Columbia Basin System Planning

SALMON and STEELHEAD PRODUCTION PLAN

LEWIS RIVER SUBBASIN

September 1, 1990

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Washington Department of Fisheries
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Olympia, Washington 98504

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Columbia Basin Fish and Wildlife Authority

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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 Lewis River headwaters arise from the southern flanks of Mount Adams and Mount St. Helens. The mainstem of the river, also known as the North Fork Lewis River, flows southwesterly from its source in Skamania County through three impoundments -- Merwin Lake (River Mile 19.5), Yale Lake (RM 34.2) and Swift Creek Reservoir (RM 47.9). Along the middle and lower sections, the river forms the boundary between Clark and Cowlitz counties. A major tributary, East Fork Lewis River, enters the mainstem at RM 3.5. From this point the Lewis River continues west, entering the Columbia River at RM 88.

North Fork

The lower 12 miles of the North Fork Lewis River flows through a wide, flat valley, much of which is under cultivation and protected from river flooding with dikes. The next eight miles of the valley begins to narrow, forming a canyon from the confluence of Cedar Creek (RM 15.7) to Merwin Dam. The major feature of the Lewis River Basin is the 240-foot high dam. From this point upriver, anadromous passage is blocked.

The middle section of the North Fork is largely inundated by the three reservoirs, each impounded by hydropower dams owned and operated by Pacific Power and Light Company. The Cowlitz County Public Utility District owns a fourth hydro project located on a power canal between Pacific Power's Swift No. 1 and Yale projects.

The upper section of the North Fork, beyond Swift Creek Reservoir, become increasingly steep and rugged. Two large tributaries, Muddy River and Clearwater Creek, along with the North Fork, form the drainage area between Mount Adams and Mount St. Helens.

East Fork

The East Fork joins the Lewis River 3.5 miles above the mouth. The lower six miles forms a relatively wide valley, but the upper sections are narrow, often canyon-like, with numerous cascades and waterfalls. Lucia Falls (RM 21) is considered the upriver limit to the majority of salmon. Steelhead, and an occasional coho, are able to pass. There is a series of 3- to 8-foot falls within the next 10 miles of river. Sunset Falls (RM 31.5) is considered the upper limits for all anadromous fishes on the East Fork.

Most of the upper East Fork watershed lies within the area known as the Yocolt Burn. This region was struck by a series of large forest fires earlier this century, which seriously denuded the area, causing extensive erosion and siltation to the streambed. The area above Sunset Falls lies in Skamania County and within the Gifford Pinchot National Forest.

The climate of the subbasin is typical of western Washington. The maritime air moderates the seasonal extremes, producing mild, wet winters and cool summers. Average annual rainfall in the subbasin varies with elevation, but ranges from 45 inches near Woodland, at the mouth of the river, to 140 inches at the peak of Mount St. Helens.

Streamflow on the lower section of the North Fork is regulated by Merwin Dam. Average annual flow, measured below Merwin (1924-1986), is 4,849 cubic feet per second (cfs). Average annual flow on the East Fork, measured at the confluence with the North Fork, is 1,000 cfs. Average annual flow for the entire watershed, measured at the river's mouth, is 6,125 cfs.

The topography of the subbasin is a result of geological uplifting, volcanic activity and river flooding. Mount Adams is the highest peak in the subbasin at 12,307 feet. Mount St. Helens is an active volcano, last erupting in May 1980. The Chelatchie Prairie and the Yocolt Basin are high benches that are relatively level.

Soils in the subbasin derive from recent alluvial deposits, overlaying an older alluvial fan known as the Troutdale Formation, which consists of clays, sands and deposits of gravel. Underlying materials of the upper watershed include volcanic and basaltic formations of the Cascade Range.

With regard to land ownership, most of the North Fork watershed above Swift Reservoir lies within the Gifford Pinchot National Forest. Some of the upper tributaries flow out of Mount St. Helens National Volcanic Monument. Below the reservoirs and along the East Fork, the majority of the land is under private holdings such as small farms and residences.

Fisheries Resource

The Lewis River is managed for six stocks of anadromous fish -- spring chinook, fall chinook, Type-S coho (early returning), Type-N coho (late returning), and summer and winter steelhead. Spring chinook and both types of coho are managed as hatchery stocks, while fall chinook is managed as a natural stock. Steelhead are managed for both natural and hatchery stocks.

There are presently two hatcheries located on the Lewis River -- the Lewis River Hatchery and Speelyai Hatchery. Both facilities produce spring chinook and coho. Lewis River Hatchery is located eight miles east of Woodland on the North Fork, about four miles below Merwin Dam. The hatchery has gone through recent renovations. It presently has 12 raceways, three half-acre ponds (one is used for juvenile rearing and adult holding), and a half-acre pond located off station. Incubation includes vertical incubators and deep troughs. Eyeing capacity is 13 million eggs; hatching capacity is 7.7 million fry. Water is supplied by pumps from the North Fork only. This facility is jointly funded by the state of Washington and Pacific Power and Light.

Lewis River Hatchery is one of the major producers of coho on the Columbia River. In addition, it operates a spring chinook program. A minor fall chinook program was discontinued in 1985 to avoid conflicts with the healthy natural spawning population.

Speelyai Hatchery is located on Speelyai Creek above Merwin Dam, also on the North Fork. It was built as a mitigation facility for the Swift No. 1 and the Swift No. 2 projects in 1960 and expanded in 1970 by Pacific Power and Light and the Cowlitz County Public Utility District. There are 12 standard ponds and two 0.14-acre ponds, one of which is used for adult holding. Vertical incubators are used for incubation. Hatching capacity is 4 million fry. Rearing capacity is 2 million fish. Water is supplied by gravity flow from Speelyai Creek. Fish are normally hauled below Merwin Dam for release. Funding for the operation and maintenance is provided by Pacific Power and Light and Cowlitz County PUD.

Speelyai Hatchery produces both early and late-returning coho. It also serves as an intermediate site for the rearing of spring chinook destined for the Lewis River.

During a recent relicensing process for Merwin Dam, an additional station to be used for the production of steelhead, rainbow trout and cutthroat trout, was negotiated. This facility (Ariel Hatchery) will be located near the base of Merwin Dam. Construction is under way. Further information will be provided in the steelhead section, Part IV.

PART II. HABITAT PROTECTION NEEDS

History and Status of Habitat

Prior to any active state or federal regulation of forest practices, significant damage was done to the region's fisheries resources. Indiscriminate logging through streams, the use of splash dams to transport logs, and poor road construction and associated siltation problems, reduced or eliminated anadromous fish from many streams. Other kinds of problems, most notably destruction of riparian vegetation, land reclamation and non-point source pollution was caused by agricultural development. Urbanization, port development, and flood control works further impacted stream habitat. Today, numerous laws limit many major impacts, but the cumulative loss of habitat continues.

Habitat management for fish production embraces two elements that fish managers have varying degrees of control over -- management of the water, and management of the physical habitat structure including the riparian edge. Management of flows in the North Fork Lewis River are largely controlled by discharges from Merwin Dam. Recent negotiations with Pacific Power and Light have alleviated some of the problems, particularly with fall chinook.

Physical modification of the aquatic habitat is controlled by federal and state statutes. This overlapping patchwork of regulation is designed to limit impacts to public stream and shoreline resources. Rules governing development are generally poorly understood by the public. Laws that set standards for, regulate, or otherwise disclose for public and agency comment, development that could degrade stream and shoreline resources are listed below.

Federal

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

2) National Environmental Policy Act (NEPA), Federal Agency taking action

Washington State

1) State Water Quality Laws RCW 90.48, Dept. of Ecology, Washington

2) State Surface Water Codes RCW 90.03, Dept. of Ecology

3) State Groundwater Codes RCW 90.44, Dept. of Ecology

4) Shorelines Management Act, local government with state oversight by Dept. of Ecology

5) Hydraulics code RCW 75.20.100 and 103, Washington Dept. of Fisheries or Dept. of Wildlife

6) Minimum Flow Program, Dept. of Ecology

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

8) Flood Control Statutes, local government

9) Forest Practices Act, Dept. of Natural Resources.

In many cases, important factors affecting the quantity and quality of stream habitat are outside the direct regulatory authority of the fisheries management agencies. Interagency cooperation is one important way this difficult management situation can be counteracted. Better interagency communication of goals and objectives within watersheds, and then cooperative administration and enforcement of rules could improve habitat protection.

A good example from Washington of how interagency cooperation strengthens a regulatory program, is the procedure the Department of Natural Resources uses to review forest practice applications. These new rules and agreements, implemented through the interagency framework commonly referred to as the Timber/Fish/Wildlife (TFW) agreement, encourage interdisciplinary review of individual forest practice applications.

In spite of the best efforts of numerous state and federal agencies, and the imposition of regulatory programs some of the public deems onerous and excessive, there is a gradual loss of stream habitat. This cumulative loss is the result of routine development of natural resources and dedication of shoreline and water resources to other uses. These incremental losses have, and will, continue to result in reduced anadromous fish production in the Columbia Basin and its tributaries. Subbasin planning needs to address the problem of cumulative habitat loss if the goals of the Northwest Power Planning Act are to be achieved.

Constraints and Opportunities for Protection

Listed below are the federal, state, and local agencies and Indian tribes that have statutory or proprietary interests and mandates over elements of the physical and biological resources affecting salmon and steelhead production in this subbasin.

Federal

- U.S. Army Corps of Engineers
- U.S. Fish and Wildlife Service
- National Marine Fisheries Service
- United States Coast Guard
- United States Forest Service
- U.S. Soil Conservation Service (SCS)
- Bureau of Land Management (BLM)
- U.S. Department of Energy (Hanford Reservation)
- Federal Energy Regulatory Commission (FERC)
- Bonneville Power Administration (BPA)

Tribes

- Confederated Tribes of the Warm Springs Indian Reservations
- Confederated Tribes of the Umatilla Indian Reservation
- Yakima Indian Nation
- Nez Perce Tribe

Washington State

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

County

- Cowlitz County
- Clark County
- Skamania County

Habitat Protection Objectives and Strategies

In general, all the fisheries management agencies subscribe to some statement of "no net loss" of existing habitat as a management goal. Even though this goal is difficult to attain, it is an appropriate policy, one that subbasin planning should support and the only one that will protect the production potential of entire river systems for the long term.

Washington Habitat Management Objectives

1) No net loss of existing habitat.

2) No degradation of water quality.

3) No decrease of surface water quantity.

4) Increase security for existing habitat.

5) Increase salmonid use of under utilized habitat.

Strategies

Habitat protection is an area that does not lend itself to easily implemented strategies. As a result, there is a danger that this portion of subbasin planning may be given less attention than it should receive. The struggle to prevent cumulative loss of habitat is ultimately one of public policy.

Existing methods for implementing these kinds of guidelines generally are outside the normal activities of the Northwest Power Planning Council. The typical approach is through regulatory programs. However, this defensive approach to habitat protection has not resulted in the desired level of protection. "Stewardship of the public resources requires more than a defensive philosophy..." (Restoring the Balance, 1988 Annual Report of the California Advisory Committee on Salmon and Steelhead Trout). Being based on prescriptive ordinance, existing habitat protection programs by definition deploy defensive measures.

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

The area of cumulative habitat loss is one which the Northwest Power Planning Council must be involved in for the sake of the investments made in the Columbia River Basin Fish and Wildlife Program to date. Unless the cumulative loss of habitat can be halted, today's losses will become tomorrow's "debt to the past" and the "investment in the future" will have been ill spent.

An excellent example of getting out in front of habitat problems before they happen is the "protected areas" program accomplished through the auspices of the Northwest Power Planning Council. Inventory of indispensable habitat and recommendation packages such as this, developed in the full light of public participation, stand as strong statements of intent to protect habitat.

The Northwest Power Planning Council could support the regulatory habitat protection work of the agencies and tribes and become more involved by:

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

2) Hosting a habitat protection symposium entitled, "Are the Investments Being Protected?"

3) Purchasing riparian property adjacent to critical habitat.

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

5) Publishing additional inventories of "key" habitat for specific stocks that must receive <u>absolute</u> protection if the goals of the Act are to be realized.

6) 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 considerations focus on United States vs. Oregon negotiations 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 the Indian and the 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 that 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 the 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.

Though the agreement focuses on above-Bonneville stocks and the need to rebuild the natural components on the runs, it does not ignore the fish runs returning to tributaries below

Bonneville Dam. And in some cases, such as Washougal coho, it is intimately tied to providing upriver opportunities to tribal fisheries. Further mention is made within the discussion of each of the stocks.

