Columbia Basin System Planning

SALMON and STEELHEAD PRODUCTION PLAN

LITTLE WHITE SALMON RIVER SUBBASIN

September 1, 1990

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Lead Agency: Washington Department of Wildlife
600 Capitol Way North
Olympia, Washington 98501-1091

Co-writers: Confederated Tribes and Bands
of the Yakima Indian Nation
P.O. Box 151
Toppenish, Washington 98948-0151

Washington Department of Fisheries
115 General Administration Building
Olympia, Washington 98504

Columbia Basin System Planning

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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 Little White Salmon River, located in Skamania County in south central Washington, drains approximately 134 square miles. The river originates in the Gifford Pinchot National Forest, west of Monte Cristo Peak, and travels south for about 19 miles before entering Bonneville Pool on the Columbia River at River Mile (RM) 162.

The subbasin's climate is influenced by the Cascade Mountains, which block westerly marine and easterly continental air masses. Consequently, the subbasin has characteristics of both marine and continental climates; winters are usually wet and mild, while summers are warm and dry. The climate is moderated by the Columbia River Gorge, which permits an exchange of air between the western and eastern sides of the Cascades. Mean annual precipitation is 65 inches; about 75 percent falls during October through March. Much of the precipitation occurs as snow above 3,000 feet.

Subbasin soils are the result of volcanism and glaciation. Soils are deep in alluvial deposits and shallow on side slopes. Topography varies from gentle slopes, formed by lava flows and volcanic cones, to steep, rugged landforms. Landslides occur where the erosion potential of surface soil is high and soil fertility is low. Soil fertility increases in the lower elevations, however no agriculture is practiced in the area.

The subbasin is generally covered with conifers such as Douglas fir, western hemlock and grand fir. Riparian vegetation includes cottonwood, red alder, quaking aspen and willow. Ground cover consists of Oregon grape, salal, vine maple, and bear grass.

Fisheries Resources

The subbasin contains fall and spring chinook, coho and resident trout. Subbasin salmon are co-managed by the Washington Department of Fisheries and Yakima Indian Nation. Management of resident and anadromous trout is through the Washington Department of Wildlife and Yakima Indian Nation. Each management entity is responsible for its own fishery regulations, enhancement activities, and licensing. However, the entities generally plan these activities cooperatively.

Anadromous fish migration is completely blocked by a series of waterfalls approximately 37 feet high located about two miles upstream of the Columbia River. Before Bonneville Dam was completed, this short reach supported chinook salmon. In 1916, Alaska sockeye were introduced into the river and a run was maintained for several generations (Bryant 1949). When Bonneville Dam was completed in 1938, this area was inundated and natural salmon production ceased. Two federal hatcheries are located on the river, Little White Salmon National Fish Hatchery (RM 1.1) and Willard National Fish Hatchery (RM 5.1).

A railroad embankment about one-half mile below the original mouth of the river cuts off a shallow embayment from the Columbia River and forms 212-acre Drano Lake. The Little White Salmon River flows through the lake before entering the Columbia River. Drano Lake is recognized for its steelhead fishing; in 1987 sportsmen caught an estimated 2,393 steelhead. Steelhead are not planted in the subbasin and no natural reproduction takes place. Fish caught are "dip-ins," where steelhead temporarily stop before continuing up the Columbia. West of the river's mouth is an Indian "in-lieu" fishing site set aside in compensation for tribal fishing grounds inundated by the Bonneville Dam reservoir.

Water Resources

Mean annual discharge is 560 cubic feet per second (cfs) and water quality is considered good. Discharge is lowest from August through October and declines to about 60 cfs, but peaks as high as 9,000 cfs in January and February. During periods of high runoff, the fish hatcheries have experienced serious sedimentation and turbidity problems.

Several small domestic water supply systems exist on the Little White Salmon River and one of its tributaries, Moss Creek. Water rights for hatchery production also exist on the Little White Salmon.

Land Use

Most of the subbasin lies within the Gifford Pinchot National Forest, where several campgrounds and numerous Forest Service and private logging roads exist. Approximately eight miles of the river runs through private land, where a few scattered homes have been built. Most residential development is concentrated in the unincorporated town of Willard.

The Little White Subbasin is part of the Yakima Indian Nation lands ceded to the United States in the Treaty of June 9, 1855. Within this area, the tribe reserved the right to hunt and fish at all usual and accustomed places in common with citizens of the territory. Legal challenges to the treaty have affirmed the tribe's right to take no more than 50 percent of the harvestable fish resources and the right to participate in resource management decisions.

PART II. HABITAT PROTECTION NEEDS

History and Status of Habitat

Prior to active state and federal regulation of forest practices, fishery habitat was damaged. Indiscriminate logging around and through streams, use of splash dams to transport logs, and poor road construction with associated siltation reduced or eliminated anadromous fish from many streams. Other problems include destruction of riparian vegetation, land reclamation and non-point source pollution from agricultural development. Urbanization, port development, and flood control efforts further impacted stream habitat. Presently, numerous laws limit impacts, but the cumulative loss of habitat continues.

