g- 1006 fish released into Boise River
   857 fish release into Hells Canyon Reservoir
h- 1 fall chinook also captured during fall trapping
i- does not include 34 females spawned but with bad eggs, which were discarded
   In past years, these were probably added on as mortalities.

The brood stock for the spring chinook and steelhead programs originally inhabited waters above Hells Canyon Dam such as the Powder and Weiser rivers. These fish were also transferred to Idaho Power's Rapid River and Pahsimeroi hatcheries in the Salmon Subbasin.

Production constraints include the fact that the Oxbow facility is not designed to be a cold water culture station. Also, an additional source of water other than river water for egg incubation is desirable.

Harvest

Harvest estimates from fall of 1974 to spring of 1987 are provided for the Snake River in Washington (Table 27).

Table 27. Summary of steelhead harvest on the Snake River. All values are corrected for punch-card bias.

Year	unk	Below Ice H.	Above Ice H.	Above L.Mont.	Above L.Goos.	Above L.Gran.	TOTAL
1974-75							201
75-76							-
76-77							-
77-78							1,042
78-79							4
80-81							352
81-82	352		13	44	37	44	490
82-83		19	16	327	69	429	860
83-84		154	50	709	66	569	1,548
84-85		132	447	1,210	726	4,880	7,395
85-86		177	275	698	670	3,153	4,973
86-87		177	653	1,354	593	4,451	7,228

Asotin Creek

Possible passage problems at Headgate Dam should be evaluated. Streamflows and high summer temperatures should be quantified for the South Fork and Charlie Creek. Also, the upper portion of the South Fork (beyond RM 4) should be surveyed to determine the extent of degradation and to locate possible flow augmentation sites. The base flow presently in effect on Asotin Creek may be too low.

Alpowa Creek

Summer stream temperatures and flows need to be quantified. Also, there is no base flow regulation established on this stream and irrigation withdrawals cannot be regulated properly. Possible flow augmentation sites should be identified (Mendel 1981).

Objectives and Strategies

Planners did not identify objectives or alternative strategies for summer steelhead in the subbasin. The mainstem river is primarily a passage area with a limited habitat base and production opportunities. Planners do, however, recommend implementing the following mainstem passage and monitoring actions.

A) Expand harvest monitoring of unsampled areas in the Columbia River sport fisheries to include waters up to Priest Rapids Dam. This information is important in determining the contribution of upriver stocks to downriver fisheries and in formulating management strategies.

B) Increase the opportunity for overwintering adult steelhead to safely pass hydroelectric facilities (principally Little Goose and Lower Granite dams).

C) Establish a restrictive work-window so that ladder maintenance can occur.

D) Continue addressing mainstem passage, flow, screening, and dredging issues.

Specific Considerations

The goal of steelhead management in the subbasin is to rebuild the natural run to meet spawning escapement goals. To protect the genetic integrity of natural fish, harvest is targeted on hatchery fish.

The largest natural fish production limitation has been inadequate escapement reaching the subbasin as a result of smolt and adult mortalities at dams and adult overharvest downstream of the subbasin. Natural fish destined for the Asotin Creek and the Snake River are subjected to non-selective mixed-stock fisheries in the Columbia River. Because large hatchery programs are present that need relatively little escapement, non-selective harvest can overharvest smaller natural populations that need a relatively large amount of escapement. As hatchery programs in other basins expand, the jeopardy of overharvest by non-selective fisheries in the Columbia increases. Selective harvest of hatchery fish at dams would allow natural fish to escape.

This subbasin is located above eight mainstem dams and smolts and adults are subjected to mortalities at each dam and impoundment. Washington Department of Wildlife policy emphasizes natural fish. The genetic consequences of the current dependency on hatchery fish may be severe. "Wild" fish release regulations are expected to increase subbasin spawning escapement of natural fish although returns will probably be inadequate unless downstream conditions are changed.

Current (1988-1990) management of steelhead in the Snake River 1) protects the earliest returning stocks by prohibiting the retention of fish greater than 20 inches between June 1 and August 1; 2) protects wild stocks with a mandatory wild fish release; 3) protects outmigrating smolts by closing the entire river to the taking of trout from April 1 through May 31; and 4) permits harvest of hatchery steelhead from September 1 to March 31. Additionally, a 400-foot no fishing easement exists below any dam and as a radius around the entrance to the Lyons Ferry Hatchery ladder.

Critical Data Gaps

Snake River

Run size, catch, and escapement data, and refinement of escapement goals (Howell et al. 1985) are needed. Distribution in the mainstem and tributary streams needs to be addressed. Juvenile life histories of natural fish are largely unknown.

