Columbia Basin System Planning

SALMON and STEELHEAD PRODUCTION PLAN

ELOCHOMAN RIVER SUBBASIN

September 1, 1990

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Washington Department of Fisheries
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Olympia, Washington 98504

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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 headwaters of the Elochoman River lie in the Willapa Hills in southwest Lewis County and northeast Cowlitz County. The river flows southwesterly into Wahkiakum County to join the Columbia River at River Mile (RM) 38, just downstream from the town of Cathlamet, Washington, encompassing a drainage area of 73.3 square miles.

The climate in the basin is similar to much of western Washington. The marine air influence from the Pacific Ocean moderates the seasons, making the winters wet but mild and the summers cool but relatively dry. Rainfall averages between 80 inches to 100 inches a year, most of it falling in the rainy season between October and March.

Water Resources

The streamflow originates almost entirely from the rainfall in the region. Average streamflow over a 31-year period (1940-1971) was 375 cubic feet per second (cfs) with wide extremes between a maximum flow of 8,530 cfs in November 1962 to a minimum of 9.8 cfs in August 1967. (Gauge records after 1971 are not continuous and the U.S. Geological Survey gauge station was discontinued in 1977.) In 1977 measured flow ranged from 19 cfs to 1,060 cfs for the year. The presence of well drained soils in the hilly areas combined with level, poorly drained soils in the floodplain contribute to the low water storage potential of the system and large fluctuations in the streamflow.

Land Use

Fishery surveys earlier this century recorded the widespread disturbance to stream habitat and riparian areas from logging. Logging in the area was conducted without regard for riparian or instream habitat. As a result, considerable erosion and silting caused damage to salmonid spawning and rearing habitat. Today second-and third-growth stands of fir, alder, and maple have grown back and the watershed is recovering, however long-term impacts of early logging appear to persist. Forestry is still the major land use on both private and state owned lands. Major timber companies own more than 50 percent of the land in the subbasin, while the Washington Department of Natural Resources owns and manages about 30 percent of the land. The remaining land is privately owned smaller tracts, many of them small farms and residences located along the lower river floodplain.

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, more typically destruction of riparian vegetation, land reclamation and non-point source pollution was caused by agricultural development. Today, numerous laws limit many major impacts, but the cumulative loss of habitat continues.

Current land-use patterns are very similar to historical ones. The floodplain of the main river was developed for agriculture with associated single-family residential. The timbered slopes continue to be logged and used for sustained forest production.

Constraints and Opportunities for Protection

In spite of the best efforts of numerous state and federal agencies, and the imposition of regulatory programs some of the public deem onerous and excessive, there is a gradual loss of stream habitat. This cumulative loss is occasioned by the 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. Subbasin planning needs to address the problem of cumulative habitat loss if the goals of the Northwest Power Planning Act are to be achieved.

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 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.

Institutional Considerations

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)

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

County
- Pacific County
- Wahkiakum County
- Cowlitz County
- Clark County
- Skamania County

Interagency
- Columbia River Inter-tribal Fish Commission
- Columbia Basin Fish and Wildlife Authority

Specific authority or interest of these entities varies widely. This list demonstrates the complex demands on the Columbia's resources. The multiple uses of the river and its resources have often pitted user groups and agencies against each other. Resolution of these problems has led to the establishment of numerous interagency technical and policy committees that work cooperatively for sustainable solutions.

Legal Considerations

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. 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

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.

Critical Data Gaps

1) Production potential of the watershed is unknown. Even though the carrying capacity of the subbasin has been estimated for each stock, through the Smolt Density Model (SDM), the input data on habitat measurements should be refined and the fish distribution data needs to be field checked.

2) Density dependent factors in the Columbia River estuary or early marine life stages may exist for stocks originating from this subbasin. Uncertainty about these factors makes it difficult to project the benefits from increased freshwater production or conduct detailed planning.

3) No quantitative measure has been developed to measure progress toward a "no net loss" policy of habitat management. This makes it a difficult policy on which to base adaptive approaches to habitat protection.

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 and to date not quantified, 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.