Lower river production acts as a major producer for ocean fisheries in helping to provide maximum opportunity on a consistent basis. Key to this is the Pacific Salmon Treaty. Negotiated in 1985, the major principles of this treaty attempt to:

1) Prevent overfishing and provide for optimum production.

2) Provide for each party to receive benefits equivalent to the production of salmon originating in its waters.

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

More locally, the major production constraint on the Lewis River has been the blockage of the upper North Fork watershed due to Merwin Dam. Before the dam was completed, salmon and steelhead production was the result of natural spawning, with major production of coho, spring chinook, fall chinook, and steelhead. Mitigation programs have attempted to reestablish these runs, but pre-dam productivity of the Lewis River watershed is unknown. Thus agreed-upon levels of mitigation are largely subjective.

Presently, there are no passage facilities above the dam, nor is there future intent to establish passage. With the exception of fall chinook, major production efforts will continue to be hatchery oriented.

PART IV. ANADROMOUS FISH PRODUCTION PLANS

The Lewis River is managed for spring chinook, fall chinook, early-returning coho (Type S), late-returning coho (Type N), and steelhead. The following information summarizes basic information with regard to run sizes, past and current production, and biological parameters of each of the stocks.

SPRING CHINOOK SALMON

Fisheries Resource

At one time, an indigenous stock of spring chinook existed in the Lewis River, but with the construction of Merwin Dam (RM 19.5) in 1931, the majority of the spawning reaches became inaccessible and the stock subsequently declined. Early attempts to save the stock through hatchery production failed. By 1950, only a remnant population existed in the river, spawning primarily in the waters immediately below Merwin Dam and Cedar Creek. In 1971 managers used the Carson Hatchery stock, which originated from Bonneville Dam fishway. These fish were reared and released from Speelyai Hatchery. Since then, releases have been made from both the Speelyai and the Lewis River hatcheries. The stocks used now include Cowlitz and Kalama, along with on-station returns to the Lewis River.

The 1977 through 1987 average run size to the Lewis River is estimated at about 6,000 fish, with about 10 percent of the returns constituting jacks. Annual returns during this time period have ranged from about 2,300 adults in 1980 to nearly 17,000 adults in 1987.

Although the spring chinook has a low contribution rate in terms of ocean harvest, returns do provide mainstem recreational fisheries and a popular sport fishery within the Lewis River. Inriver sport catch estimates during 1977 through 1987 have ranged from about 1,250 to nearly 10,000 adults, with an average annual catch of about 3,660 adults. In addition, a significant number of jacks are also taken, averaging about 400 per year.

Natural escapement of adult fish, based on annual spawning ground counts, have averaged about 1,400 adults, ranging from just over 300 to nearly 7,000 adults. The remainder of the fish return to the hatcheries, which averages only a few hundred adults annually because of poor trapping efficiency.

Both the Lewis and the Speelyai hatcheries continue to release spring chinook as part of their annual programs. Release numbers have varied considerably, consisting of fry, fall releases and yearlings. Recent programs have focused on yearlings, with releases in the neighborhood of 1 million fish. Fish are generally released on station into the North Fork or mainstem Lewis. Some off-station releases have occurred in Speelyai, Greenfork and Little creeks, along with the East Fork Lewis River. Releases have also been made into Merwin Lake above the dam. Tagging of juveniles, according to the different release strategies, has not been undertaken. Thus release strategies have not been evaluated.

Recent year returns to the hatcheries have exhibited an average of 57 percent females, with an average of 4,000 eggs per female. Egg-to-smolt survival rate averages 76.4 percent. The majority of the fish return as 4-year-olds (64.9 percent), with 5- and 6-year-olds constituting 26.7 percent. Three-year-old fish consist of 6.7 percent of the returns while 2-year-old jacks 1.7 percent. Based on fork length measurements, fish greater than 85 cm are identified as 5-year-olds or greater. Those between 65 cm and 85 cm can be considered 4-year-old fish, however there is considerable overlap of 4- and 5-year-old fish in lengths between 80 cm and 85 cm. Fish less than 65 cm in size are regarded as 3-year-olds.

Adult immigration into fresh water occurs from May through the beginning of July. Typical of spring chinook are extended periods of holding just prior to spawning. This holding period can extend up to the middle of September with spawning taking place toward the end of August through September. Incubation occurs from September through December, followed by emergence from December into January. Under natural conditions, out-migration of juveniles generally takes place as subyearlings, leaving the river during May and June. Overwintering of juveniles in other watersheds does occur, although minimally. Levels of natural yearling outmigration on the Lewis River has not been determined, but is considered minimal because high water temperatures during late summer inflict high mortality. Since spring chinook in the Lewis are of hatchery origin, outmigration is dependent on release. The majority of releases at the two hatcheries has been of fingerlings and yearlings. Studies conducted in the early 1970s, based on coded-wire tags, indicated higher levels of returns for fingerlings as opposed to yearling releases. This information, however, is based only on a two-year program (McIsaac and Fiscus 1979).

Tables 1 through 5 provide summaries of the above information.

Table 1. Lewis River spring chinook; stock abundance and harvest information.

YEAR	Sport Catch a/ Jacks	Sport Catch a/ Adults	Natural Escapement b/ Jacks	Natural Escapement b/ Adults	Hatchery Escapement Jacks	Hatchery Escapement Adults	Total Returns Jacks	Total Returns Adults
1977	449	2787	0	459	3	337	452	3583
1978	213	3363	0	324	17	333	230	4020
1979	96	1636	0	792	0	183	96	2611
1980	337	1269	10	992	2	84	349	2345
1981	302	1985	21	324	0	713	323	3022
1982	895	2558	100	980	4	488	999	4026
1983	287	2965	69	732	1	103	357	3800
1984	233	4508	88	1565	1	451	322	6524
1985	554	3301	18	570	30	408	602	4279
1986	884	6084	180	1962	162	394	1226	8440
1987	417	9845	89	6850	74	221	580	16916
averages	424	3664	52	1414	27	338	503	5415

a/ Sport estimates = (chinook, Feb to July + 1/2 Aug)
b/ Natural spawning estimates = peak count * 3.

Table 2. Lewis River spring chinook; sex ratios and fecundity*

Return Year	Males	Females	Jacks	Total Adults	Percent Females	Eggs/ Female	Egg/smlt Survival
1979	74	109	0	183	59.6	4329	78.8
1980	57	56	0	113	49.6	3547	all killed
1981	317	390	0	707	55.2	3973	75.1
1982	180	308	4	488	63.1	4510	73.3
1983	40	63	1	103	61.2	4375	78.4
1984	201	250	1	451	55.4	3851	84.1
1985	176	232	30	408	56.9	4408	69.4
1986	147	244	161	391	62.4	3965	68.8
1987	82	139	74	221	62.9	4000	83.6
1988	177	155	215	332	46.7	3875	**
averages	145	195	49	340	57.3	4083	76.4

* Includes both Lewis River and Speelyai hatcheries
** to be released

Table 3. Lewis River spring chinook; hatchery production

Brood Year	Fingerling	Fall Release	Yearlings
Lewis River Hatchery			
1976		25,620 L	
1977		25,984 NF	
1978	25,706 L		
1979		807,408 NF	
1980			
1981		755,701 NF	
1982		850,400 NF	
1983			1,047,500 NF
1984			766,400 NF
1985			
1986			
1987			
Speelyai Hatchery			
1976		300,825 NF	56,800 a
1977	201,000 NF	306,950 b	
1978		371,870 c	
1979			
1980	811,800 L	332,560 L	
1981		261,240 e	
1982			
1983	352,200 f		
1984			280,680 L
1985			
1986			
1987			
Totals			
1976	0	326,445	56,800
1977	201,000	332,934	0
1978	25,706	371,870	0
1979	0	807,408	0
1980	811,800	332,560	0
1981	0	1,016,941	0
1982	0	850,400	0
1983	352,200	0	1,047,500
1984	0	0	1,047,080
1985			
1986			
1987			

a/ 2,400 into Speelyai Creek, the rest into NF.
b/ 16,000 into Merwin Lake, the rest into NF.
c/ 3,000 into Merwin Lake, the rest into NF.
d/ 7,500 into Merwin Lake, the rest into NF.
e/ 1,600 into Merwin Lake, the rest into NF.
f/ 305,000 into EF, 32,000 ~~into~~ Greenfork Ck.
15,000 into Little Ck.

Table 4. Lewis River spring chinook age and length data (1980-1987)*.

AGE FW.OCEAN	% of Total	Mean Fk Length	Sample Size
1.1	1.70	NA	548
1.2	6.71	NA	3502
1.3	64.89	NA	33832
1.4+5	26.70	NA	12933

* Includes information from sport catch, hatchery returns and escapement.

Table 5. Lewis River spring chinook, freshwater life history.

	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB
ADULT IMMIGRATION			------	------								
ADULT HOLDING				------	------	------	------					
SPAWNING							------					
EGG/ALEVIN INCUBATION							------	------	------	------		
EMERGENCE										------		
REARING	------	------	------	------	------	------	------	------	------	------	------	------
JUVENILE EMIGRATION		------	------									

Specific Considerations

Spring chinook are addressed in United States vs. Oregon, but focus is on above-Bonneville stocks in determining escapement goals. With regard to harvest sharing and rebuilding, the primary concern is ocean catches and the need to maintain minimal harvest in marine waters. To remain consistent with United States vs. Oregon, any increases in spring chinook production should result in fishery opportunities primarily directed toward Lewis River harvest.

As evident from the sport catch data, spring chinook provide a popular recreational fishery, especially within the Lewis River. Spring chinook are an excellent quality fish, catchable in fresh water. Because of the entry pattern during April, May and June, they offer extended fisheries.

Because of the demise of the indigenous population due to Merwin Dam, Lewis River spring chinook are managed on a hatchery basis, and any objective will, most likely, incorporate forms of hatchery strategies for maintenance and improvement of the run. According to the Merwin Dam mitigation agreement, Pacific Power and Light will be responsible for spring chinook production at the level of achieving annual run sizes of 12,800 adults. Using a five-year moving average smolt-to-adult survival rate of 5.1 percent, this translates into an annual production level of 250,000 yearlings. Yearling releases from the 1989 brood stock will be tagged to better evaluate the smolt-to-adult survival rates. Hatchery production will be modified accordingly.

Lewis River Hatchery spring chinook have experienced disease problems. In 1986 brood juveniles were found to have infectious hematopoietic necrosis (IHN) at the Lewis River Hatchery, although no loss was reported. This could, however, have serious consequences on future programs. Adult spring chinook require injections of Terramycin to control bacterial kidney disease (BKD). Formalin treatments are also needed to control fungus until spawning.

At the Lewis River Hatchery, water quality has also been a problem, which is reflected in high water temperatures. The three lakes above Merwin Dam are heated during the summer months. The subsequent release of this water over the course of the year shifts the temperature profile to a later time-frame than normal. The result is warmer water during the fall months and potential pathogen load during times of adult holding and incubation. In addition, waters supersaturated with nitrogen have also been documented. Other Lewis River Hatchery problems are as follows.

A) Less than optimum flows occur in the delivery line, which runs from the lower pump intake to Davis Creek pond.

B) Spring chinook production is constrained by space and water availability.

C) There is poor adult attraction to the adult pond.

Objectives

Biological Objectives

1. Manage spring chinook on a hatchery stock basis.

2. Achieve minimum total annual release of 2 million spring chinook, with 1 million as yearlings and 1 million to fingerlings size for transfer to acclimation sites.

Utilization Objective

Achieve a terminal harvest potential of 15,000 adults. This would require annual run sizes of about 68,000 fish. Mitigation requirement will remain at the production level of 12,800 adults. The difference, or 55,600 fish, will be the result of production beyond mitigation requirements.

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.

Estimated costs of the alternative strategies below are summarized in Table 6a.

STRATEGY 1: Natural Stock Enhancement

There are no natural enhancement actions, since this stock is managed strictly on a hatchery management basis.

STRATEGY 2: Supplementation

There are no natural enhancement actions, since this stock is managed strictly on a hatchery management basis.

STRATEGY 3: Artificial Propagation

This strategy consists of hatchery improvements and establishing acclimation sites for the rearing of fingerling chinook. It also includes Action 4, which was not modeled. Results of the following actions is dependent upon a number of items including disease control and maintaining ocean harvest at current levels.

ACTIONS: 1-4

1. Construct additional rearing ponds at the Lewis River Hatchery to double present capacity of 1 million to 2 million fish.

2. Improve attraction of adult spring chinook into hatchery by extending the entry ladder. Current operations require dredging a shallow bar. Use of a morphorline drip, which has been done for one year, may also help with adult attraction.