Fishery managers can influence fish habitat through management of the water and management of the physical habitat including the riparian edge. Physical modification of aquatic habitat is controlled by state and federal statutes. Regulations overlap and are designed to limit impacts to public stream and shoreline resources. Laws addressing developments that could degrade stream and shoreline resources follow.

Federal

1. Clean Water Act, Section 404 and 10, U. S. Army Corps of Engineers, with State of Washington, Department of Ecology certification.

2. National Environmental Policy Act (NEPA), federal agency taking action.

State (Washington)

1. State Water Quality Laws RCW 90.48, Department of Ecology.

2. State Surface Water Codes RCW 90.03, Department of Ecology.

3. State Groundwater Codes RCW 90.44, Department of Ecology.

4. Shoreline Management Act, local government with state oversight by Department of Ecology.

5. Hydraulics Code RCW 75.20.100 and 103, Washington Department of Fisheries or Wildlife.

6. Minimum Flow Program, Department of Ecology.

7. State Environmental Policy Act (SEPA), local government or Department of Ecology.

8. Flood Control Statutes, local government.

9. Forest Practices Act, Department of Natural Resources.

Constraints and Opportunities for Protection

The primary use of land in the subbasin is timber. Logging practices, including road construction and timber harvest, have caused a loss of riparian vegetation. Poor road construction increases sedimentation and road culverts impede fish passage. In addition, loss of streamside vegetation can decrease bank stability; eliminate food, cover, and large woody debris; fluctuate flows and water temperatures; and increase sediment loads and passage obstructions, such as log and debris jams.

Several agencies share the responsibility of managing the Little White Salmon River Subbasin's resources. While each agency has its own policy and management objectives, no one agency has sole authority over the subbasin. All of the following agencies work cooperatively to protect and enhance the natural resources of the area.

Federal
- U.S. Forest Service
- U.S. Fish and Wildlife Service
- National Marine Fisheries Service
- U.S. Geological Service
- U.S. Soil Conservation Service
- Gifford Pinchot National Forest

State
- Washington Department of Wildlife
- Washington Department of Fisheries
- Department of Ecology
- Department of Natural Resources

Local
- Skamania Public Utility District
- Skamania County

Tribal
- Yakima Indian Nation

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.

Habitat Protection Objectives and Strategies

In general, all fisheries management agencies subscribe to the concept of "no net loss" of existing habitat as a management goal. Even though this is difficult to attain, it is prudent policy and should be supported within the subbasin planning process for long-term production protection.

Objectives for habitat protection include:

1) No net loss of existing habitat.

2) No degradation of water quality.

3) No decrease of surface water quantity.

4) Increased security for existing habitat.

5) Increased salmonid use of underutilized habitat.

Strategies to protect habitat are not always easily implemented and as a result, the habitat portion of the subbasin process may not receive the attention it deserves. Prevention of cumulative loss of habitat is ultimately one of public policy.

Methods for implementing the objectives mentioned are generally outside the normal activities of the Northwest Power Planning Council and the typical approach is through regulatory programs. However, this results in habitat protection being defensive whereby some habitat loss frequently occurs.

The combination of an effective public education program, an aggressive regulatory program with stiff penalties, tax incentives for riparian landowners, and demonstrated resource benefits to local residents is likely the only way to preserve and realize the production potential of the region's stream habitat resources. Within these broad categories, there is opportunity for the Power Planning Council to take a leadership and coordinating role. However, the daily business of protecting small habitat units will continue to be an agency burden. Effectiveness of these programs will depend on agency staffing levels of field management and enforcement personnel, public and political acceptance of program goals, local judicial support and importantly, the level of environmental awareness practiced by individual landowners.

The area of cumulative habitat loss is one that the Northwest Power Planning Council must be involved in for sake of the investments made in the Columbia River Basin Fish and Wildlife Program to date. The council could support the agencies' regulatory habitat protection work and become more involved by:

1) Continuing to broaden the public education and information program it already supports.

2) Purchasing riparian property adjacent to critical habitat.

3) Purchasing water rights if they can revert to instream uses.

4) Publishing additional inventories of important habitat for specific stocks.

5) Working with state and federal government for the development and passage of improved habitat protective legislation.

PART III. CONSTRAINTS AND OPPORTUNITIES FOR ESTABLISHING PRODUCTION OBJECTIVES

Systemwide Considerations

In terms of identifying objectives, general consideration should focus on the United States vs. Oregon document and the need to use this planning process as a means to fulfill the implementation of that decision. At the core of this agreement is the objective to rebuild weak runs at full productivity and to achieve fair sharing of the available harvest between Indian and non-Indian fisheries. A secondary objective is to rebuild upriver spring and summer chinook runs that would restore fisheries within 15 years. Harvests would be managed so that natural steelhead and other salmon runs also continue to rebuild. The rebuilding is to be accomplished through a systematic harvest management approach as well as implementation of appropriate production measures.

Consistent with United States vs. Oregon is the need to maintain flexible and dynamic plans, which can be evaluated at defined intervals and modified whenever conditions change or new information becomes available. Long-term plans should also work to avoid disputes among the parties and attempt to resolve disagreements over fishing regulations and the collection and interpretation of management data.