It is the objective of the Washington departments of Fisheries and Wildlife to achieve a net gain of the productive capacity of the habitat of food fish, shellfish and game fish resources of the state of Washington. This policy guides the agencies in decisions affecting habitat.

Progress toward the objective of a net gain in the productive capacity of the state's food fish, shellfish and game fish habitat can be achieved by pursuit of three goals:

1) Maintain the present productive capacity of all aquatic habitat.

2) Restore the productive capacity of habitats that have been damaged or degraded by natural causes or as a result of man's activities.

3) Improve the productive capacity of existing habitat and create new habitat.

In general, the policy will be pursued by implementing the four broad strategies:

1) Actively enforce the habitat protection laws in the of the state of Washington.

2) Repair damaged habitat.

3) Devise and implement methods for removing limiting factors on specific populations.

4) Actively pursue applied research required to maintain, restore and improve the productive capacity of habitat.

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 program 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 Northwest Power Act are to be realized.

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

7) Fund the development of a habitat risk assessment plan for the Elochoman River watershed.

PART III. CONSTRAINTS AND OPPORTUNITIES FOR ESTABLISHING PRODUCTION OBJECTIVES

Institutional Considerations

Existing harvest management for stocks originating below Bonneville Dam is largely based on hatchery escapement needs. This overriding consideration sets the basic framework for all production strategies. Since the harvest management system accounts for only large aggregate stocks, production plans for subbasins below Bonneville should avoid management complexity.

In general, subbasin plans should promote production that:

1. Stabilizes harvest.
2. Provides fishing opportunities for a variety of user groups.
3. Addresses long-term habitat productivity.
4. Optimizes production from existing opportunities and explores new ones.
5. Promotes stock diversity and relies on a variety of production methods.
6. Relies on adaptive practices to maintain dynamic plans.

Legal Considerations

The United States vs. Oregon management plan imposes some specific production constraints that must be considered in subbasin plans below Bonneville (such as the transfer of Washougal River coho to the Klickitat River). No specific considerations were made for the Elochoman River. Harvest allocation of production originating below Bonneville Dam in the Columbia River is not presently subject to specific treaty and non-treaty fishery allocation requirements. It is unlikely though that significant shifts of production that would substantially upset existing fishery balances would be acceptable to the parties to United States vs. Oregon.

Critical Data Gaps

Significant data gaps frustrate detailed planning for Elochoman River anadromous fish. Even though many of these pertain to natural production, others impinge on hatchery production options. Some information needs are specific to the subbasin such as carrying capacity, others like estuary limiting factors are regionally important. Strategies should be developed so that their implementation and evaluation provide data in these critical areas:

1) Natural stock status (coho, winter steelhead).

2) Carrying capacity of subbasin (all stocks).

3) Stock productivity (all stocks).

4) Estuary and early marine limiting factors (all stocks).

5) Species interactions (coho, winter steelhead, chum).

PART IV. ANADROMOUS FISH PRODUCTION PLANS

FALL CHINOOK SALMON

<u>Fisheries Resource</u>

Natural Production

The size of historical fall chinook runs in the Elochoman River are difficult to determine. At the time the first fisheries surveys were conducted in the 1940s, the natural stream habitat had been seriously damaged by logging practices. Records of initial surveys done for the Columbia River Fisheries Development Program in 1948 and 1949 document serious logjams, splash dams forming complete blockages, and logging-related landslides, siltation, and erosion. These impacts, coupled with harvest, limited natural production in this period.

In 1951 estimated annual escapement of fall chinook in the Elochoman River was 2,000 fish. Today, the most heavily spawned area is in the main river above tidewater. A weir just above tidewater is used to collect fall chinook for the hatchery. When the hatchery has reached its egg-take goal, the remaining fish are allowed to proceed into the watershed and spawn naturally. On favorable flows they could go as high as the dam at the hatchery at RM 9.2.