3. Develop acclimation sites (ponds and/or net pens) for rearing fingerling spring chinook. This action may also provide better distribution of adult fish throughout the watershed. Suggestions for acclimation sites include ponds within the East Fork Lewis River and Cedar Creek, and net pens within Merwin Lake. Past

practices have included release of fingerlings into Merwin Lake.

4. Construct boat launch between Lewisville Park and Heisson Bridge to give better access into the East Fork Lewis River.

Recommended Strategy

The recommended strategy is the only one identified, which is Strategy 3.

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

Utilization Objective:
Achieve a terminal harvest potential of 15,000 adults. This would require annual run sizes of about 68,000 fish. Mitigation requirement will remain at the production level of 12,800 adults. The difference, or 55,600 fish, will be the result of production beyond mitigation requirements.

Biological Objective:
1. Manage on a hatchery basis. 2. Achieve minimum total annual release of 2 million spring chinook, with 1 million as yearlings and 1 million to fingerlings size for transfer to acclimation sites.

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	4,585 -C	1,611	6,281	6,277	0(1.00)
All Nat	4,585 -C	1,611	6,281	6,277	0(1.00)
1	4,585 -C	1,611	6,281	6,277	0(1.00)
2	4,585 -C	1,611	6,281	6,277	0(1.00)
3*	12,346 -C	3,308	15,828	15,818	19,088(2.52)

*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. Natural stock enhancement. Pre Mainstem Implementation.
2. Supplementation. Pre Mainstem Implementation.
3. Artificial Production. Pre 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 6a. Estimated costs of alternative strategies for Lewis River 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	3*
Hatchery Costs			
Capital[1]	0	0	230,000
O&M/yr[2]	0	0	25,000
Other Costs			
Capital[3]	0	0	2,475,000
O&M/yr[4]	0	0	30,000
Total Costs			
Capital	0	0	2,705,000
O&M/yr	0	0	55,000

* 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.

FALL CHINOOK SALMON

Fisheries Resource

As defined by harvest management units, there are four defined stocks of fall chinook that return to the Columbia River. These include the lower river hatchery (LRH), lower river wild (LRW), Bonneville Pool Hatchery (BPH) and the upriver brights (URB). The North Lewis wild fall chinook represent about 80 percent to 85 percent of the wild fall chinook returning to the lower Columbia River (Norman 1987). LRW fish also return to the East Fork Lewis. In addition, LRW fish are also found in the Cowlitz and Sandy rivers.

Hatchery production of fall chinook has been inconsistent in terms of numbers and types of releases. Some release groups were for experimental rather than production purposes. After brood year 1985, no hatchery production has taken place. Current production is entirely natural.

Total returns to the subbasin during 1977 through 1987 have averaged about 14,700 fish, with 19 percent constituting jacks, based on harvest information. Total adult return has ranged from 6,500 to 21,000 fish. There are no apparent trends in the return pattern. Sport catch within the subbasin, based on punch-card information, normally harvests about 15 percent of the total returns. Catch has ranged from a low of about a 1,000 fish in 1979 to a high of about 3,000 fish in 1981 and 1985. Jacks comprise approximately 50 percent of the harvest. Average annual catch is around 2,000 fish, including both jacks and adults.

Natural spawning over the last 10 years has ranged from about 5,300 to 19,000 adults. Escapement estimates are based on peak fish counts, which are used as an index to estimate total spawners. The majority of the spawning takes place within the 4-mile stretch between the Lewis River Hatchery and Merwin Dam, in addition to Cedar Creek. Surveys are also conducted in the East Fork Lewis River within the 4.2-mile stretch from the area of Lewisville Park to Daybreak Park.

The entry pattern of lower river wild fall chinook into the Lewis River exhibits a broad time period, normally beginning early to mid-August and peaking in September and October. Based on coded-wire tag recoveries, wild fall chinook have been recorded in the North Fork Lewis River as early as July. At the other extreme, live adults and fresh redds have been observed in the North Fork as late as April 19 (1985). Peak spawning in the North Fork generally occurs about mid-November. In the East Fork, two distinct spawning segments are evident. The early segment spawns in October while the late segment spawns November through January. Emergence generally occurs in April, however, it has been observed as early as March 23 and as late as August 22. Coded-wire tag recoveries in the Columbia River estuary in August indicates extended rearing in fresh water. Most juveniles leave the river mid to late summer. Freshwater overwintering of some juveniles does occur, with outmigration occurring the following spring.

Smolt-to-adult survival rate, measured in terms of total catch plus escapement, was estimated to be 1.7 percent, based on 14 tag groups originating from the 1977 through 1979 brood years (McIsaac, pers. commun.)

Age composition, based on a combination of scale readings and coded-wire tag analysis, indicates that most lower river wild fall chinook return as 4-year-old fish (48 percent). Three-year-old fish constitute about 19 percent of the total return, 5-year-olds constitute about 18 percent, and 6-year-olds, only a trace. Jacks, which are 2-year-olds, average about 19 percent of the population. Lengths overlap significantly for 3-, 4- and 5-year-olds. Adult fish are similar in size to upriver brights, but tend to be smaller than the two hatchery stocks (BPH and LRH).

With regard to sex ratios, 3-year-olds are predominantly males, while 4- and 5-year-olds are mostly females. Based on past hatchery returns, 57 percent of all adult fish were females. Eggs per female average about 4,400.

Tables 7 through 11 provide annual summaries of the above information.

Specific Considerations

Lewis River fall chinook are managed strictly on a natural stock basis. However, formalized spawning escapement goals have not been established. Harvest restrictions within the lower Columbia are based on weak stock management for the four major stocks. The lower river wild stock has never been the constraining stock. In fact, the average annual escapement of about 12,000 adults is believed to be higher than what would be considered a MSY escapement goal. It has been suggested that MSY escapement would fall within the range of 3,000 to 8,000 adults (McIsaac, pers. commun.).

The pre-season forecast has been used as the predictor for run size estimates. This has proved to be fairly reliable. There is no inseason assessment of fall chinook.

Table 7. Lewis River fall chinook; stock abundance information.*

YEAR	Sport Catch Jacks	Sport Catch Adults	Natural Escapement Jacks	Natural Escapement Adults	Hatchery Escapement Jacks	Hatchery Escapement Adults	Total Returns Jacks	Total Returns Adults
1977	863	668	849	6930	0	86	1712	7684
1978	924	918	766	5363	140	225	1830	6506
1979	495	473	931	8023	295	273	1721	8769
1980	219	1362	963	13882	46	647	1228	15891
1981	2305	1001	1979	19297	113	633	4397	20931
1982	774	1771	837	8370	178	205	1789	10346
1983	2021	964	1216	13540	151	446	3388	14950
1984	535	1008	947	7132	219	135	1701	8275
1985 **	1450	756	1984	7491	363	434	3797	8681
1986	733	1526	2578	11983	99	122	3410	13631
1987	1736	1239	4145	12935	399	613	6280	14787
averages	1096	1062	1563	10450	182	347	2841	11859

* Information presented includes all stocks, including Lower River Hatchery, Lower River Wild, and Kalama egg bank. Final brood release of KEB occurred in 1982.

** The 1985 brood was the last brood of fall chinook released from the Lewis River hatcheries. The Lewis River is presently managed on a natural stock basis.

Table 8. Lewis River fall chinook, sex ratios and fecundity.*

RETURN YEAR	Males	Females	Jacks	Total Adults	Percent Females	Eggs/ Female	Egg/smlt Survival
1979	121	152	295	273	0.56	4862	68.6
1980	306	346	46	652	0.53	4790	78.3
1981	183	450	113	633	0.71	4956	67.2
1982	61	144	178	205	0.70	4659	57.2
1983	238	196	151	434	0.45	4500	69.3
1984	57	78	218	135	0.58	3269	64.4
1985	237	199	364	436	0.46	3970	90.3
1986	No adults	spawned					
1987	No adults	spawned					
1988	No adults	spawned					
averages 1979-1985	172	224	195	395	0.57	4429	70.8

* Information based on hatchery returns.

Table 9. Lewis River fall chinook; hatchery releases.

Brood Year	Lewis River Fry	Lewis River Fall Release	Speelyai Fry	Speelyai Fall Release	Totals Fry	Totals Fall Rele
1976	49,157		25,625		74,782	0
1977	145,388		66,024	51,800	211,412	51,800
1978	60,912	52,080	473,803		534,715	52,080
1979	501,598				501,598	0
1980	446,775				446,775	0
1981	80,500 a		1,166,350 a,c		1,246,850	0
1982	117,400 b				117,400	0
1983		287,000			0	287,000
1984		164,400			0	164,400
1985 d		346,300	356,640 a		356,640	346,300

a/ Releases made into Merwin Lake.
b/ 55,900 released into Merwin Lake.
c/ 1,085,850 released as unfed fry.
d/ No releases were made after the 1985 brood.

Table 10. Lewis River fall chinook stock size and age composition from hatchery samples

AGE FW.OCEAN	% of Total	Mean Fk Length	Sample Size
Hatchery			
1.1	29.2	NA	864
1.2	26.5	NA	785
1.3	39.8	NA	1179
1.4	4.6	NA	135
Natural			
1.1	14.7	NA	?
1.2	19.6	NA	?
1.3	47.8	NA	?
1.4	17.9	NA	?
1.5	0.3	NA	?

Table 11. Lewis River fall chinook; freshwater life history.

```
                    MAR       APR       MAY       JUNE      JULY      AUG       SEPT      OCT       NOV       DEC       JAN       FEB

ADULT
  IMMIGRATION                                                   - - - - - - - - ---------------- - - - - - - - - - - -

ADULT
  HOLDING                                                        - - - - - - - - - ------------------------- - - - - - - -

SPAWNING                                                                                       ----------------- - - - - - - -

EGG/ALEVIN
  INCUBATION        -----------                                                                          -------------------------------

EMERGENCE                 ---------------- - - - - - -

REARING                                 ------------------------------

JUVENILE
  EMIGRATION                                                ------------------------
```

Under the Merwin Dam Relicensing Agreement (September 1983), the intent is focused on the need to maintain Lewis River fall chinook as a natural spawning stock. Thus no hatchery production was proposed. Instead, mitigation takes the form of enhanced water flows during the incubation and rearing stages. Prior to this, water discharges out of Merwin Dam were erratic, governed by overflow and refill periods of the reservoir. This resulted in the stranding of redds and juvenile fish along with the reduction of rearing potential within the river.

Objectives

Biological Objectives

1. Maintain management on a natural stock basis.

2. Provide terminal run sizes with a minimum of 12,000 adults

Utilization Objective

Maintain current harvest opportunities (2,000 fish) within the terminal area. No new production is scheduled.

Alternative Strategies

Modeling results for each strategy are presented in Table 12 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 12. 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.

STRATEGY 1: Natural Stock Enhancement

This strategy is composed strictly of natural stock enhancement actions that emphasize enhanced flows, habitat protection, and revegetation programs. Successful maintenance of this stock lies in the assumption that there will be no further habitat degradation. Loss of riparian habitat is detrimental for all stocks, especially naturally spawning stocks like Lewis River fall chinook.

Planners estimate costs to be approximately $1.3 million in capital with no operation and maintenance costs over 50 years.

ACTIONS: 1, 2

1. Since increased production of Lewis River fall chinook is not being scheduled, emphasis is directed on maintaining and improving habitat. This includes the following list of actions.

   A) Provide enhanced flows during spawning, incubation and rearing stages. Under the Merwin relicensing agreement, Pacific Power and Light, in concert with the fish management agencies, is developing appropriate flows.

   B) Control development so that it does not impact fall chinook habitat. One area of concern is a privately owned island on the North Fork, located about four miles below the Lewis River Hatchery. There is speculation that this island could be sold to development interests. The waters within the region are critical areas for juvenile rearing and must be protected. Washington Department of Wildlife is considering purchasing the property, but it is questionable whether this will happen. Purchase of the land for non-developmental uses would assure continued habitat protection and possibly provide additional recreational opportunities.

   C) Revegetate areas such as the pastured areas East Fork and lower North Fork.

   D) Impose regulatory actions regarding boat traffic and speed of travel to reduce bank erosion.

2. Program hatcheries to minimize species interaction that may be detrimental to the wild fall chinook population. This would include the following preventive actions.

   A) Release no fingerling spring chinook prior to September 25 of each year.

   B) Do not allow fingerling fall chinook hatchery releases.