As an extension of these objectives, subbasin plans should:

1) Achieve a balance with the stock of any given type (such as spring and fall chinook).

2) Work toward harvest stability within subbasins.

3) Provide equitable opportunity to each user group.

4) Maintain habitat and improve where possible.

5) Manage for the consistent escapement of escapement allowances.

6) Optimize production and maximize long-term net benefits.

7) Use indigenous stocks where feasible and maintain stock diversity of all species to ensure perpetual existence and ability to adapt to change.

In fulfilling their obligations, the parties will cooperate in management research and enhancement. In addition, the parties will take into account the following items.

1) The desirability, in most cases, of reducing interceptions.

2) The desirability, in most cases, of avoiding undue disruption of existing fisheries.

3) Annual variation in abundance of the stocks.

Local Considerations

Above the natural barrier, the Little White Salmon River is steep, with a succession of rapids and cascades (Bryant 1949). Above this section are several miles of good spawning and rearing habitat. Bryant (1949) concluded that if a fish ladder was constructed around the lowest falls, and the lesser obstructions removed, fish would migrate into these areas, increasing the natural productivity of the river several-fold.

The Gifford Pinchot National Forest surveyed the river from RM 13.1 to RM 18.3 in 1983. Most sections surveyed had a moderate gradient (5 percent to 9 percent) and generally a cobble or rock bottom. Anadromous fish habitat appeared good in some areas and marginal in others. The middle sections (RM 14.8 to RM 16.0) had a low stream gradient (less than 5 percent), low water velocity, and were relatively unshaded. Most of the stream bottom was sandy and lacked spawning gravel.

A considerable amount of logging has taken place in the watershed, which has contributed to streambank instability and sedimentation, reduced riparian vegetation, and increased road surfaces (sedimentation source and culverts) throughout the basin. Current forest practices are seeking to minimize these impacts and rectify problems created during operations.

The Gifford Pinchot National Forest, Washington Department of Fisheries, and Washington Wildlife Department have signed a memorandum of understanding to work cooperatively to promote the successful management of fishery and wildlife resources, and habitat in national forest lands. Opportunities exist for these agencies to work together to potentially increase the fisheries resources by minimizing proposed activities that would impact fish habitat and implementing habitat rehabilitation and enhancement projects.

A federal court case involving treaty fishing rights on the mainstem Columbia River also has implications for the management of tributary fish resources. The Columbia River Fish Management

Plan, recently signed into law under United States vs. Oregon, includes specific instructions for hatchery production of spring chinook in the Little White Salmon River Subbasin. Consequently, subbasin production plans must be compatible with the production goals set forth in the Columbia River Fish Management Plan.

PART IV. ANADROMOUS FISH PRODUCTION PLANS

FALL CHINOOK SALMON

Fisheries Resource

Natural Production

Fall chinook were historically present in small numbers below the barrier falls in the lower river (Bryant 1949). The chinook salmon run consisted of fish known as "tules." However, fish were unable to pass above the barrier falls and when Bonneville Pool flooded the lower river area, natural production ceased in the subbasin. Hatchery production began in 1896 from eggs collected in the river, however, the hatchery received eggs from other strains of tule fall chinook over the years. Nelson and Bodle (1988) indicated that from 1968 to 1983, 51 percent of the fall chinook released in the Little White Salmon River were not indigenous. Low returns, coupled with little contribution to commercial or sport harvest, led managers to discontinue production of this stock. In 1984, the hatchery began producing upriver bright fall chinook.

Upriver brights are usually more silver than tule fall chinook when they begin their freshwater migration, and are destined for areas above Bonneville Dam. Brood stock for upriver bright production started from upriver-bound fall chinook trapped at Bonneville Dam and is a mixture of fish from several different production areas above Bonneville (Howell et al. 1984).

The Northwest Power Planning Council's smolt capacity model indicated that a total of 73,652 fall chinook fingerlings could be produced using all subbasin habitat. Constraints included basin size, steep gradients, and lack of spawning habitat.

Hatchery Production

The Little White Salmon National Fish Hatchery produces the subbasin fall chinook. The hatchery has operated since 1898 and is located one mile upstream from the Columbia River. The hatchery sits on 410 acres and includes 10 indoor concrete tanks, 52 outdoor raceways, and 108 Heath incubators. The hatchery's water supply comes from the Little White Salmon River and two springs. The hatchery holds four water rights permits totaling 72.5 cfs from the river. Even though the springs (3 cfs) are smaller than river flows, the spring water is important to the hatchery because it is warmer and free of silt in winter. The hatchery previously had some major losses due to flooding, but 1974 improvements should circumvent further flooding hazards.

The Little White Salmon and Willard hatcheries produce spring and fall chinook and coho. Coho eggs are taken at the Little White Hatchery, but are reared at Willard.