Entry of adults into the subbasin occurs from early September to November. Natural escapement estimates for the Elochoman River has averaged 722 fish during 1977 through 1986 (Table 1). Spawning occurs from late September to mid-November with a peak usually in mid-October. Mark sampling on the spawning grounds indicates natural spawners are largely hatchery origin. The run is predominately composed of 3-year-old fish (Table 2). Average fecundity for the stock is 4,730 eggs per female, based on Form 46 records at the Elochoman River Hatchery for 1978 through 1086. Male-female ratios are 1-to-0, 2.07-to-1, 0.62-to-1, and 0.81-to-1 for 2-, 3-, 4- and 5-year-old returns, respectively.

Table 1. Subbasin run size, catch and escapement for Elochoman River fall chinook (1977-1986).

Return Year	Sport Catch[1]		Natural Escapement[2]		Hatchery Escapement[3]		Total	
	Jacks	Adults	Jacks	Adults	Jacks	Adults	Jacks	Adults
1977	17	10	95	568	0	1,815	53	3,393
1978	37	144	0	1,846	0	1,755	37	3,745
1979	8	16	0	1,478	0	1,165	8	2,659
1980	29	23	0	64	0	1,064	29	1,151
1981	14	43	0	138	1	633	15	814
1982	29	102	23	317	3	2,059	55	2,478
1983	356	82	0	1,016	1	2,690	357	3,788
1984	72	80	2	292	6	1,708	80	2,080
1985	32	236	57	407	23	1,809	112	2,452
1986	94	103	360	555	139	1,515	593	2,173

1 From Washington state sport catch reports 1977-1986.
2 From WDF unpubl. data; many of the natural spawners are of hatchery origin.
3 From Columbia River Hatchery Returns 1972-1986. Steven D. King, March 1987

Table 2. Size and age composition of Elochoman River fall chinook, 1982-1987.

Age	Percent of Run[1]	Size[2]			
		Male		Female	
		Average	Range	Average	Range
2	1.4	52.0	40-74	--	--
3	58.8	82.0	46-112	79.7	67-98
4	38.2	93.3	64-114	89.2	68-107
5	1.6	98.5	81-115	92.4	79-103

1 From WDF unpubl. data, Elochoman River Hatchery returns 1982-1987.
2 From Washington state sport Catch reports 1977-1986

Hatchery Production

Hatchery releases of tule fall chinook began in 1950 when 70,000 fingerlings were released. This supplementation continued until the Elochoman River salmon hatchery was constructed under the Lower Columbia River Fishery Development Program. Brood stock for these hatcheries was obtained from local stock or from transfers from other hatcheries. Spring Creek Hatchery fall chinook (Bonneville Pool Hatchery stock) have been the primary fall chinook stock transferred to lower river hatcheries.

Straying of lower river hatchery (LRH) fall chinook from a number of Oregon and Washington hatcheries is not unusual, and contributes to natural production. The overall result of straying and transfers of fall chinook at lower Columbia River hatcheries is the development of a widely distributed, blended hatchery stock. Returns of adults to the hatchery has averaged 1,621 fish from 1977 through 1986 (Table 1). Juvenile releases in this same period are presented in Table 3.

Table 3. Hatchery production on fall chinook for Elochoman River hatchery, 1975-1984 brood years.

Brood Year	Number Released Fry	Fingerling	Fall Release
1975		2,786,055	
1976		2,397,342	138,024
1977	1,236,750	2,329,531	
1978	564,515	2,875,406	
1979		4,790,886	
1980		2,220,093	
1981		285,062	
1982		2,558,000	
1983		2,796,000	
1984		2,562,000	
1985		2,502,873	

Harvest

Lower river hatchery fall chinook contribute to ocean commercial and recreational fisheries from Alaska to the Columbia River. Mainstem Columbia river gill net fisheries and recreational fisheries also harvest this stock. From 1983 through 1987, the overall harvest rate was 81 percent. Aggregate escapement requirements at Oregon and Washington hatcheries has on occasion restricted mainstem fisheries and is actively managed for, however natural escapement is not. A small subbasin recreational harvest occurs annually (Table 1).