Recommended Strategy

The recommended strategy is the only one identified, which is Strategy 1, natural enhancement. The strategy adheres to the objective of maintaining fall chinook as a natural stock and maintaining harvest levels at about 12,000 adults. As the model shows, improvement of the smolt capacity will increase adults returns to the subbasin. In light of this, habitat protection is the single most important aspect of providing harvest opportunities on Lewis River fall chinook.

Table 12. System Planning Model results for fall chinook in the Lewis Subbasin. Baseline value is for pre-mainstem implementation, all other values are post-implementation.

Utilization Objective:
Maintain current harvest opportunities within the terminal area. No new production is scheduled.

Biological Objective:
1. Maintain management on a natural stock basis. 2. Provide terminal run sizes with a minimum of 12,000 adults.

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	0 -C	18,674	19,656	183,463	0(1.00)
All Nat	0 -C	39,137	41,197	384,510	222,587(2.10)
1*	0 -C	29,353	30,898	288,384	116,162(1.57)

*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. Natural stock enhancement. Pre 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.

COHO SALMON

Fisheries Resource

The Lewis River historically has had excellent runs of coho salmon. Before the construction of Merwin Dam in 1931, coho spawned in the headwater tributaries Pine Creek (RM 59) and those of the Muddy River (RM 60), including Clearwater and Clear creeks. Despite the blockage of the river by the dam, coho continued to return in good numbers, in part due to the successful hatchery program started in 1930. In 1949, Bryant described the Lewis River as one of the most important producers of coho in the Columbia Basin. In 1951, the Washington Department of Fisheries estimated coho escapement to the river to be about 15,000 fish, with 10,000 entering the North Fork and 5,000 entering the East Fork. After Merwin Dam was built, but before Yale Dam was constructed, coho returning to the North Fork were trapped immediately below the dam and released into the reservoir to utilize upstream habitat.

In terms of harvest management, coho returning to the Columbia River are managed for two major stocks. The early-run fish are referred to as the south-turning or S-type because they contribute well to the more southern ocean fisheries. The later coho are referred to as north-turning or N-type since they contribute more heavily to the northern ocean fisheries. Coho returning to Lewis River include both the north and south types.

Both types are managed on a hatchery stock basis. Adult straying does exist, but the number and success of natural spawning has not been assessed. Escapement to the subbasin is dependent on a number of factors, some of which include estuary and ocean survival, ocean interceptions and pre-terminal harvests within the Columbia River. Lewis River coho are not managed to achieve specific inriver escapements. Instead, fisheries attempt to achieve overall goals for the Columbia River, consistent with United States vs. Oregon and the Pacific Salmon Treaty.

Data recorded prior to 1982 does not separate the two types of coho. For that reason, discussion will be limited to information since 1982. Background information for S-type and N-type fish will be treated separately, but because of closely related management ties, objectives and strategies will be treated collectively.

Type-S Coho

Escapement estimates to the Lewis River are based solely on returns to the hatchery. Natural spawning and sport catch estimates are unavailable. From 1982 through 1986, hatchery returns have ranged from about 1,000 to 12,000 adults, with an average of around 5,000 fish. In addition, returns include a significant number of jacks, averaging about 1,700 annually.

Females comprise about 39 percent of the adult return. This small female composition level is a problem at many Columbia River hatcheries. Eggs per female averages about 2,500. Egg-to-smolt survival rate has averaged about 70 percent.

Both the Speelyai and the Lewis River hatcheries rear coho. Yearlings usually constitute the majority of the production, with about 1 million released annually. Fingerling production is less consistent, primarily dependent upon surpluses that cannot be reared to yearling size because of pond constraints. Yearlings are generally released into the North Fork or mainstem Lewis River. Fingerlings are normally released into tributaries for off-station rearing. Some fingerlings are taken above Merwin for release into the lake.

Freshwater immigration for early coho occurs from the beginning of September through the middle of October, with spawning taking place from mid-October into mid-November. The young emerge about three months later, after the incubation and intergravel development. Rearing usually occurs for at least a year with juvenile emigration occurring from late April through the beginning of June of the subsequent year.

Tables 13 through 17 provide further information regarding early coho.

Type-N Coho

Escapement estimates to the Lewis River are based solely on returns to the hatchery. Natural spawning and sport catch estimates are unavailable. From 1982 through 1986, hatchery returns have ranged from about 9,000 to 48,000 adults, with an average of around 18,000 fish. In addition, returns include a significant number of jacks, averaging about 17,000 fish annually.

Females comprise about 27 percent of the adult return, averaging about 2,700 eggs per female. Egg-to-smolt survival rate has averaged about 85 percent.

Table 13. Lewis River coho (Type-S) stock abundance and harvest information combined hatchery returns.*

YEAR	Hatchery Escapement Jacks	Hatchery Escapement Adults	% adults
1977 **	1105	1409	
1978 **	5698	2365	
1979 **	188	3095	
1980 **	385	7424	
1981 **	3532	4669	
1982	1028	12709	92.5
1983	6895	4365	38.8
1984	107	5324	98.0
1985	650	1016	61.0
1986	95	2914	96.8
1982-86 averages	1755	5266	77.4

* Specific sport catch data and natural spawning data is unavailable.

** Late and early coho not separated prior to 1982.

Table 14. Lewis River hatchery releases; coho (Type-s).

Brood Year	Fry	Fingerling	Yearling
Lewis River Hatchery			
1975			1,143,965 NF
1976		92,187 NF	1,018,507 NF
1977		43,584 NF	1,002,769 NF
1978		413,011 b	920,375 LR
1979		2,247,229 LR	3,648,248 NF
1980		508,060 e	498,810 NF
1981	7,447,570 LR		
1982			1,127,623 LR
1983			678,500 NF
1984		550,800 i	1,232,100 LR
1985			
1986			
Speelyai Hatchery			
1975			
1976		120,750 a	c
1977			6,233,300
1978		429,381 d	LR,f
1979			344,000 LR
1980	2,395,350 g		883,536 LR,h
1981	336,000 ML		1,118,720
1982		154,000 ML	
1983			
1984		1,437,500 j	
1985		419,600 k	

a) 108,250 into Cedar Ck., 12,500 into Merwin Lake
b) 80,300 into Lockwood, 118,800 into Mason Ck., 44,000 into Riley Ck. 169,911 into Lewis River
c) 7,500 into Merwin Lake
d) 85,500 into Rock Ck., 172,197 into Greenfork Ck. 86,184 into Copper Ck., 85,500 into Speelyai
e) 152,950 into Lockwood Ck., 152,950 into Mason Ck., 202,160 into Riley Ck.
f) 4,800 into Merwin Lake.
g) 690,900 into Cedar Ck., 124,950 into Chelatchee Ck., 1,099,500 into East Fork 330,000 into Rock Ck., 150,000 into Merwin Lake.
h) 10,000 into Merwin Lake.
i) 510,000 into Merwin Lake, 16,2000 into Houghton Ck., 243000 into Ross Ck.
j) 280,500 into East Fork, 23,000 into Little Ck., 23,100 into Slide Ck., 77,000 into Pup Ck., 38,500 into John Ck., 168,400 into Cedar Ck., 534,600 into Merwin Lake.
k) 88,200 into Cedar Ck., 104,800 into Rock Ck., 12,200 into Houghton Ck., 24,000 into Ross Ck., 5,600 into Robinson Ck., 12,900 into Unnamed (9050) 14,700 into Dean Ck., 6,300 into McCormick Ck., 150,900 into Speelyai

Table 15. Lewis River hatchery releases (totals for coho type-s).

Brood Year	TOTAL RELEASES Fry	Fingerling	Yearling
1975	0	0	1,143,965 NF
1976	0	212,937	1,018,507 NF
1977	0	43,584	7,236,069 NF
1978	0	842,392	920,375 LR
1979	0	2,247,229	3,992,248 NF
1980	2,395,350	508,060	1,382,346 NF
1981	7,783,570	0	1,118,720
1982	0	154,000	1,127,623 LR
1983	0	0	678,500 NF
1984	0	1,988,300	1,232,100 LR
1985	0	419,600	0
1986			

Table 16. Lewis River coho (Type-s), sex ratios and fecundity.

RETURN YEAR	Males	Females	Jacks	Total Adults	Percent Females	Eggs/ Female	Egg/smlt Survival
1979	1498	1597	188	3095	0.52	3017	76.1
1980	3607	2805	385	6412	0.44	2136	63.7
1981	2765	1904	3532	4669	0.41	2728	81.9
1982	6540	6169	1028	12709	0.49	2817	80.1
1983	3015	1350	6895	4365	0.31	2042	32.4
1984	3483	1841	107	5324	0.35	2428	86.2
1985	677	339	650	1016	0.33	2787	77.1
1986	1762	1152	95	2914	0.40	2323	61.2
1987	2575	813	6954	3388	0.24	2253	*
1988	3059	1938	464	4997	0.39	3044	*
Averages	2898	1991	2030	4889	0.39	2558	69.8

Table 17. Lewis River coho (Type-S), freshwater life history.

	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB
ADULT IMMIGRATION							---	---	---			
ADULT HOLDING							---	---	---			
SPAWNING									---	---		
EGG/ALEVIN INCUBATION									---	---	---	---
EMERGENCE											---	---
REARING	---	---	---	---	---	---	---	---	---	---	---	---
JUVENILE EMIGRATION		---	---									

Both the Speelyai and the Lewis River hatcheries rear Type-N coho. Yearlings usually constitute the majority of the production, with about 4.4 million released annually. Fingerling production is less consistent, primarily dependent upon surpluses that cannot be reared to yearling size because of pond constraints. Yearlings are generally released into the North Fork or mainstem Lewis River. Fingerlings are either released on station or into tributaries for off-station rearing. Some fingerlings are taken above Merwin for release into the lake.

Freshwater immigration for late coho occurs from the middle of October through December, about six weeks after the early coho. Spawning takes place from late November through December. Incubation lasts three to four months, with emergence occurring March through April. Juvenile coho normally are reared to yearling size. Those that are off-station planted as fingerlings generally remain in the tributaries until the subsequent spring. Yearlings move out of the watershed sometime during April to June.

Tables 18 through 21 provide further information regarding some biological parameters.

Specific Considerations

Coho programs for the Lewis River and most other subbasins below Bonneville are focused on an overall objective of providing for ocean fisheries. Although the non-Indian ocean, non-Indian lower river and the Indian harvest of coho are not subject to formal allocations, attempts are being made to satisfy treaty Indian needs (see the Washougal River Plan).

For the Lewis River the major objective will continue to maximize production from the subbasin through major hatchery programs. In addition, there should be attempts to best utilize potential natural production.

The Merwin Dam agreement calls for mitigation of coho as well as other anadromous species. Pacific Power and Light is responsible for operating expenses of the Lewis River Hatchery and the Speelyai facility, on the order of producing a total run size of 71,000 adults, combined early and late coho. Based on the Oregon Production Index, using a five-year moving average, smolt-to-adult survival rate is currently established at 3.7 percent. This translates into annual releases of 2.1 million yearlings. Coded-wire tagging of the 1990 releases will update this survival rate.

Table 18. Lewis River coho (Type-N), stock abundance and harvest information; combined hatchery returns.*

YEAR		Hatchery Escapement Jacks	Hatchery Escapement Adults	% adults
1982 **		9019	10803	54.5
1983		58788	13410	18.6
1984		1983	9712	83.0
1985		14207	9236	39.4
1986		1313	48001	97.3
	averages	17062	18232	58.6

* Specific sport catch and natural spawning data is unavailable

** Late and early coho were not separated prior to 1982.

Table 19. Lewis River hatchery production, coho (Type-N).

Brood Year	LEWIS RIVER HATCHERY Fingerling	LEWIS RIVER HATCHERY Yearlings	SPEELYAI HATCHERY Fingerling	SPEELYAI HATCHERY Yearlings	COMBINED TOTALS Fingerlings	COMBINED TOTALS Yearlings
1975			203,000 NF	1,185,000 NF,a	203,000	1,185,000
1976				1,235,250 NF,b	0	1,235,250
1977				883,482 NF,c	0	883,482
1978		1,152,543 LR			0	1,152,543
1979		2,811,262 NF	400,000 LR,d	520,200 LR,e	400,000	3,331,462
1980		3,469,360 NF			0	3,469,360
1981		2,767,410 NF			0	2,767,410
1982		3,266,000 NF,f			0	3,266,000
1983		4,664,100 NF	150,300 g		150,300	4,664,100
1984	739,016 h	4,403,900 NF			739,016	4,403,900
1985	1,464,100 j			8,405 i	1,464,100	8,405

a) 55,380 into Speelyai.
b) 7,750 into Merwin Lake.
c) 7,500 into Merwin Lake.
d) 69,520 into Merwin Lake.
e) 9,000 into Merwin Lake.
f) 100,700 into Merwin Lake.
g) all into Merwin Lake.
h) 233,400 into Rock Ck., 203,000 into NK, 74,100 into Yacolt Ck., 100,416 into Chelatchee Ck., 36,300 into Weaver Ck., 44,500 into Lockwood Ck., 34,700 into Mason Ck., 12,000 into Riley Ck., 23,200 into Jenny Ck., 33,200 into Greenfork Ck., 49,900 into Copper Ck.
i) Merwin Lake
j) 101,500 into Rock Ck., 236,400 into Cedar Ck., 152,800 into Mason Ck., 220,000 into East Fork, 104,500 into Chelatchee Ck., 88,200 into Yacolt Ck., 59,700 into Canyon Ck., 21,8000 into Mill Ck., 75,400 into Pup Ck., 71,400 into Weaver Ck., 14,000 into Riley Ck., 24,000 into Jenny Ck.,S72 60,000 into Copper Ck., 30,000 into John Ck., 71,400 into Johnson Ck.