Station development plans for the hatcheries propose to upgrade and expand the facilities. The proposal includes 1) completing an adult fish facility, 2) constructing an incubation building, 3) reconstructing and rehabilitating raceways, and 4) improving public-use facilities. The present incubation building uses a reuse water system although a single-pass water incubation is necessary to prevent spread of diseases such as infectious hematopoietic necrosis (IHN) (USFWS 1987). Hatchery production objectives require incubation of 13 million eggs from approximately 3,000 fish.

The Little White Salmon Hatchery holds a federal "C" classification, meaning a viral or kidney disease is present. IHN was detected in adults in 1981 and common bacterial diseases are bacterial kidney disease (BKD) and furunculosis.

In 1984, the Little White Salmon Hatchery received upriver bright fall chinook eggs from Bonneville Hatchery, and released both fingerlings and yearlings in 1985 (Table 1). Currently, 1.1 million fingerlings are released at the hatchery to maintain brood stock and for John Day Dam mitigation. An additional 2 million fingerlings are also planted in the Yakima River and will be increased to 4.3 million fish as planting sites in the Yakima are developed. In 1987, the fish were exposed to IHN during initial rearing and the entire brood year of juveniles was destroyed. About 183,660 upriver brights (another stock) were reared in a net pen for four months in Drano Lake (Nelson et al. 1987). These fish were monitored for IHN, but tested negative.

Table 1. Releases of upriver bright fall chinook in the Little White Salmon Subbasin.

Year	Fingerlings	Yearlings
1985	1,984,359	95,364
1986	1,045,722	85,830
1987	183,660	0
1988	3,063,500	0
1989	1,456,852	0

Upriver brights migrate to the hatchery from mid-September to November. Adults are held from mid-October to November and spawned in November. Incubation usually occurs from November to February and fry emerge in March. Juveniles are reared for approximately four months for fingerling releases, and 14 months for yearling releases.

Age and sex of upriver brights returning in 1986-1987 indicated ocean age-3 fish dominate, and females comprised 53.7 percent of ocean age-3 fish (Table 2). Fecundity of upriver bright fall chinook at Bonneville Hatchery is 4,503 eggs per female (Howell et al. 1984).

Table 2. Age and sex of Little White Salmon upriver bright fall chinook, 1986-1987.

	Age			
	1	2	3	4
Age composition	1.0	19.3	58.0	21.8
Mean length(cm)*	48.8	70.8	87.9	100.5
Percent females	0.0	30.0	53.7	35.7

* Includes 1985 returns.

Harvest

Harvest of upriver brights within the subbasin averaged 13 jacks and 32 adults for 1985 through 1987 (Table 3). Harvest rate within the subbasin averaged 2.6 percent for 1985 through 1987.

Based on hatchery returns and 2.6 percent inbasin harvest, returns to the subbasin averaged 2,012 fish for 1985 through 1989.

When a sport fishery is allowed, angling regulations allow an August 1 through December 31 season downstream from markers on point of land downstream and across from the salmon hatchery. Daily bag limit is six salmon of 10-inch minimum size of which two adults (more than 24 inches) are allowed.

Table 3. Sport catch and hatchery returns of Little White Salmon upriver bright fall chinook.

Year	Sport Catch Jacks	Sport Catch Adults	Hatchery Return (Jacks + Adults)	Total (Jacks + Adults)
1985	19	10	853	882
1986	1	45	1,827	1,873
1987	18	41	3,091	3,150
1988	n\a	n\a	2,092	n\a
1989	n\a	n\a	1,937	n\a

Specific Considerations

Upriver bright fall chinook on the Little White Salmon are a non-indigenous hatchery stock started at the Little White Salmon Hatchery in 1984. There is no spawning or rearing habitat access to adults due to a barrier falls near the mouth of the river. The present constraint is the ability of the hatchery to produce juveniles.

The United States vs. Oregon management plan stipulates that the interim spawning escapement goal for upriver bright fall chinook is to return enough brood stock necessary to meet hatchery production requirements; the majority of harvest opportunity goes to the treaty Indian fisheries. In addition, the United States vs. Oregon plan states treaty Indian and non-Indian fisheries in Columbia River tributaries, other than the mainstem Columbia River between McNary and Priest Rapids dams, shall be governed by the subbasin plans.

The close proximity of the Wind, Little White Salmon, White Salmon and Klickitat rivers and the diversity of production opportunities among them provides a unique opportunity to develop a regional management approach that best meets the needs of treaty and non-treaty fishermen. All enter the Columbia River within a 26-mile reach.

Little White Salmon fall chinook suffer mortality hazards associated with Bonneville Dam which impacts survival of emigrating smolts and returning adults. Adult fish are subjected to Columbia River sport and commercial fisheries.

Objectives

Utilization Objective

Provide 200 upriver brights for sport and tribal harvest to be shared according to the United States vs. Oregon agreement. The utilization objective has priority within the subbasin.

Biological Objective

Maintain the biological characteristics of the locally adapted upriver bright fall chinook. This will require a subbasin return of about 3,900 fish at existing harvest rates.

Alternative Strategies

Strategies for fall chinook in this report have specific themes. Means to obtain the objectives are first attempted utilizing natural methods followed by less natural techniques and finally, hatchery production.