Specific Considerations

- All production is considered to be from one stock (lower river hatchery), and straying of hatchery fish into natural production areas or transfer of eggs between hatcheries is not a management concern.
- Relatively short freshwater residence makes fall chinook a good subject for pen rearing.
- Total harvest rates for the most recent five year period averaged 81 percent.
- LRH fall chinook are managed for hatchery escapement needs.
- Limiting factors in the estuary or early marine life stage of the stock are unknown, increasing the uncertainty about advisability of increased production in fresh water.

Objectives

Columbia River fall chinook production (predominately from hatcheries) is a major contributor to the catches in Washington and Oregon ocean fisheries. Significant commercial net catch and recreational fishing occurs in the mainstem as well and minor catches are recorded in individual tributary streams.

The overall approach to fall chinook production advanced in this subbasin plan works within the context of existing harvest management regimes utilizing both hatchery and natural production opportunities.

The general objectives in order of priority for Elochoman River fall chinook are:

1. Provide for increased catches in ocean recreational and commercial fisheries.

2. Provide for increased recreational opportunities in tributaries and mainstem fisheries.

3. Provide for increased mainstem commercial catch.

All of these general objectives are subject to current constraints on harvest rates set to meet escapement needs of critical Oregon and Washington hatchery chinook stocks.

Biological Objectives

1. Reduce pre-spawning mortality of hatchery fish.

2. Improve the productivity of the natural stock and utilize natural production potential of the subbasin.

Utilization Objective

Provide a total harvest of 25,000 fish. It is expected that ocean and mainstem fisheries will be the primary beneficiaries of additional harvest with a smaller portion available for harvest in a subbasin recreational fishery.

Alternative Strategies

Alternative strategies are organized according to the level of artificial intervention in stock production. Strategy 1 addresses actions to improve natural production. Strategy 2 augments production with hatchery fish in ways that should lead to higher levels of natural production. Strategy 3 imposes traditional hatchery approaches to meeting the objective. Other combination strategies may also be listed.

Modeling results for each strategy are presented in Table 4 as fish produced at "maximum sustainable yield" (MSY). The sustainable yield of a fish population refers to that portion of the population that exceeds the number of fish required to spawn and maintain the population over time. Sustainable yield can be "maximized," termed MSY, for each stock at a specific harvest level. The MSY is estimated using a formula (Beverton-Holt function) that analyzes a broad range of harvest rates. Subbasin planners have used MSY as a tool to standardize results so that decision makers can compare stocks and strategies.

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

The amount of buffer appropriate for each stock is a management question not addressed in the subbasin plans. For this reason, the utilization objective, which usually refers to harvest, may not be directly comparable to the MSY shown in Table 4. At a minimum, a strategy should produce an estimated MSY equal to or greater than the utilization objective. A MSY substantially larger than the subbasin utilization objective may be needed to meet subbasin biological objectives.

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

STRATEGY 1: Natural Production. Proposed actions are designed to promote natural production of fall chinook in the Elochoman River.

ACTIONS: 1-4

1. Emphasize habitat protection through continuation and expansion of state regulatory programs, including the Fisheries code, the Shorelines Management Act and the Forest Practices Act.

2. Develop a habitat risk assessment map for the watershed to be used by state and local agencies when reviewing and permitting forest practices (see Part II of this report).

3. Ensure enough chinook are passed above the trap at tidewater and weir at the hatchery to adequately use the available habitat.

4. Identify and correct man-caused sources of sediment.

STRATEGY 2: Supplementation. This strategy incorporates actions from Strategy 1 and proposes construction of net pen facilities.

ACTIONS: 1-5

1. -
2. -

3. -
4. -

5. Construct and operate net pens in the Elochoman River slough to produce an additional 500,000 fall chinook fingerlings.

STRATEGY 3: Hatchery Production. Existing juvenile production is assumed to be doubled and the chronic pre-spawning mortality associated with existing trapping and holding procedures are substantially improved. It may be difficult to achieve a doubling of existing juvenile production.

ACTIONS: 5-7

5. -

6. Construct holding and spawning facilities at the trap just above tidewater.

7. Double juvenile production to approximately 6 million fish through use of net pens (Action 5), use of new holding and spawning facilities for juvenile rearing, and reprogramming of hatchery (3 million fingerlings new production).