Table 20. Lewis River coho (Type-N) sex ratios and fecundity, Lewis and Speelyai hatcheries.

RETURN YEAR	Males	Females	Jacks	Total Adults	Percent Females	Eggs/ Female	Egg/smlt Survival
1979	No Adult Returns						
1980	No Adult Returns						
1981	No Adult Returns						
1982	8684	2119	9019	10803	0.20	2971	87.5
1983	9067	4343	5878	13410	0.32	2258	84.2
1984	6678	3034	1983	9712	0.31	2608	69.2
1985	7000	2236	13623	9236	0.24	3105	96.2
1986	37369	10632	1313	48001	0.22	2844	88.2
1987	5815	3221	17053	9036	0.36	2968	*
1988	21619	6146	13634	27765	0.22	2685	*
Averages 1982-1988	13747	4533	8929	18280	0.27	2777	85.1

Table 21. Lewis River coho (Type-N), freshwater life history.

	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB
ADULT IMMIGRATION								----	----	----		
ADULT HOLDING								--	----	----		
SPAWNING									--	----		
EGG/ALEVIN INCUBATION	----	--							--	----	----	----
EMERGENCE	----	----										
REARING	----	----	----	----	----	----	----	----	----	----	----	----
JUVENILE EMIGRATION		--	----	--								

Objectives

Biological Objectives

1. Maintain management on a hatchery stock basis.

2. Maintain current balance of early and late coho.

3. Achieve an annual hatchery escapement for Type-S coho of 2,250 adults. Achieve an annual hatchery escapement for Type-N coho of 4,250 adults.

4. Utilize habitat for natural production.

Utilization Objectives

Since the Lewis River and Speelyai hatcheries are part of an overall objective to provide harvest opportunities in the ocean and pre-terminal regional, the majority of production will be to enhance these fisheries. However, increases in coho production should also provide increases in terminal fisheries opportunities. Current production goals are 1 million early coho yearlings and 4 million late coho yearlings, which result in a combined total estimated adult run size of about 169,000 fish. (Mitigation requirements according to the Merwin Dam agreement call for release of the combined total of 2.1 million yearlings to achieve an annual run size of 71,000 fish. This production will be part of the overall goal.)

Objective for off-station plants of fingerlings will be 1 million of each type for a total of 2 million fish.

Alternative Strategies

Modeling results for each strategy are presented in Tables 22a and 22b 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 Tables 22a and 22b. 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 22c.

STRATEGY 1: Natural Stock Enhancement

This strategy consists of fencing and revegetation projects along with the siting of overwintering ponds. As with all strategies, the System Planning Model was used in attempt to identify benefits, in terms of increases in production.

ACTIONS: 4, 5

4. Improve habitat through fencing and revegetation projects on Cedar Creek on the North Fork and Mason and Rock creeks on the East Fork.

5. Overwintering ponds are in the process of construction in the East Fork, Breezy Creek and Cedar Creek. Other potential sites should be considered, such as on Mason Creek and other tributaries.

STRATEGY 2: Supplementation

A supplementation program would involve off-station planting of fry and fingerling. This program has been conducted on an annual basis, thus benefits, as described through the System Planning Model, may not be readily apparent. Nevertheless, this program is important and should continue, with the goal of maximizing natural production opportunities.

ACTIONS: 6

6. Provide fry and fingerling supplementation programs that maximize natural production throughout the Lewis River Basin.

STRATEGY 3: Artificial Propagation

This strategy involves certain improvements in the Lewis River Hatchery, most notably, expansion of rearing ponds.

ACTIONS: 1-6

1. Expand the number of available ponds at the Lewis Hatchery to eliminate high loadings of juveniles and to assure quality coho production at levels indicated above. This would also alleviate problems with cold water disease. (Additional pond space would be integrated with spring chinook needs.)

2. Devise a better method to separate steelhead and coho at trap. This may become more of a problem with the addition of new steelhead production via the Ariel Hatchery, yet to be constructed.

3. Acquire additional tanker trucks to transport fingerlings for off-station plants.

4. -
5. -
6. -

Recommended Strategy

Strategy 3 is the recommended strategy, which includes all of the actions with particular emphasis on hatchery improvements. Through the System Planning Model analysis, implementation of this strategy should provide increases for ocean harvest as well as additional returns to the subbasin so that harvest opportunities and escapement goals are met. For early coho, this means an increase of about 5,000 adults, of which an estimated 1,400 would be additional subbasin returns. For late coho, it is projected that there would be an increase of about 50,000 adults, with 15,000 additional fish returning to the subbasin if this strategy is implemented.

Table 22a. System Planning Model results for early run coho in the Lewis Subbasin. Baseline value is for pre-mainstem implementation, all other values are post-implementation.

Utilization Objective:
(See text)

Biological Objective:
1. Maintain management on a hatchery stock basis. 2. Maintain current balance of early and late type coho. 3. Achieve an annual hatchery escapement for Type-S coho of 2,250 adults. Achieve an annual hatchery escapement for Type-N coho of 4,250 adults. 4. Utilize habitat for natural production.

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	153 -N	7,110	7,637	23,372	0(1.00)
All Nat	79 -N	7,383	7,850	24,021	862(1.03)
1	79 -N	7,383	7,850	24,021	862(1.03)
2	79 -N	7,383	7,850	24,021	862(1.03)
3*	362 -N	8,255	9,051	27,700	5,742(1.19)

*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. Natural stock enhancement. Pre Mainstem Implementation.
2. Supplementation. Pre Mainstem Implementation.
3. Artificial Production. Pre 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 22b. System Planning Model results for late run coho in the Lewis Subbasin. Baseline value is for pre-mainstem implementation, all other values are post-implementation.

Utilization Objective:
(See text)

Biological Objective:
1. Maintain management on a hatchery stock basis. 2. Maintain current balance of early and late type coho. 3. Achieve an annual hatchery escapement for Type-S coho of 2,250 adults. Achieve an annual hatchery escapement for Type-N coho of 4,250 adults. 4. Utilize habitat for natural production.

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	424 -N	39,842	42,363	106,172	0(1.00)
All Nat	429 -N	40,348	42,900	107,520	1,884(1.01)
1	429 -N	40,348	42,900	107,520	1,884(1.01)
2	430 -N	40,407	42,963	107,676	2,104(1.01)
3*	27,231 -C	24,855	53,394	133,819	38,677(1.26)

*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. Natural stock enhancement. Pre Mainstem Implementation.
2. Supplementation. Pre Mainstem Implementation.
3. Artificial Production. Pre 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 22c. Estimated costs of

Table 22c. Estimated costs of alternative strategies for Lewis River coho. 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	0	0
O&M/yr[2]	0	0	0
Other Costs			
Capital[3]	1,300,000	0	1,800,000
O&M/yr[4]	5,000	0	5,000
Total Costs			
Capital	1,300,000	0	1,800,000
O&M/yr	5,000	0	5,000

* 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.

CHUM SALMON

Earlier this century, chum salmon commonly returned to the Lewis River. A hatchery on Johnson Creek (tributary to Lewis River at RM 12) collected chum and eggs from 1909 to 1917. When the Lewis River Hatchery went into operation in 1930, chum salmon were produced up until 1940. Since then, there has been no further attempt to supplement chum salmon.

In 1951, the Washington Department of Fisheries estimated the chum escapement to be about 3,000 fish. The run has since declined, and, today, chum to the Lewis River is considered a rarity. It has been suggested that intensive hatchery production of chinook, coho and steelhead, and the resultant predation of these fish on chum fry, is a major reason for this decline (Stockley 1979). Other contributing factors would include habitat alteration and destruction. It should also be noted that the Columbia River is the extreme southerly range of the chum salmon.

At this time, no objectives for chum salmon are identified for the Lewis River. There are, however, strategies developed for lower Columbia River chum salmon that focus on development of a brood stock via the Abernathy National Fish Hatchery. The Lewis River may become a recipient of future production.

Very little age data for wild fish is available. Howell et al. (1985) presumed that wild summer steelhead migrating to the Lewis River would follow much the same pattern as Kalama River summer stocks, which enter the river from April through December, but peak in July. The normal catch pattern generally occurs in the spring and early summer, followed by a slack period during July and August, with fish appearing again from the middle of September through the fall months. Spawning occurs from January through May, but peaks from mid-January to mid-March. Emergence starts in late February and continues through June. Fish usually rear for two years, migrating in April or May and peaking in early May at a size of about 160 mm (Table 23).

Hatchery Production

Currently, no summer steelhead production facilities exist in the basin. A mitigation facility that will include summer steelhead production will be constructed at Ariel on the North Fork. Off-station releases of summer steelhead in the North Fork Lewis River have taken place since 1966 and since 1964 in the East Fork (Anonymous 1984). The Washington Department of Wildlife has released an average of 70,000 summer steelhead smolts into the North Fork while releasing an average of 90,000 summer steelhead smolts into the East Fork.

Pacific Power and Light has reared about 60,000 additional summer steelhead smolts for release into the North Fork yearly since 1979 as part of the Merwin Dam relicensing studies. Occasional fry releases have also been made by both parties. Rearing has taken place at the Beaver Creek Hatchery, Skamania Hatchery and net pens in Merwin Reservoir. In all cases, managers use the Skamania stock of summer steelhead. Return rates on the North Fork between 1976 and 1980 revealed an average return to the creel of 1.9 percent. Estimates of the returning summer hatchery fish ranged from 2,014 to 2,350 adults during the study period (LaVoy and Fenton 1983) (Table 24).

Harvest

Sport harvest in the North Fork has been hampered by poor access. Since the 1970s, harvest, in general, has increased. Average catch for the last five years was 3,562 fish, with a maximum harvest of 6,100 fish taken during the 1986-1987 season (Table 25).

SUMMER STEELHEAD

Fisheries Resource

Natural Production

Historically, steelhead occupied a much greater portion of the Lewis River Basin than is currently observed. The construction of Merwin Dam in 1929 along with Yale and Swift dams in 1953 and 1958, respectively, blocked passage into the areas above Ariel on the North Fork Lewis. Current population distribution occurs from about RM 7 to RM 20. Cedar Creek, a tributary to the North Fork, once provided spawning areas only in its lower portion until a mill dam was removed in 1946. With additional stream improvements, spawning now occurs throughout most of this tributary.

The East Fork Lewis River has remained relatively unchanged, with the exception of urbanization impacts in the lower reaches. Consequently, fish continue to spawn throughout most of the river. Few steelhead were reported to have ascended Sunset Falls prior to 1982, when the falls were "notched." This lowered the falls from 13.5 feet to 8 feet (McMillan 1985) and made the upper reaches more accessible. Now spawning takes place in the mainstem, as well as Rock Creek and other tributaries. Summer run fish do not pass over the falls in the upper mainstem as readily as winter fish (Howell et al. 1983), and numerous small falls provide barriers to migrating adults during periods of low flow (Fulton 1970).

Although the summer steelhead stocks in both the North and East Fork Lewis rivers are thought to be native, it is likely that interbreeding has occurred with the Skamania stock steelhead that have been released. It is also possible that stocks from nearby basins contributed genetic material as they strayed after the eruption of Mount St. Helens in May 1980. No total estimates of total wild run sizes or escapements exist for the North or East Fork Lewis River.

Total escapement of summer steelhead to the Lewis River between 1925 and 1933 was estimated to be 4,000 fish, while the average run size between 1963 and 1967 was estimated to be 6,150 fish. No total estimates are available for the wild component of summer steelhead with the exception of 1984 when the East Fork wild component was estimated to be about 600 while the North Fork was estimated to be less than 50 fish. Lucas (1985) determined that the wild component of the summer steelhead at Lucia Falls averaged about 27 percent of the creeled fish between 1974 and 1983.