Modeling results for each strategy are presented in Table 4 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 4. 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.

Estimated costs of the alternative strategies below are summarized in Table 5.

STRATEGY 1: Natural Production. This strategy seeks to achieve the objectives by planting fry into habitat to utilize natural production potential.

Hypothesis: Existing habitat has potential to produce a number of smolts.

Assumptions: This strategy assumes adults or fry would fully utilize available habitat. Fry-to-fingerling survival of fry plants was assumed to be 50 percent. Also, this strategy assumes the hatcheries' water supplies would not be threatened by disease by putting fish upstream of the water intake. The resident trout fishery may be impacted, but this strategy assumes no impacts. Each of the above assumptions is unproven and uncertain.

Numeric Fish Increases: The System Planning Model indicated an additional 214 fish will return to the subbasin with this strategy under current conditions. MSY would increase by 171 fish after mainstem program implementation.

ACTIONS: 1

1. Plant 150,000 fry to seed the habitat above the falls (see Appendix C for cost estimates).

STRATEGY 2: Hatchery Production. This strategy seeks to achieve the objectives solely through traditional hatchery production. Only those actions necessary for maintenance of the hatchery program are included.

Hypothesis: Increasing hatchery plants will increase adult returns.

Assumptions: This strategy assumes increased hatchery production will result in commensurate adult returns.

Numeric Fish Increases: This strategy would add 5,221 fish to the subbasin under current conditions. MSY would increase by 4,450 fish after mainstem program implementation.

ACTION: 2

2. Increase hatchery production by 3.6 million fingerlings (see Appendix C for cost estimates).

Recommended Strategy

The recommended strategy for Little White Salmon fall chinook is Strategy 2, hatchery expansion by 3.6 million smolts. This program is managed for hatchery fish with little habitat present for natural fish. Hatchery expansion will also assist toward goals outlined in United States vs. Oregon. The SMART analysis also supports Strategy 2 (Appendix B).

Table 4. System Planning Model results for fall chinook in the Little White Salmon Subbasin. Baseline value is for pre-mainstem implementation, all other values are post-implementation.

Utilization Objective:
200 for sport and tribal harvest to be shared according to United States vs. Oregon.

Biological Objective:
Maintain biological characteristics of the locally adapted stock.

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	1,929 -C	283	2,243	9,901	0(1.00)
All Nat	1,917 -C	281	2,229	9,839	- 78(0.99)
1	2,100 -C	308	2,442	10,776	1,107(1.09)
2*	6,379 -C	935	7,417	32,738	28,895(3.31)

*Recommended strategy.

[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. Fry plant natural habitat. Post Mainstem Implementation.
2. From baseline add 3.6 million smolts. 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.

Table 5. Estimated costs of alternative strategies for Little White Salmon 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*
Hatchery Costs		
Capital[1]	8,625	828,000
O&M/yr[2]	938	90,000
Other Costs		
Capital[3]	0	0
O&M/yr[4]	0	0
Total Costs		
Capital	8,625	828,000
O&M/yr	938	90,000

* 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.

SPRING CHINOOK SALMON

Fisheries Resource

Natural Production

Spring chinook may have been historically present in small numbers below the barrier falls in the lower river (Bryant 1949). However, since Bonneville Pool inundated the lower river, only hatchery fish are present.

The Northwest Power Planning Council's habitat capacity model indicated that a total of 32,350 spring chinook smolts could be produced using all subbasin habitat. Constraints included the basin size, steep gradients, low summer flows, and lack of spawning habitat.

Hatchery Production

Spring chinook releases began in the late 1960s using Eagle Creek Hatchery stock plus strays returning to the Little White Salmon River. In 1972, the previously described Little White Salmon River Hatchery began to use its own returns and/or received eggs from Carson Hatchery. Spring chinook raised at the Little White Salmon Hatchery are considered a Carson stock derivative (Howell et al. 1984). Annual spring chinook production averaged 704,176 smolts for 1977 through 1989 and 527,760 age-0 fingerlings for 1980 through 1989 (Table 6). Egg-to-smolt survival has been about 87.9 percent.

Table 6. Number of spring chinook juveniles released from Little White Salmon National Fish Hatchery, 1977-1987.

Year	Fingerlings	Smolts
1977	0	693,990
1979	0	621,116
1979	0	790,401
1980	223,988	510,802
1981	0	646,574
1982	100,000	583,682
1983	210,521	750,262
1984	736,068	212,994
1985	573,621	1,254,959
1986	665,939	412,212
1987	803,736	1,075,500
1988	558,000	1,102,000
1989	574,191	499,796
AVE	527,760*	704,176

*1982-1989

Adult spring chinook return to the hatchery from April to July. Fish are held from mid-April through August and spawned from mid-July to August. Since 1982, adults have been held indoors and exposed to lights to advance the photoperiod and induce earlier spawning (Nelson and Bodle 1988). Incubation runs from mid-July to mid-December and fry emerge from October to December. Fingerlings are reared until spring release in April through June. Yearlings are reared until the following April through July. Yearling spring chinook egg-to-smolt survival averaged 53 percent for 1970 through 1985.