STRATEGY 4: Combination. This strategy combines actions from the previous three strategies.

ACTIONS: 1-7 (see above)

STRATEGY 5: Hatchery Production. This strategy addresses pre-spawning losses only.

ACTIONS: 8

8. Construct holding and spawning facilities to be used for adult purposes only.

STRATEGY 6: Combination. This strategy combines actions from Strategy 1 and incorporates a net pen program for 100,000 smolts. The pond at the trap site is also used to rear an additional 1 million juveniles.

ACTIONS: 1-4, 9, 10

1. -
2. -
3. -
4. -

9. Construct and operate net pens in the Elochoman River slough to produce an additional 100,000 fall chinook juveniles.

10. Use the pond at the trap site to rear an additional 1 million juvenile fall chinook.

Recommended Strategy

Strategy 6 is recommended for implementation. This suite of actions represents the greatest benefits within the realistic constraints and opportunities to production in the watershed. This strategy is also best aligned with the policies (see Appendix A) set down to guide the Northwest Power Planning Council Columbia Basin Fish and Wildlife Program.

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

Utilization Objective:
Provide a harvest of 25,000 fish. It is expected that ocean and mainstem fisheries will be the primary beneficiaries of additional harvest with a smaller portion available for harvest in a subbasin recreational fishery.

Biological Objective:
1. Reduce pre-spawning mortality of hatchery fish. 2. Improve the productivity of the natural stock and utilize natural production potential of the subbasin.

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	347 -C	2,337	3,473	19,945	0(1.00)
All Nat	575 -N	2,273	3,595	20,646	824(1.04)
1	575 -N	2,273	3,595	20,646	824(1.04)
2	774 -N	2,463	4,071	23,379	4,033(1.17)
3	2,297 -N	4,823	7,656	43,959	28,198(2.20)
4	2,376 -N	4,759	7,663	43,998	28,245(2.21)
5	766 -C	2,444	3,481	19,989	53(1.00)
6*	1,159 -N	2,819	4,291	24,639	5,513(1.24)

*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 production. Proposed actions are designed to promote natural production of fall chinook in the Elochoman River. Pre Mainstem Implementation.
2. Strategy 1 plus supplementation. Pre Mainstem Implementation.
3. Hatchery production. Pre Mainstem Implementation.
4. Strategies 2 and 3. Pre Mainstem Implementation.
5. Hatchery production. This strategy addresses pre-spawning losses only. Pre Mainstem Implementation.
6. Strategy 1 plus net pen program for 1 million smolts. 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 5. Estimated costs of alternative strategies for Elochoman fall chinook. Cost estimates represent new or additional costs to the 1987 Columbia River Basin Fish and Wildlife Program; they do not represent projects funded under other programs, such as the Lower Snake River Compensation Plan or a public utility district settlement agreement. (For itemized costs, see Appendix C.)

	Proposed Strategies					
	1	2	3	4	5	6*
Hatchery Costs						
Capital[1]	0	0	690,000	690,000	0	230,000
O&M/yr[2]	0	12,500	87,500	87,500	0	27,500
Other Costs						
Capital[3]	0	150,000	250,000	250,000	100,000	130,000
O&M/yr[4]	0	50,000	60,000	60,000	10,000	20,000
Total Costs						
Capital	0	150,000	940,000	940,000	100,000	360,000
O&M/yr	0	62,500	147,500	147,500	10,000	47,500

* Recommended strategy.

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

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

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

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

COHO SALMON

Fisheries Resource

Natural Production

U.S. Fish and Wildlife Service surveys in 1936 and 1937 indicated coho were present in all accessible tributaries of the Elochoman River, but no population estimates were made. At this time portions of the watershed were being logged and splash dams, log and debris jams, and logging through the streams was detrimental to fish production. Under the Columbia River Fisheries Development Program some of these problems were addressed on an ad hoc basis and production was further expanded by removing natural and man-made barriers to migration.

The precise distribution of coho in the watershed is unknown. Anecdotal information suggests coho spawn in most accessible tributaries. Escapement figures are not known since no directed surveys are done. The hatchery dam on the main river shunts all coho into the hatchery holding pond until the egg-take requirements are met, after which the ladder is opened to the river and fish are allowed to proceed upstream.