Table 23. Freshwater life history of Lewis River summer steelhead.

	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB
ADULT IMMIGRATION	- -	- -	---	---	---	- -	---	---	---	- -	- -	- -
ADULT HOLDING		- -	- -	- -	---	---	---	---	---	- -		
SPAWNING	- -	- -	- -							- -	- -	---
EGG/ALEVIN INCUBATION	---	---	- -	- -							- -	- -
EMERGENCE	---	---	---	- -	- -							
REARING	---	---	---	---	---	---	---	---	---	---	---	---
JUVENILE EMIGRATION	---	---	- -								- -	- -

Table 24. Lewis River summer steelhead smolt releases.

Release Year	North Fork	East Fork	Total
1962	NA	NA	
1963	NA	NA	
1964	NA	NA	
1965	NA	NA	
1966	NA	NA	
1967	24,000	NA	24000
1968	103,515	NA	103515
1969	NA	NA	
1970	73,705	NA	73705
1971	103,130	NA	103130
1972	70,360	NA	70360
1973	89,430	NA	89430
1974	67,930	NA	67930
1975	73,745	NA	73745
1976	72,465	NA	72465
1977	16,279	NA	16279
1978	88,988	NA	88988
1979	88,746	109,935	198681
1980	116,495	91,918	208413
1981	106,741	92,618	199359
1982	42,429	87,680	130109
1983	24,735	43,900	68635
1984	127,170	99,219	226389
1985	130,994	45,899	176893
1986	123,874	NA	123874
1987	78,090	NA	78090
1988	NA	NA	
1989	128262	NA	128262

Table 25: Summary of summer steelhead occurring in sport harvest in the Lewis River watershed based on punchcard returns.

Year	NF Lewis	Cedar Ck	EF Lewis	Rock Ck.	Mainstem Lewis	Total
1962	1		302		149	452
1963	16		411		156	583
1964	11		331		119	461
1965	35	2	452		208	697
1966	11	0	1800		825	2636
1967	315	2	1260		662	2239
1968	162	3	1908		439	2512
1969	312	0	2150		551	3013
1970	826	0	1179		559	2564
1971	357	6	2035		595	2993
1972	632	8	2782		826	4248
1973	1663	10	2055		1005	4733
1974	771	0	1904	0	490	3165
1975	931	2	1316	0	530	2779
1976	1673	8	1910	4	778	4373
1977	2623	0	2760	33	1353	6769
1978	1733	0	3455	8	763	5959
1979	741	0	1078	0	445	2264
1980	2557	3	1861	0	853	5274
1981	2210	7	2249	13	460	4939
1982	3278	28	1619	25	292	5242
1983	1641	2	1254	0	248	3145
1984	2498	10	2167	4	352	5031
1985	2764	6	2161	4	751	5686
1986	6100	14	2084	0	516	8714
1987	4807	29	1116	13	443	6408
5 YR MEAN	3562	12	1756	4	462	5797
10 YR MEAN	2833	10	1904	7	512	5266

The East Fork has long supported a popular sport fishery for summer steelhead. Large wild fish continue to propagate in the system. Although sport harvest in the East Fork historically exceeded the catch in the North Fork, since 1980 harvest has been higher on the North Fork. There has been no commercial harvest of steelhead in Zones 1-5 (below Bonneville Dam) since 1975, with the exception of incidental harvest during salmon fisheries (Raymond 1988).

Sport harvest is regulated by the Washington Department of Wildlife. The management goal is to allow for maximum harvest of hatchery fish, while allowing maximum escapement of natural fish. Harvest is monitored through sport steelhead permit card returns and limited creel surveys.

Specific Considerations

Lewis River summer steelhead are composed of both wild and hatchery stocks. On the North Fork, only about 1.6 percent of the returning summer steelhead are wild fish, while on the East Fork, the wild fish component is higher, (27 percent based on one study). The primary management intent is to maximize wild fish escapement while using hatchery fish to provide the harvest opportunities.

Due to the presence of three dams on the North Fork, opportunities for wild fish production are limited. Although natural production potential in the tributaries above the dams has not been determined, good habitat does exist. A mitigation facility at Ariel is scheduled to be operational by the early 1990s.

The East Fork provides a good summer steelhead fishery, with an estimated harvest rate of 50 percent on the hatchery fish.

Objectives

Stock: East Lewis Natural Summer Steelhead

Utilization Objective: Zero; catch and release only. The utilization component is secondary to the biological component for this stock.

Biological Objective: Maintain the biological characteristics of the natural stock. The biological component has priority within the subbasin. This population is managed for maximum sustained population.

Stock: East Lewis Hatchery Summer Steelhead

Utilization Objective: 2,200 fish for sport harvest. The utilization component has priority within the subbasin for this stock.

Biological Objective: Maintain the biological characteristics of the hatchery stock. The biological component is secondary to the utilization component for this stock.

Stock: North Lewis Summer Steelhead

Utilization Objective: 6,750 fish for sport harvest. The utilization component has priority within the subbasin for this stock.

Biological Objective: Maintain the biological characteristics of the existing stock. The biological component is secondary to the utilization component for this stock.

Alternative Strategies

Strategies for summer steelhead in this report have specific themes. Means to obtain the objectives are first attempted using natural methods followed by less natural techniques and finally, hatchery production. Actions identified under each strategy are closely related to the theme.

Modeling results for each strategy are presented in Table 26 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 26. 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 26a.

STRATEGY 1: Natural Stock Enhancement

This strategy consists of trap and haul operations along with habitat improvement activities. Implementation would provide opportunity to expand distribution of current returning stock to areas of good quality habitat that are currently inaccessible. Strategy would include a program for monitoring and evaluation. This strategy also assumes the new mitigation hatchery on the North Fork is in place.

ACTIONS: 1-5

1. On the North Fork, implement adult trap and haul operations to bypass the three dams. Implement smolt collection facility at Swift Creek Dam and hauling to specified area below Ariel Dam.

2. On the East Fork, restore and enhance riparian and instream habitat through sedimentation control, such as fencing, riparian planting and placement of instream structures throughout the drainage, such as in Yacolt Creek. Habitat activities could also include the use of Lucia Falls area as a steelhead and salmon sanctuary zone, where facilities could be developed for pubic viewing and education. Area below the falls concentrates steelhead at high levels. This area is currently closed to fishing. Surrounding property may be developed in the next few years.

3. Protect native steelhead through continued implementation of regulations that call for release of wild fish on the East Fork.

4. Acquire angler stream access to increase harvest rate on hatchery fish.

5. Attempt to maintain streamflow on the North Lewis at about 5,000 cfs.

STRATEGY 2: Supplementation

This strategy uses most actions identified in Strategy 1 along with the use of rearing ponds on the East Fork.

ACTIONS: 2-6

2. -
3. -
4. -
5. -

6. On the East Fork, construct acclimation/rearing ponds for existing production (90,000 smolts) to increase return rate and improve distribution of returning adults to increase sport harvest opportunities.

STRATEGY 3: Artificial Propagation

This strategy involves the previous strategies (except Action 1) along with expansion of 60,000 additional smolts on the East Lewis River.

ACTIONS: 2-7

2. -
3. -
4. -
5. -
6. -

7. Produce an additional 60,000 smolts for the East Lewis with off-station releases. Develop a reliable smolt source free from IHN contamination.

STRATEGY 4: Additional Supplementation

This strategy uses the above actions, except Action 1, and places all the East Fork production of hatchery fish in a rearing pond.

ACTIONS: 2-8

2. -
3. -
4. -
5. -
6. -
7. -

8. Construct the acclimation pond mentioned in Action 6 for the East Fork large enough to accommodate the smolt increase in Action 7. The pond should increase return rate and improve distribution of returning adults to increase sport harvest opportunities.

Recommended Strategy

The recommended strategy is Strategy 4, which incorporates all potential actions except Action 1. The System Planning Model estimates that implementation of the actions will increase total returns to the subbasin by about 5,000 fish. This should meet the total objectives for the North and East forks. The SMART analysis (Appendix B) also supports Strategy 4.

Table 26. System Planning Model results for summer steelhead (A's) in the Lewis Subbasin. Baseline value is for pre-mainstem implementation, all other values are post-implementation.

Utilization Objective:
Provide a sport harvest of 6,750 in the North Lewis and 2,200 in the East Lewis.

Biological Objective:
Maintain genetic fitness and diversity of wild fish. Achieve utilization of existing and potential habitat for natural production.

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	8,299 -N	2,107	10,640	262	0(1.00)
All Nat	9,400 -N	2,386	12,052	297	1,447(1.13)
1	9,400 -N	2,386	12,052	297	1,447(1.13)
2	9,817 -N	2,349	12,427	306	1,831(1.17)
3	12,490 -N	2,810	15,613	384	5,096(1.47)
4*	12,805 -N	2,703	15,808	388	5,295(1.49)

*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. Natural stock enhancement. Pre Mainstem Implementation.
2. Strategy 1 plus supplementation. Pre Mainstem Implementation.
3. Strategy 2 plus artificial Production. Pre Mainstem Implementation.
4. Strategy 3 plus additional Supplementation Pre 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 26a. Estimated costs of alternative strategies for Lewis River summer steelhead. 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	4*
Hatchery Costs				
Capital[1]	0	552,000	552,000	690,000
O&M/yr[2]	0	60,000	60,000	75,000
Other Costs				
Capital[3]	2,000,000	2,600,000	2,600,000	2,600,000
O&M/yr[4]	0	20,000	20,000	20,000
Total Costs				
Capital	2,000,000	3,152,000	3,152,000	3,290,000
O&M/yr	0	80,000	80,000	95,000

* 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.

WINTER STEELHEAD

Fisheries Resource

Natural Production

No total estimates of wild run size or escapement exist for either the North or East Fork Lewis River. Smoker et al. (1951) believed that combined winter and summer runs of native steelhead on the North Fork above Merwin Dam formerly exceeded 1,000 adults. Lucas (1985) determined that the wild component of winter steelhead at Lucia Falls ranged from 35 percent to 74 percent of the creeled fish between 1973 and 1984, averaging 56 percent.

Specific age information for wild fish is limited. Of the 12 wild winter steelhead sampled from the 1977-1978 season through the 1979-1980 season in the North Fork fishery, 17 percent were 1-ocean jacks and 83 percent were 2-ocean adults (Lavoy and Fenton 1983). In another study by the same authors, hatchery and wild fish were not separated; of 364 fish from the North Fork winter fishery, the largest group (63 percent) was 2-ocean fish with fork lengths that averaged between 67.1 cm and 71 cm. Three-ocean fish and return spawners made up the next largest group (30 percent) and had average fork lengths of 80.1 cm to 84.2 cm. Only 2 percent of 1-ocean fish were found, with fork lengths of 24 cm and 46 cm (Table 27).

Adult winter steelhead enter the basin from November through May, with peak migration occurring in January and March for hatchery and wild fish, respectively (Table 28). Spawning occurs from March through June in both the North and East forks (Howell et al. 1985). Lucas and Pointer (1987) found that peak spawning during the 1987 brood year in the East Fork occurred from mid-March through late April. McMillan (1985) suggests that spawning above Sunset Falls on the East Fork occurs over a short period of time in mid-March. Emergence occurs from April through July and the fish rear until spring a year later. Most wild North Fork smolts probably outmigrate in April and May at a size of 160 mm. The majority (83 percent) were found to have emigrated after two years, while about 17 percent emigrated after three years (LaVoy and Fenton 1983). East Fork stocks tend to follow the same time-frame, however no distribution of freshwater residency is available.

Table 27. Fork length of steelhead examined from
winter run sport fishery in the North Fork, 1977 to 1981 (LaVoy and Fenton

Year	Mean Length in Centimeters 1-ocean (n)	2-ocean (n)	3-ocean (n)
1977		67.1 (27)	80.1 (6)
1978	46.0 (1)	71.0 (37)	84.2 (7)
1979		68.3 (93)	80.1 (44)
1980		69.1 (51)	81.9 (35)
1981	24.0 (1)	68.1 (23)	81.3 (39)

Table 28. Freshwater life history of Lewis River winter steelhead.