Subbasin spawning escapement is accounted for at the hatchery rack; about 50 percent is normally collected by May 31. Run size for 1977 through 1987 ranged from 577 to 3,680 fish and averaged 1,914 adults and 72 jacks, a total of 1,986 fish (Table 7).

Table 7. Sport catch and hatchery escapement of subbasin spring chinook, 1977-1986.

Year	Sport Catch		Hatchery Rack		Total	
	Jacks	Adults	Jacks	Adults	Jacks	Adults
1977	0	0	69	3,422	69	3,422
1978	13	0	206	1,650	219	1,650
1979	0	120	21	889	21	1,009
1980	0	0	115	974	115	974
1981	0	7	1	2,594	1	2,601
1982	0	573	37	3,070	37	3,643
1983	0	111	14	2,594	14	2,705
1984	0	0	43	534	43	534
1985	3	157	8	1,349	11	1,506
1986	19	119	171	973	190	1,092
AVE	5*	181*	69	1,805	72	1,914

* Years in which adults were caught.

The biological characteristics of the Little White Salmon River stock is thought to be similar to the donor stock from Carson Hatchery. Age profiles of Carson Hatchery adults indicate 0.9 percent, 57.4 percent, 41.5 percent, and 0.2 percent returned at ocean age I, II, III, and IV. Females comprised 0 percent, 67.8 percent, 39.6 percent, and 0 percent, respectively (Howell et al. 1984). Mean length of ocean age-III and -IV fish was 75 cm and 92 cm, respectively. Mean fecundity is 4,300 eggs per female (Howell et al. 1984).

Harvest

When harvestable numbers of fish are expected, a sport harvest of spring chinook is permitted and occurs in Drano Lake. The United States vs. Oregon management plan should be consulted for detailed harvest plans. Sport harvest averaged 181 adults and five jacks in years when the sport fishery was open for 1977 through 1986. Harvest rate was 8.7 percent on adults, 7.2 percent on jacks, and 8.4 percent overall.

When a sport fishery is allowed, angling regulations allow an August 1 through December 31 season downstream from markers on point of land downstream and across from the salmon hatchery. Daily bag limit is six salmon of 10-inch minimum size of which two adults (more than 24 inches) are allowed.

Specific Considerations

Spring chinook in the Little White Salmon are a non-indigenous hatchery stock started at the Little White Salmon Hatchery in the 1960s. There is no spawning or rearing habitat accessible to adults due to a barrier falls near the mouth of the river. The present constraint is the ability of the hatchery to produce juveniles.

The close proximity of the Wind, Little White Salmon, White Salmon and Klickitat rivers and the diversity of production opportunities among them provides a unique opportunity to develop a regional management approach that best meets the needs of treaty and non-treaty fishermen. All enter the Columbia River within a 26-mile reach.

Little White Salmon spring chinook suffer mortality hazards associated with Bonneville Dam, which impacts survival of emigrating smolts and returning adults. Adult fish are subjected to Columbia River sport and commercial fisheries.

Objectives

Utilization Objective

Increase sport and tribal harvest within the subbasin to 2,000 spring chinook, to be shared as per United States vs. Oregon. The utilization objective has priority within the subbasin.

Biological Objective

Maintain the biological characteristics of the locally adapted spring chinook.

Alternative Strategies

Modeling results for each strategy are presented in Table 8 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 8. 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.

Estimated costs of the alternative strategies below are summarized in Table 9.

STRATEGY 1: Natural Production. This strategy seeks to achieve the objectives by planting adults or fingerlings into habitat to utilize natural production potential.

Hypothesis: Existing habitat has potential to produce a number of smolts.

Assumptions: This strategy assumes adults or fingerlings would fully utilize available habitat. Fingerling-to-smolt survival of fingerling plants was assumed to be 25 percent. Also, this strategy assumes the hatcheries' water supplies would not be threatened by disease by putting fish upstream of the water intake. The resident trout fishery may be impacted, but this strategy assumes no impacts. Each of the above assumptions is unproven and uncertain.

Numeric Fish Increases: The System Planning Model indicated an additional 161 fish will return to the subbasin with this strategy under current conditions. MSY would increase by 163 fish after mainstem program implementation.

ACTIONS: 1

1. Plant 130,000 fingerlings to fully seed the habitat.

STRATEGY 2: Hatchery Production. This strategy seeks to achieve the objectives solely through traditional hatchery production. Only those actions necessary for maintenance of the hatchery program are included.

Hypothesis: Increasing hatchery plants will increase adult returns.

Assumptions: This strategy assumes increased hatchery production will result in commensurate adult returns.

Numeric Fish Increases: This strategy would add 1,642 fish to the subbasin under current conditions. MSY would increase by 1,563 fish after mainstem program implementation.

ACTION: 2

2. Increase hatchery production from 740,000 smolts to 1.4 million smolts, an increase of 660,000 smolts.

Recommended Strategy

The recommended strategy for Little White Salmon spring chinook is Strategy 2, hatchery expansion by 660,000 smolts. This program is managed for hatchery fish with little habitat present for natural fish. Hatchery expansion will also assist toward goals outlined in United States vs. Oregon. The SMART analysis also supports Strategy 2 (Appendix B).