PART V. SUMMARY AND IMPLEMENTATION

Objectives and Recommended Strategies

Spring Chinook

The primary objective is to re-establish the run into suitable tributaries of the Snake River and to increase returns to Asotin Creek. Ultimate goal is to restore historic tribal and non-treaty fisheries within the subbasin. Strategies 1 and 2 focus on natural production increases in Asotin Creek while Strategy 3 identifies selected tributaries for outplanting of spring chinook. Strategy 4 involves the current Lower Snake River Compensation Plan that addresses mitigation through hatchery production at levels of 1 million smolts annually. Planners recommend Strategy 1, natural production increases through habitat improvements in Asotin Creek and screening of mainstem Snake River diversions.

Fall Chinook

The major objective involves the present mitigation program to compensate for the losses of 18,300 fall chinook and to re-establish historic fisheries. Strategy 1 focuses on screening improvements throughout the Snake River. Strategy 2 incorporates the primary mitigation effort presently under way at Lyons Ferry Hatchery, which calls for the annual release of 9.1 million fingerlings. Strategy 3 addresses supplementation potentials in the Snake River for reseeding habitat that is presently underutilized. Planners recommend Strategy 2, continuing the Lyons Ferry Hatchery production program as established through the Lower Snake River Compensation Plan, screening diversions, and providing additional production for mitigation level of Hells Canyon at 1 million fish and 4 million fish to the Grande Ronde.

Summer Steelhead

Planners did not identify alternative strategies or production or harvest objectives beyond those of the Lower Snake River Compensation Plan. The mainstem Snake River is primarily a passage area with limited production opportunities. Planners did, however recommend implementing various mainstem passage improvements and monitoring and evaluation procedures.

Implementation

In the summer of 1990, the Columbia Basin Fish and Wildlife Authority submitted to the Northwest Power Planning Council the Integrated System Plan for salmon and steelhead in the Columbia Basin, which includes all 31 subbasin plans. The system plan attempts to integrate this subbasin plan with the 30 others in the Columbia River Basin, prioritizing fish enhancement projects and critical uncertainties that need to be addressed.

From here, the Northwest Power Planning Council will begin its own public review process, which will eventually lead to amending its Columbia River Basin Fish and Wildlife Program. The actual implementation schedule of specific projects or measures proposed in the system plan will materialize as the council's adoption process unfolds.

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APPENDIX A
NORTHWEST POWER PLANNING COUNCIL
SYSTEM POLICIES

In Section 204 of the 1987 Columbia River Basin Fish and Wildlife Program, the Northwest Power Planning Council describes seven policies to guide the systemwide effort in doubling the salmon and steelhead runs. Pursuant to the council's plan, the basin's fisheries agencies and Indian tribes have used these policies, and others of their own, to guide the system planning process. The seven policies are paraphrased below.

1) The area above Bonneville Dam is accorded priority.

Efforts to increase salmon and steelhead runs above Bonneville Dam will take precedence over those in subbasins below Bonneville Dam. In the past, most of the mitigation for fish losses has taken the form of hatcheries in the lower Columbia Basin. According to the council's fish and wildlife program, however, the vast majority of salmon and steelhead losses have occurred in the upper Columbia and Snake river areas. System planners turned their attention first to the 22 major subbasins above Bonneville Dam, and then to the nine below.

2) Genetic risks must be assessed.

Because of the importance of maintaining genetic diversity among the various salmon and steelhead populations in the Columbia River Basin, each project or strategy designed to increase fish numbers must be evaluated for its risks to genetic diversity. Over millions of years, each fish run has evolved a set of characteristics that makes it the best suited run for that particular stream, the key to surviving and reproducing year after year. System planners were to exercise caution in their selection of production strategies so that the genetic integrity of existing fish populations is not jeopardized.

3) Mainstem survival must be improved expeditiously.

Ensuring safe passage through the reservoirs and past the dams on the Columbia and Snake River mainstems is crucial to the success of many efforts that will increase fish numbers, particularly the upriver runs. Juvenile fish mortality in the reservoirs and at the dams is a major cause of salmon and steelhead losses. According to estimates, an average of 15 percent to 30 percent of downstream migrants perish at each dam, while 5 percent to 10 percent of the adult fish traveling upstream perish. Projects to rebuild runs in the tributaries have and will represent major expenditures by the region's ratepayers -- expenditures and long-term projects that should be protected in the mainstem.

4) Increased production will result from a mix of methods.