	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB
ADULT IMMIGRATION	- -	------	- -	- -					- -	- -	- -	- -
ADULT HOLDING	------	------	- -								- -	- -
SPAWNING	- -	------	------	- -								- -
EGG/ALEVIN INCUBATION	- -	- -	------	- -	- -							- -
EMERGENCE	- -	- -	------	------	- -	- -						
REARING	------	------	------	------	------	------	------	------	------	------		
JUVENILE EMIGRATION	- -	- -	------	- -								- -

Hatchery Production

Currently, no winter steelhead production facilities exist in the basin. A mitigation facility, which will include winter steelhead production, is planned for construction at Ariel. Off-station releases have occurred in the North Fork since 1958 and in the East Fork since 1954. The Washington Department of Wildlife has released an annual average of 86,000 winter steelhead smolts into the North Fork and 89,000 winter steelhead smolts into the East Fork during the last 10 years (Table 29). Additionally, Pacific Power and Light has reared about 35,000 winter steelhead smolts annually for release into the North Fork since 1979 as part of the Merwin Dam relicensing studies. Rearing has taken place at both Beaver Creek and Skamania hatcheries as well as the Merwin net pens. Stocks reared and released have included Chambers Creek, Elochoman and Cowlitz fish. Analysis of releases and returns on the North Fork between 1976 and 1980 determined that, of an average annual release of 68,000, estimates of returning winter run hatchery populations ranged from 1,855 to 2,147 fish (LaVoy and Fenton 1987).

Harvest

Sport fishing in the North Fork became popular in the mid-1960s. Estimates of catch, based on punch-card returns, ranged from about 50 to almost 600 fish through the 1960s and 1970s, averaging about 300 fish per year (Table 30). Harvest has increased in the 1980s with the average catch over the past five seasons being 1,577 fish; a high of 1,953 fish were caught in the 1984-1985 season.

The East Fork has long been a popular sport harvest stream, known for the large wild fish that continue to propagate in the system. The current state record steelhead (32 pounds, 12 ounces) was taken from the East Fork in April 1980. Historic catch estimates, based on punch-card returns, range from about 1,100 fish to a high of 4,338 fish, which occurred in the 1980-1981 season. The average harvest for the last 10 years has been 2,730 fish for the East Fork. Catches also occur in Rock and Cedar creeks and in the mainstem Lewis. Total catch for the system has averaged 4,423 fish per season for the last 10 seasons.

Sport harvest is managed by the Washington Department of Wildlife. The overriding management goal is to maximize harvest of hatchery fish and allow escapement of natural fish. Harvest is monitored through sport steelhead permit card returns and creel survey activities. There has been no commercial harvest of steelhead in Zones 1-5 (below Bonneville Dam) since 1975, with the exception of incidental harvest during the spring chinook fishery (Raymond 1988).

Table 29. Lewis River winter steelhead smolt releases and subsequent harvest.

East Fork				North Fork			
Release Year	Number Released	Subsequent Catch	% Return to Catch	Release Year	Number Released	Subsequent Adult Return	Return to Catch
1962	87,677	1,458	1.66	1962	41,400	52	0.13
1963	60,960	1,353	2.22	1963	30,000	49	0.16
1964	84,775	3,092	3.65	1964	29,135	464	1.59
1965	76,400	3,271	4.28	1965	30,185	218	0.72
1966	76,188	2,097	2.75	1966	127,852	493	0.39
1967	76,004	2,149	2.83	1967	51,758	325	0.63
1968	75,040	1,497	1.99	1968	40,238	107	0.27
1969	80,165	3,000	3.74	1969	56,770	488	0.86
1970	75,552	3,154	4.17	1970	67,346	474	0.70
1971	73,795	2,166	2.94	1971	49,625	323	0.65
1972	81,563	1,716	2.10	1972	41,135	144	0.35
1973	73,651	1,504	2.04	1973	77,336	88	0.11
1974	66,047	1,709	2.59	1974	58,091	151	0.26
1975	58,658	1,125	1.92	1975	52,036	488	0.94
1976	66,396	2,685	4.04	1976	39,405	598	1.52
1977	76,650	2,115	2.76	1977	67,947	374	0.55
1978	81,594	3,169	3.88	1978	55,075	418	0.76
1979	84,823	4,338	5.11	1979	100,555	1,323	1.32
1980	85,220	2,086	2.45	1980	93,512	550	0.59
1981	82,131	1,543	1.88	1981	94,731	802	0.85
1982	109,050	2,489	2.28	1982	76,525	1,460	1.91
1983	52,359	3,467	6.62	1983	61,119	1,953	3.20
1984	90,106	2,483	2.76	1984	71,070	1,294	1.82
1985	71,840	2,691	3.75	1985	73,085	1,931	2.64
1986	114,300	2,741	2.40	1986	113,171	1,247	1.10
1987	84,750	1,983	2.34	1987	95,090		
1988	105,499			1988			
10 year averages	88008	2699	3.35		86540	1220	1.58

Table 30. Summary of winter steelhead occurring in sport harvest in the Lewis River watershed based on punch card returns.

Year	NF Lewis	Cedar Ck	EF Lewis	Rock Ck.	Mainstem Lewis	Total
1962	135		2185		971	3291
1963	52		1458		380	1890
1964	49	8	1353		457	1867
1965	464	85	3092		1323	4964
1966	218	64	3271		1419	4972
1967	493	133	2097		746	3469
1968	325	26	2149		442	2942
1969	107	33	1497		362	1999
1970	488	83	3000		854	4425
1971	474	164	3154		934	4726
1972	323	180	2166		698	3367
1973	144	20	1716		373	2253
1974	88	4	1504	16	288	1900
1975	151	40	1709	18	275	2193
1976	488	20	1125	2	261	1896
1977	598	21	2685	18	568	3890
1978	374	4	2115	16	504	3013
1979	418	10	3169	14	517	4128
1980	1323	97	4338	6	915	6679
1981	550	38	2086	0	730	3404
1982	802	50	1543	3	571	2969
1983	1460	34	2489	2	546	4531
1984	1953	65	3587	4	506	6115
1985	1294	14	2541	11	310	4170
1986	1931	19	2691	6	302	4949
1987	1247	37	2741	8	244	4277
5 YR MEAN	1577	34	2810	6	382	4808
10 YR MEAN	1135	37	2730	7	515	4424

Specific Considerations

Lewis River winter steelhead are composed of both wild and hatchery stocks. On the North Fork, only about 6 percent of the returning winter steelhead are wild fish, while on the East Fork, the wild fish component averages over 50 percent. The primary management intent focuses on maximizing wild fish escapement through the use of wild release regulations, while using hatchery fish to provide the bulk of the recreational opportunities through the use of wild release regulations in the sport fishery.

Due to the presence of three dams on the North Fork, opportunities for wild fish production are limited. Although natural production potential in the tributaries above the dams has not been quantified, good habitat does exist. A mitigation facility at Ariel is scheduled to be operational by the early 1990s.

The East Fork provides a good winter steelhead fishery, however, angler access is limited from Lewisville downstream. Current harvest rate is estimated to be about 40 percent of the hatchery fish entering the East Fork.

Objectives

Stock: East Lewis Natural Winter Steelhead

Utilization Objective: Zero; catch and release only. The utilization component is secondary to the biological component for this stock.

Biological Objective: Maintain the biological characteristics of the natural stock. The biological component has priority within the subbasin. This population is managed for maximum sustained population.

Stock: East Lewis Hatchery Winter Steelhead

Utilization Objective: 4,200 fish for sport harvest. The utilization component has priority within the subbasin for this stock.

Biological Objective: Maintain the biological characteristics of the hatchery stock including different return timing than natural fish. The biological component is secondary to the utilization component for this stock.

Stock: North Lewis Winter Steelhead

Utilization Objective: 3,000 fish for sport harvest. The utilization component has priority within the subbasin for this stock.

Biological Objective: Maintain the biological characteristics of the hatchery stock including different return timing than natural fish. The biological component is secondary to the utilization component for this stock.

Alternative Strategies

Strategies for winter steelhead in this report have specific themes. Means to obtain the objectives are first attempted using natural methods followed by less natural techniques and finally, hatchery production. Actions identified under each strategy are closely related to the theme.

Modeling results for each strategy are presented in Table 31 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 31. 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 32.

STRATEGY 1: Natural Stock Enhancement

This strategy would provide opportunity to expand distribution of current returning stock to areas of good quality and that are currently inaccessible. This strategy would include program for monitoring and evaluation. This strategy assumes the new mitigation facility is in place.

ACTIONS: 1-4

1. On the North Fork, implement adult trap and haul operation to bypass three dams. Implement smolt collection facility at Swift Creek Dam and hauling program from location to specified area below Ariel Dam.

2. On the East Fork, restore and enhance riparian and instream habitat through sedimentation control, such as fencing, riparian planting and placement of instream structures throughout the drainage, such as in Yacolt Creek. Habitat activities could also include the use of Lucia Falls area as a steelhead and salmon sanctuary zone, where facilities could be developed for pubic viewing and education. Area below the falls concentrates steelhead at high levels. This area is currently closed to fishing. Surrounding property may be developed in the next few years.

3. Protect native steelhead through continued implementation of regulations that call for release of wild fish.

4. Provide additional angler stream access to increase harvest rate on hatchery fish.

STRATEGY 2: Supplementation

This strategy calls for the above, except Action 1, and the use of acclimation ponds to enhance the indigenous stock of the North Fork.

ACTIONS: 2-5

2. -
3. -
4. -

5. Construct conditioning ponds to accommodate existing production in the East Lewis River.

STRATEGY 3: Artificial Propagation

This strategy includes all of the actions except Action 1, and calls for expansion of current releases of hatchery production.

ACTIONS: 2-6

2. -
3. -
4. -
5. -

6. Produce 60,000 additional smolts of East Fork origin to increase return rate and sport harvest opportunities.

STRATEGY 4: Additional Supplementation

This strategy utilizes the above actions, except Action 1, and places all the East Fork production of hatchery fish in a rearing pond.

ACTIONS: 2-7

2. -
3. -
4. -
5. -
6. -

7. Construct the acclimation pond mentioned in Action 5 for the East Fork large enough to accommodate the smolt increase in Action 6. The pond should increase return rate and improve distribution of returning adults to increase sport harvest opportunities.

Recommended Strategy

Strategy 4 is the recommended strategy, which is an accumulation of all actions except Action 1. Modeling results show that total winter steelhead could be increased by an estimated 4,400 adults, with an increase of 4,000 available for harvest within the Lewis River. This would meet the objectives as stated above.

Table 31. System Planning Model results for winter steelhead in the Lewis Subbasin. Baseline value is for pre-mainstem implementation, all other values are post-implementation.

Utilization Objective:
Provide a sport harvest of 3,000 fish on the North Fork and 4,200 on the East Fork.

Biological Objective:
Achieve utilization of existing and potential habitat for natural production. Maintain genetic fitness and diversity of wild fish. Continue with protection of wild fish.

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	6,970 -N	2,207	9,293	614	0(1.00)
All Nat	7,802 -N	2,604	10,543	697	1,333(1.13)
1	N/M				
2	7,802 -N	2,604	10,543	697	1,333(1.13)
3	8,203 -N	2,461	10,793	713	1,599(1.16)
4*	10,380 -N	2,946	13,481	891	4,464(1.45)

*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. Natural stock enhancement. Pre Mainstem Implementation.
2. Strategy 1 plus supplementation. Pre Mainstem Implementation.
3. Strategy 2 plus artificial Production. Pre Mainstem Implementation.
4. Combination of 2 and 3.

[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 32. Estimated costs of alternative strategies for Lewis River winter steelhead. 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	4*
Hatchery Costs				
Capital[1]	0	552,000	552,000	690,000
O&M/yr[2]	0	60,000	60,000	75,000
Other Costs				
Capital[3]	2,000,000	2,600,000	2,600,000	2,600,000
O&M/yr[4]	0	20,000	20,000	20,000
Total Costs				
Capital	2,000,000	3,152,000	3,152,000	3,290,000
O&M/yr	0	80,000	80,000	95,000

* 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.

PART V. SUMMARY AND IMPLEMENTATION

Objectives and Recommended Strategies

Spring Chinook

Objectives focus on continuing management of the stock on a hatchery basis, with an attempt to double the present production (1 million fish to 2 million fish). Planners recommend Strategy 3, which calls for additional rearing ponds at the Lewis River Hatchery, improving the attraction of adult spring chinook back to the hatchery for brood stock, and developing acclimation sites for fingerling rearing.

Fall Chinook

Objectives are directed at continuing natural stock management. Planners recommend Strategy 1, enhanced flows, revegetation programs and protection of present habitat. Avoiding interspecific competition, especially with spring chinook, is also an important consideration.

Coho

Objectives focus on maintaining management on a hatchery stock basis, but utilizing habitat for natural production and maintaining current balance of early and late coho. Planners recommend Strategy 3, which includes a number of hatchery improvements, construction of overwintering ponds, fencing and revegetation projects, and supplementation programs that maximize natural production.