Table 8. System Planning Model results for spring chinook in the Little White Salmon Subbasin. Baseline value is for pre-mainstem implementation, all other values are post-implementation.

Utilization Objective:
2,000 for sport and tribal harvest to be shared as per United States vs. Oregon.

Biological Objective:
Maintain biological characteristics of existing stock.

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	1,956 -C	112	2,081	328	0(1.00)
All Nat	1,966 -C	113	2,092	331	15(1.01)
1	2,119 -C	122	2,254	356	221(1.08)
2*	3,519 -C	202	3,743	591	2,119(1.80)

*Recommended strategy.

[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. Fry plant natural habitat. Post Mainstem Implementation.
2. From baseline add 660,000 smolts. 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.

Table 9. Estimated costs of alternative strategies for Little White Salmon spring 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*
Hatchery Costs		
Capital[1]	29,900	1,518,000
O&M/yr[2]	3,250	165,000
Other Costs		
Capital[3]	0	0
O&M/yr[4]	0	0
Total Costs		
Capital	29,900	1,518,000
O&M/yr	3,250	165,000

* 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.

COHO SALMON

Fisheries Resource

Natural Production

Coho may have been historically present in small numbers below the barrier falls in the lower river (Bryant 1949). However, after Bonneville Pool inundated the lower river, only hatchery fish have been present.

The Northwest Power Planning Council's smolt capacity model indicated that a total of 18,709 smolts could be produced using all subbasin habitat. Constraints include basin size, steep gradients, low summer flows, and lack of spawning habitat.

Hatchery Production

Subbasin coho production occurs exclusively at the Willard National Fish Hatchery, which is located approximately four miles above the Little White Salmon Hatchery. Adults return to the Little White Salmon Hatchery where eggs are taken; incubation, rearing, and release occur at Willard. The hatchery was built in 1952 and occupies 80 acres. Willard's facilities consist of 52 concrete tanks, 44 Heath incubators and 50 raceways. Water source is the Little White Salmon River (hatchery rights are 50 cfs) and two wells, which are used for egg incubation. Intensive maintenance at the hatchery intake is necessary due to heavy silt and gravel bedloads in the river.

Early-returning coho, derived from the Toutle River, are used at the hatchery. Because of extensive egg transfers among Columbia River facilities, early coho stocks are probably a mixture of various populations (Howell et al. 1984). Plants for 1977 through 1986 averaged 2,851,000 smolts and 155,000 fingerlings, although fingerling plants are not annual (Table 10).

Table 10. Coho plants in the Little White Salmon, 1977-1986.

Year	Fingerlings	Smolts
1977	745,800	4,522,185
1978		4,008,772
1979		1,636,244
1980	213,325	3,122,569
1981		2,790,185
1982	105,983	2,413,933
1983	247,500	3,175,594
1984		2,071,148
1985	244,914	999,358
1986		3,771,630
AVE	155,752	2,851,162

Adults migrate to the Little White Salmon Hatchery from September through the first week in November. Adults are held from late September to late November when they are spawned. Fry emerge from mid-January to February. Juveniles are reared for approximately 17 months and released in May.

An average of 10.8 percent and 89.2 percent of Little White Salmon Hatchery coho return after one and two years in the ocean, respectively (King 1987). All 1-year ocean fish were males; 62 percent of 2-year ocean fish were males. Mean length was 62 cm for males and 64 cm for females. Fecundity averaged 2,100 eggs per female.

Diseases identified at the hatchery include bacterial kidney disease (BKD), sunburn and cold water disease. Water temperature is too low for efficient coho production and may be responsible for cold water disease. River water temperature usually averages about 42.5 F while well temperature is 41 F.

Harvest

A coho sport fishery occurs in Drano Lake; harvest averaged 31 jacks and 158 adults, a harvest rate of 1.8 percent (Table 11). The United States vs. Oregon management plan indicates existing or enhanced upriver coho stocks are not subject to a formal allocation scheme. However, expanded harvest opportunities are to be provided within tributary areas for early coho stocks. Little White Salmon coho are primarily harvested in the ocean and Columbia River by commercial and sport fisheries; total harvest rate approaches 80 percent.

Angling regulations allow an August 1 through December 31 season downstream from markers on point of land downstream and across from the salmon hatchery. Daily bag limit is six salmon of 10-inch minimum size of which two adults (more than 20 inches long) are allowed.

Table 11. Sport catch and returns of Little White Salmon coho, 1977-1986.

Year	Sport Catch		Hatchery Escapement		Total	
	Jacks	Adults	Jacks	Adults	Jacks	Adults
1977	6	3	532	1,800	538	1,803
1978	7	7	228	4,780	235	4,787
1979	4	16	46	5,035	50	5,051
1980	2	5	466	1,641	468	1,646
1981	15	36	273	8,957	288	8,993
1982	67	733	194	30,589	261	31,322
1983	7	21	1,057	1,870	1,064	1,891
1984	38	123	444	6,619	402	6,742
1985	56	226	907	10,591	963	10,817
1986	110	406	711	25,014	821	25,420
AVE	31	158	486	9,690	517	9,848

Specific Considerations

No spawning or rearing habitat is accessible to returning adults due to a barrier falls near the mouth of the river. The present constraint is the ability of the hatchery to produce juveniles.