To rebuild the basin's salmon and steelhead runs, fisheries managers are to use a mixture of wild, natural and hatchery production. Because many questions still exist as to whether wild and natural stocks can coexist with significant numbers of hatchery fish, no one method of production will be solely responsible for increasing fish numbers. System planners were to take extra precaution when considering outplanting hatchery fish into natural areas that still produce wild fish. The council is relying on the fish and wildlife agencies and tribes to balance artificial production with wild and natural production.

5) Harvest management must support rebuilding.

Like improved mainstem passage, effective harvest management is critical to the success of rebuilding efforts. A variety of fisheries management entities from Alaska to California manage harvest of the Columbia Basin's salmon and steelhead runs. The council is calling on those entities to regulate harvest, especially in mixed-stock fisheries, in ways that support the basin's efforts to double its runs.

6) System integration will be necessary to assure consistency.

The Northwest Power Planning Council intends to evaluate efforts to protect and rebuild Columbia River Basin salmon and steelhead from a systemwide perspective. Doubling the runs will require improvements in mainstem passage, fish production and harvest management -- three extremely interdependent components. System planners from all parts of the basin are to coordinate their efforts so, for example, activities in the lower Columbia are consistent with and complement the activities 800 miles upstream in Idaho's Salmon River. The fisheries management organizations and their plans vary from subbasin to subbasin, but the council is calling upon the agencies and tribes to help resolve conflicts that arise.

7) Adaptive management should guide action and improve knowledge.

System planners were to design projects so that information can be collected to improve future management decisions. By designing projects that test quantitative hypotheses and lend themselves to monitoring and evaluation, managers can learn from their efforts. This learning by doing is called "adaptive management." Using such an approach, managers can move ahead with plans to rebuild the Columbia Basin's salmon and steelhead runs, despite many unanswered questions about how best to accomplish their goal. With time, the useful information revealed by these "experiments" can guide future projects.

APPENDIX B
SMART ANALYSIS

To help select the preferred strategies for each subbasin, planners used a decision-making tool known as Simple Multi-Attribute Rating Technique (SMART). SMART examined each proposed strategy according to the following five criteria. In all cases, SMART assumed that all of the Columbia River mainstem passage improvements would be implemented on schedule.

1) Extent the subbasin objectives were met

2) Change in maximum sustainable yield

3) Impact on genetics

4) Technological and biological feasibility

5) Public support

Once SMART assigned a rating for each criteria, it multiplied each rating by a specific weight applied to each criteria to get the "utility" value (see following tables). Because the criteria were given equal weights, utility values were proportional to ratings. The confidence in assigning the ratings was taken into consideration by adjusting the weighted values, (multiplying the utility value by the confidence level) to get the "discount utility." SMART then totaled the utility values and discount utility values for all five criteria, obtaining a "total value" and a "discount value" for each strategy.

System planners used these utility and discount values to determine which strategy for a particular fish stock rated highest across all five criteria. If more than one of the proposed strategies shared the same or similar discount value, system planners considered other factors, such as cost, in the selection process. Some special cases arose where the planners' preferred strategy did not correspond with the SMART results. In those cases, the planners provide the rationale for their selection.

SUBBASIN: Snake

STOCK: Spring chinook

STRATEGY: 1. nat. production, screens and habitat improvements Asotin Creek

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1 EXT OBJ	5	0.9	20	100	90
2 CHG MSY	5	0.9	20	100	90
3 GEN IMP	9	0.9	20	180	162
4 TECH FEAS	7	0.9	20	140	126
5 PUB SUPT	5	0.9	20	100	90

TOTAL VALUE 620

DISCOUNT VALUE 558

CONFIDENCE VALUE 0.9

SUBBASIN: Snake

STOCK: Spring chinook

STRATEGY: 4. Hatchery program

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1 EXT OBJ	5	0.9	20	100	90
2 CHG MSY	5	0.9	20	100	90
3 GEN IMP	5	0.6	20	100	60
4 TECH FEAS	9	0.9	20	180	162
5 PUB SUPT	9	0.9	20	180	162

TOTAL VALUE 660

DISCOUNT VALUE 564

CONFIDENCE VALUE 0.85454545

SUBBASIN: Snake

STOCK: Fall chinook

STRATEGY: 1. Screens

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1 EXT OBJ	5	0.9	20	100	90
2 CHG MSY	5	0.9	20	100	90
3 GEN IMP	9	0.9	20	180	162
4 TECH FEAS	9	0.9	20	180	162
5 PUB SUPT	7	0.9	20	140	126