Summer Steelhead

Wild stock objectives focus on protecting and enhancing the run through habitat improvement measures and providing access to upriver areas via trap and haul operations. Harvest opportunities will continue to be directed on the hatchery stock. Planners recommend Strategy 4, which includes construction of a new mitigation facility on the North Fork and use of an acclimation pond on the East Fork for the production of additional smolts.

Winter Steelhead

Wild stock objectives focus on protecting and enhancing the run through habitat improvement measures and providing access to upriver areas via trap and haul operations. Harvest opportunities will continue to be directed on the hatchery stock. Planners recommend Strategy 4, which includes construction of a new mitigation facility on the North Fork and use of an acclimation pond on the East Fork for the production of additional smolts.

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.

LITERATURE CITED

Advisory Committee on Salmon and Steelhead Trout. 1988. Restoring the balance. Annual Report of the California Advisory Committee on Salmon and Steelhead Trout.

Anonymous. 1984. Synopsis of information pertaining to steelhead in drainages below Bonneville Dam. Washington State Department of Game.

Bryant, 1949.

Fulton, L.A. 1970. Spawning areas and abundance of steelhead trout and coho, sockeye, and chum salmon in the Columbia River Basin--past and present. U.S. Department of Commerce, National Marine Fisheries Service Scientific Report Fisheries #618.

Howell, P., K. Jones, D. Scarnecchia, L. LaVoy. W. Kendra, and D. Ortman. 1985. Stock assessment of Columbia River anadromous salmonids. Volume II: Steelhead stock summaries stock transfer guidelines-information needs. Final report prepared for U.S. Department of Energy, Bonneville Power Administration. Project# 83-335.

Lavier, D.C. 1964. Washington State Department of Game progress report, district 9.

LaVoy and Fenton, 1983.

LaVoy and Fenton, 1987.

Lucas, R. 1985. Draft Analysis of creel check data at Lucia Falls, East Fork Lewis River. Washington Department of Wildlife.

Lucas, R., and K. Pointer. 1987. Wild steelhead spawning escapement estimates for southwest Washington streams. Washington Department of Wildlife Report # 87-6.

McIssac D., and H. Fiscus. 1979. Memo from Don McIssac and Hugh Fiscus to Dick Laramie, Washington Department of Fisheries, February 1, 1979.

McMillan, B. 1985. Clark-Skamania Flyfisher's snorkel survey of the East Fork Lewis River.

McMillan, B. 1985. A study of the status of wild steelhead stocks returning to the upper Washougal River. Clark-Skamania Flyfishers.

Norman, G. 1987. Memo from Guy Norman to Lee Blankenship, Washington Department of Fisheries, October 26, 1987.

Raymond, 1988.

Smoker, W.A., J.M. Hurley, and R.C. Meigs. 1951. Compilation of observations on the effect of Ariel Dam on the production of salmon and trout in the Lewis River. Washington Department of Fisheries.

Stockley, 1979.

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: Lewis

STOCK: Spring Chinook

STRATEGY: 3

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1 EXT OBJ	5	0.9	20	100	90
2 CHG MSY	6	0.9	20	120	108
3 GEN IMP	3	0.9	20	60	54
4 TECH FEAS	8	0.9	20	160	144
5 PUB SUPT	7	0.9	20	140	126

TOTAL VALUE 580

DISCOUNT VALUE 522

CONFIDENCE VALUE 0.9

SUBBASIN: Lewis

STOCK: Fall chinook

STRATEGY: 1

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1 EXT OBJ	9	0.9	20	180	162
2 CHG MSY	4	0.9	20	80	72
3 GEN IMP	9	0.9	20	180	162
4 TECH FEAS	8	0.9	20	160	144
5 PUB SUPT	9	0.9	20	180	162

TOTAL VALUE 780

DISCOUNT VALUE 702

CONFIDENCE VALUE 0.9

SUBBASIN: Lewis

STOCK: Coho

STRATEGY: 1

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1 EXT OBJ	2	0.9	20	40	36
2 CHG MSY	3	0.9	20	60	54
3 GEN IMP	3	0.9	20	60	54
4 TECH FEAS	5	0.9	20	100	90
5 PUB SUPT	6	0.9	20	120	108

TOTAL VALUE 380

DISCOUNT VALUE 342

CONFIDENCE VALUE 0.9

SUBBASIN: Lewis

STOCK: Coho

STRATEGY: 2

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1 EXT OBJ	3	0.9	20	60	54
2 CHG MSY	4	0.9	20	80	72
3 GEN IMP	3	0.9	20	60	54
4 TECH FEAS	3	0.9	20	60	54
5 PUB SUPT	5	0.9	20	100	90

TOTAL VALUE 360

DISCOUNT VALUE 324

CONFIDENCE VALUE 0.9

SUBBASIN: Lewis

STOCK: Coho

STRATEGY: 3

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	3	0.9	20	60	54
4 TECH FEAS	9	0.9	20	180	162
5 PUB SUPT	7	0.9	20	140	126

TOTAL VALUE 580

DISCOUNT VALUE 522

SUBBASIN: Lewis

STOCK: Summer Steelhead

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	3	0.9	20	60	54
4 TECH FEAS	4	0.9	20	80	72
5 PUB SUPT	4	0.9	20	80	72

TOTAL VALUE 300

DISCOUNT VALUE 270

CONFIDENCE VALUE 0.9

SUBBASIN: Lewis

STOCK: Summer Steelhead

STRATEGY: 2

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1 EXT OBJ	3	0.9	20	60	54
2 CHG MSY	4	0.9	20	80	72
3 GEN IMP	3	0.9	20	60	54
4 TECH FEAS	6	0.9	20	120	108
5 PUB SUPT	7	0.9	20	140	126

TOTAL VALUE 460

DISCOUNT VALUE 414

CONFIDENCE VALUE 0.9

SUBBASIN: Lewis

STOCK: Summer Steelhead

STRATEGY: 3

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1 EXT OBJ	6	0.9	20	120	108
2 CHG MSY	6	0.9	20	120	108
3 GEN IMP	3	0.9	20	60	54
4 TECH FEAS	7	0.9	20	140	126
5 PUB SUPT	8	0.9	20	160	144

TOTAL VALUE 600

DISCOUNT VALUE 540

CONFIDENCE VALUE 0.9

SUBBASIN: Lewis

STOCK: Summer Steelhead

STRATEGY: 4

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1 EXT OBJ	6	0.9	20	120	108
2 CHG MSY	7	0.9	20	140	126
3 GEN IMP	3	0.9	20	60	54
4 TECH FEAS	7	0.9	20	140	126
5 PUB SUPT	8	0.9	20	160	144

TOTAL VALUE 620

DISCOUNT VALUE 558

CONFIDENCE VALUE 0.9

SUBBASIN: Lewis

STOCK: Winter Steelhead

STRATEGY: 1

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1 EXT OBJ	3	0.9	20	60	54
2 CHG MSY	4	0.9	20	80	72
3 GEN IMP	3	0.9	20	60	54
4 TECH FEAS	6	0.9	20	120	108
5 PUB SUPT	7	0.9	20	140	126

TOTAL VALUE 460

DISCOUNT VALUE 414

CONFIDENCE VALUE 0.9

SUBBASIN: Lewis

STOCK: Winter Steelhead

STRATEGY: 3

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1 EXT OBJ	6	0.9	20	120	108
2 CHG MSY	6	0.9	20	120	108
3 GEN IMP	3	0.9	20	60	54
4 TECH FEAS	9	0.9	20	180	162
5 PUB SUPT	7	0.9	20	140	126

TOTAL VALUE 620

DISCOUNT VALUE 558

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: Lewis River
Stock: Spring Chinook

Action	Cost Categories*	Proposed Strategies 1	2	3**
Habitat Enhancement	Capital:			
	O&M/yr:			
	Life:			
Screening	Capital:			
	O&M/yr:			
	Life:			
Acclimation Sites	Capital:			400,000
	O&M/yr:			30,000
	Life:			10
Misc. Projects	Capital:			475,000[a]
	O&M/yr:			0
	Life:			50
Hatchery Production	Capital:			230,000
	O&M/yr:			25,000
	Life:			50
TOTAL COSTS	Capital:	0	0	2,705,000
	O&M/yr:	0	0	55,000
	Years:			50
Water Acquisition		N	N	N
Fish to Stock	Number/yr:			1,000,000
	Size:			J, 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.

[a] Integrated with coho program.

ESTIMATED COSTS FOR ALTERNATIVE STRATEGIES

Subbasin: Lewis River
Stock: Fall Chinook

Action	Cost Categories*	Proposed Strategies 1**
Habitat Enhancement	Capital:	1,300,000
	O&M/yr:	0
	Life:	50
Screening	Capital:	
	O&M/yr:	
	Life:	
Barrier Removal	Capital:	
	O&M/yr:	
	Life:	
Misc. Projects	Capital:	
	O&M/yr:	
	Life:	
Hatchery Production	Capital:	
	O&M/yr:	
	Life:	
TOTAL COSTS	Capital:	1,300,000
	O&M/yr:	0
	Years:	50
Water Acquisition		N
Fish to Stock	Number/yr:	
	Size:	
	Years:	

* 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: Lewis River
Stock: Coho

Action	Cost Categories*	Proposed Strategies 1	2	3**
Habitat Enhancement	Capital:	300,000		300,000
	O&M/yr:	0		0
	Life:	50		50
Screening	Capital:			
	O&M/yr:			
	Life:			
Overwintering Ponds	Capital:	200,000		200,000
	O&M/yr:	5,000		5,000
	Life:	10		10
Misc. Projects	Capital:			500,000[a]
	O&M/yr:			0
	Life:			50
Hatchery Production	Capital:			
	O&M/yr:			
	Life:			
TOTAL COSTS	Capital:	1,300,000	0	1,800,000
	O&M/yr:	5,000	0	5,000
	Years:	50		50
Water Acquisition		N	N	N
Fish to Stock	Number/yr:			
	Size:			
	Years:			

* 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.

[a] Integrated with spring chinook program.

ESTIMATED COSTS FOR ALTERNATIVE STRATEGIES

Subbasin: Lewis River
Stock: Summer Steelhead

Action	Cost Categories*	Proposed Strategies 1	2	3	4**
Habitat Enhancement	Capital:	2,000,000	2,000,000	2,000,000	2,000,000
	O&M/yr:	0	0	0	0
	Life:	50	50	50	50
Screening	Capital:				
	O&M/yr:				
	Life:				
Barrier Removal	Capital:				
	O&M/yr:				
	Life:				
Misc. Projects	Capital:		120,000[a]	120,000[a]	120,000[a]
	O&M/yr:		20,000	20,000	20,000
	Life:		10	10	10
Hatchery Production	Capital:		552,000	552,000	690,000
	O&M/yr:		60,000	60,000	75,000
	Life:		50	50	50
TOTAL COSTS	Capital:	2,000,000	3,152,000	3,152,000	3,290,000
	O&M/yr:	0	80,000	80,000	95,000
	Years:	50	50	50	50
Water Acquisition		N	N	N	N
Fish to Stock	Number/yr:		120,000	120,000	150,000
	Size:		S, 5/lb.	S, 5/lb.	S, 5/lb.
	Years:		50	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.

[a] Integrated with winter steelhead program.

ESTIMATED COSTS FOR ALTERNATIVE STRATEGIES

Subbasin: Lewis River
Stock: Winter Steelhead

Action	Cost Categories*	Proposed Strategies 1	2	3	4**
Habitat Enhancement	Capital:	2,000,000	2,000,000	2,000,000	2,000,000
	O&M/yr:	0	0	0	0
	Life:	50	50	50	50
Screening	Capital:				
	O&M/yr:				
	Life:				
Barrier Removal	Capital:				
	O&M/yr:				
	Life:				
Misc. Projects	Capital:		120,000[a]	120,000[a]	120,000[a]
	O&M/yr:		20,000	20,000	20,000
	Life:		10	10	10
Hatchery Production	Capital:		552,000	552,000	690,000
	O&M/yr:		60,000	60,000	75,000
	Life:		50	50	50
TOTAL COSTS	Capital:	2,000,000	3,152,000	3,152,000	3,290,000
	O&M/yr:	0	80,000	80,000	95,000
	Years:	50	50	50	50
Water Acquisition		N	N	N	N
Fish to Stock	Number/yr:		120,000	120,000	150,000
	Size:		S, 5/lb.	S, 5/lb.	S, 5/lb.
	Years:		50	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.

[a] Integrated with summer steelhead program.