The close proximity of the Wind, Little White Salmon, White Salmon and Klickitat rivers and the diversity of production opportunities among them provides a unique opportunity to develop a regional management approach that best meets the needs of treaty and non-treaty fishermen. All enter the Columbia River within a 26-mile reach.

Little White Salmon coho suffer mortality hazards associated with Bonneville Dam, which impacts survival of emigrating smolts and returning adults. Adult fish are subjected to Columbia River sport and commercial fisheries.

Objectives

Utilization Objective

Provide 200 coho for sport and tribal harvest and support out-of-basin harvest, to be shared as per United States vs. Oregon. The utilization objective has priority within the subbasin.

Biological Objective

Maintain the biological characteristics of the existing stock.

Alternative Strategies

Because objectives for Little White Salmon coho are currently being met, planners are not offering strategies for increasing production.

PART V. SUMMARY AND IMPLEMENTATION

Objectives and Recommended Strategies

Upriver Bright Fall Chinook

The objective for upriver bright fall chinook is to provide a sport and tribal harvest of 200 fish. The recommended strategy is Strategy 2, increasing hatchery production by 3.6 million fingerlings.

Spring Chinook

The objective for spring chinook is to increase sport and tribal harvest to 2,000 fish. Planners recommend Strategy 2, increasing hatchery production by 660,000 smolts.

Coho

The objective for coho is to provide a sport and tribal harvest of 200 fish. This goal is currently being met and consequently, planner are not proposing alternative strategies.

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: Little White Salmon Stock: Upriver bright fall chinook
Strategy: 1

Criteria	Rating	Confidence	Weight	Utility	Discount Utility
1 EXT OBJ	2	0.9	20	40	36
2 CHG MSY	2	0.9	20	40	36
3 GEN IMP	4	0.9	20	80	72
4 TECH FEAS	6	0.6	20	120	72
5 PUB SUPT	5	0.6	20	100	60
TOTAL VALUE				380	
DISCOUNT VALUE					276
CONFIDENCE VALUE					0.78

Subbasin: Little White Salmon Stock: Upriver bright fall chinook
Strategy: 2

Criteria	Rating	Confidence	Weight	Utility	Discount Utility
1 EXT OBJ	5	0.6	20	100	60
2 CHG MSY	6	0.6	20	120	72
3 GEN IMP	4	0.9	20	80	72
4 TECH FEAS	7	0.6	20	140	84
5 PUB SUPT	6	0.6	20	120	72
TOTAL VALUE				560	
DISCOUNT VALUE					360
CONFIDENCE VALUE					0.66

Subbasin: Little White Salmon	Stock: Spring chinook
Strategy: 1

Criteria	Rating	Confidence	Weight	Utility	Discount Utility
1 EXT OBJ	2	0.9	20	40	36
2 CHG MSY	2	0.9	20	40	36
3 GEN IMP	4	0.9	20	80	72
4 TECH FEAS	6	0.6	20	120	72
5 PUB SUPT	5	0.6	20	100	60
TOTAL VALUE				380	
DISCOUNT VALUE					276
CONFIDENCE VALUE					0.78

Subbasin: Little White Salmon	Stock: Spring chinook
Strategy: 1

Criteria	Rating	Confidence	Weight	Utility	Discount Utility
1 EXT OBJ	6	0.6	20	120	72
2 CHG MSY	6	0.6	20	120	72
3 GEN IMP	4	0.9	20	80	72
4 TECH FEAS	7	0.6	20	140	84
5 PUB SUPT	6	0.6	20	120	72
TOTAL VALUE				560	
DISCOUNT VALUE					372
CONFIDENCE VALUE					0.66

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: Little White Salmon River
Stock: Upriver Bright Fall Chinook

Action	Cost Categories*	Proposed Strategies 1	2**
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:	8,625	828,000
	O&M/yr:	938	90,000
	Life:	50	50
TOTAL COSTS	Capital:	8,625	828,000
	O&M/yr:	938	90,000
	Years:	50	50
Water Acquisition		N	N
Fish to Stock	Number/yr:	150,000	3,600,000
	Size:	F, 400/lb.	J, 100/lb.
	Years:	50	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.

ESTIMATED COSTS FOR ALTERNATIVE STRATEGIES

Subbasin: Little White Salmon River
Stock: Spring Chinook

Action	Cost Categories*	Proposed Strategies 1	2**
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:	29,900	1,518,000
	O&M/yr:	3,250	165,000
	Life:	50	50
TOTAL COSTS	Capital:	29,900	1,518,000
	O&M/yr:	3,250	165,000
	Years:	50	50
Water Acquisition		N	N
Fish to Stock	Number/yr:	130,000	660,000
	Size:	J, 100/lb.	S, 10/lb.
	Years:	50	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.