TOTAL VALUE 700

DISCOUNT VALUE 630

CONFIDENCE VALUE 0.9

SUBBASIN: Snake

STOCK: Fall chinnok

STRATEGY: 2. Supplementation level one and other investigations, evaluations

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1 EXT OBJ	7	0.9	20	140	126
2 CHG MSY	7	0.9	20	140	126
3 GEN IMP	6	0.6	20	120	72
4 TECH FEAS	9	0.9	20	180	162
5 PUB SUPT	9	0.9	20	180	162

TOTAL VALUE 760

DISCOUNT VALUE 648

CONFIDENCE VALUE 0.85263157

SUBBASIN: Snake

STOCK: Fall chinook

STRATEGY: 3. supplementation level 2, Oxbow and mainstem Snake

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1 EXT OBJ	8	0.9	20	160	144
2 CHG MSY	8	0.9	20	160	144
3 GEN IMP	5	0.6	20	100	60
4 TECH FEAS	9	0.9	20	180	162
5 PUB SUPT	9	0.9	20	180	162

TOTAL VALUE 780

DISCOUNT VALUE 672

CONFIDENCE VALUE 0.86153846

APPENDIX C
SUMMARY OF COST ESTIMATES

The cost estimates provided in the following summary tables represent new or additional costs necessary to implement the alternative strategies. Although many strategies involve projects already planned or being implemented under the Columbia River Basin Fish and Wildlife Program or other programs, such as the Lower Snake River Compensation Plan, the associated costs and hatchery production do not appear in the following tables.

In many cases, the following costs are no more than approximations based on familiarity with general costs of similar projects constructed elsewhere. Although the costs are very general, they can be used to evaluate relative, rather than absolute, costs of alternative strategies within a subbasin.

Particular actions are frequently included in strategies for more than one species or race of anadromous fish. In these cases, the same costs appear in several tables, but would only be incurred once, to the benefit of some, if not all, of the species and races of salmon and steelhead in the subbasin.

Subbasin planners used standardized costs for actions "universal" to the Columbia River system, such as costs for installing instream structures, improving riparian areas, and screening water diversions (see the Preliminary System Analysis Report, March 1989). For other actions, including the removal of instream barriers, subbasin planners developed their own cost estimates in consultation with resident experts.

Planners also standardized costs for all new hatchery production basinwide. To account for the variability in fish stocking sizes, estimates were based upon the cost per pound of fish produced. For consistency, estimated capital costs of constructing a new, modern fish hatchery were based on $23 per pound of fish produced. Estimated operation and maintenance costs per year were based on $2.50 per pound of fish produced.

All actions have a life expectancy, a period of time in which benefits are realized. Because of the variation in life expectancy among actions, total costs were standardized to a 50-year period. Some actions had life expectancies of 50 years or greater and thus costs were added as shown. Other actions (such as instream habitat enhancements) are expected to be long term, but may only have life expectancies of 25 years. Thus the action would have to be repeated (and its cost doubled) to meet the 50-year standard. Still other actions (such as a study or a short-term supplementation program) may have life expectancies of 10 years after which no further action would be taken. In this case, operation and maintenance costs were amortized over 50 years to develop the total O&M per year estimate. Capital costs, being up-front, one-time expenditures, were added directly.

Subbasin planners have estimated all direct costs of alternative strategies except for the purchase of water rights. No cost estimates have been or will be made for actions that involve purchasing water. Indirect costs, such as changes in water flows or changes in hydroelectric system operations, are not addressed.

ESTIMATED COSTS FOR ALTERNATIVE STRATEGIES

Subbasin: Mainstem Snake
Stock: Fall Chinook

Action	Cost Categories*	Proposed Strategies 1	2**	3
Habitat Enhancement	Capital:			
	O&M/yr:			
	Life:			
Screening	Capital:			
	O&M/yr:			
	Life:			
Barrier Removal	Capital:			
	O&M/yr:			
	Life:			
Misc. Projects	Capital:			
	O&M/yr:			
	Life:			
Hatchery Production	Capital:		1,150,000	
	O&M/yr:		125,000	
	Life:		50	
TOTAL COSTS	Capital:		1,150,000	
	O&M/yr:		125,000	
	Years:	50	50	50
Water Acquisition				
Fish to Stock	Number/yr:		5 million	
	Size:		100/lb.	
	Years:		50	

* Life expectancy of the project is defined in years. Water acquisition is defined as either Y = yes, the strategy includes water acquisition; N = no, water acquisition is not part of the strategy. The size of fish to stock is defined as E = eggs; F = fry; J = juvenile, fingerling, parr, subsmolt; S = smolt; A = adult.

** Recommended strategy.