Early descriptions of coho runs in Columbia River tributaries suggest that time of return and spawning spanned a broad seasonal period in the same watershed. Today, hatchery stocks are generally referred to as early (Type S) and late (Type N). Type-S coho are distributed in a more southerly ocean area, and contribute to coastal Oregon fisheries more heavily than their more northerly distributed Type-N cohorts. It is possible that the timing of the stocks may be more an artifact of hatchery selection than a stock specific trait since early records from the Toutle River indicate a wide spawning timing for Type-S coho. Both stocks are probably represented on the spawning grounds in the Elochoman River today.

Type-S coho enter the Columbia River by mid-August and begin entering tributary streams in early September. Spawning activity peaks between October 20 and November 1. The only data collected on natural escapement has been incidental to directed fall chinook surveys and no estimates of annual escapements are available. Type-N coho pass through the lower Columbia in mid-October, entering tributary streams in November and spawning into late November and December. For purposes of this report and when natural run sizes were required for modeling, natural escapement has been assumed to be 10 percent of the hatchery return. Available run size data on both stocks is presented in Tables 6 and 7. In the absence of any data, this value was selected based on escapement studies from the Cowlitz River (DeVore 1987).

Both Type-S and Type-N stocks are reared at the Elochoman Salmon Hatchery. Biological data collected at the hatchery is assumed to be applicable to naturally produced fish since the magnitude of hatchery production, high regional harvest rates, and the weir have affected the status of natural production. Approximately 75 percent to 80 percent of the run returns as 3-year-olds for the Type-N and Type-S stocks, respectively. Fecundity of the Type-S stock (2,830 eggs per female) is slightly higher than the Type-N stock (2,670 eggs per female).

The juvenile life history for subbasin coho is similar to that of other stocks in the region with a spring emergence, followed by a full year of freshwater residence prior to ocean migration the following spring. Subbasin natural production potential was estimated to be 43,393 smolts using the Smolt Density Model.

Table 6. Subbasin run size, catch and escapement for Elochoman River Type-N coho.

Year	Sport Catch		Hatchery Escapement		Total Return[1]	
	Jacks	Adults	Jacks	Adults	Jacks	Adults
1977	96	15	1,215	623	1,311	638
1978	26	96	596	1,677	622	1,773
1979	84	89	694	2,151	778	2,240
1980	96	52	486	4,240	582	4,293
1981	56	373	0	45	56	410
1982	274	966	599	1,895	873	3,154
1983	728	83	609	495	1,337	580
1984	365	713	1,234	2,094	1,615	2,846
1985	279	874	892	5,563	1,171	6,437
1986	158	1,219	682	5,548	840	6,677

[1] Natural escapement and hatchery strays are not included since no systematic spawning ground surveys are done for coho.

Table 7. Subbasin run size, sport catch and escapement of Elochoman Type-S coho.

Year	Sport Catch		Hatchery Escapements		Total Returns[1]	
	Jacks	Adults	Jacks	Adults	Jacks	Adults
1977	117	77	1,481	706	1,598	783
1978	84	330	1,925	5,766	2,009	6,096
1979	329	715	2,716	8,138	3,045	8,853
1980	120	126	547	4,779	667	4,905
1981	50	403	241	2,562	291	2,965
1982	181	1,660	0	11,856	181	13,516
1983	441	104	-	-	441	104
1984	471	621	-	-	471	621
1985	179	1,369	-	-	179	1,369
1986	120	113	-	-	120	113

[1] Natural escapement is not included since no systematic spawning ground surveys are done for coho.

Hatchery Production

Elochoman River Hatchery is located on the Elochoman River, seven miles northwest of Cathlamet, Washington, on State Highway 407. The hatchery was built in 1954 with funds from the Columbia River Fishery Development Program and currently administered through the National Marine Fisheries Service.

The hatchery has 20 concrete raceways, two large rearing ponds (one asphalt and one dirt bottom), and a large dirt bottom adult holding pond that doubles as a juvenile rearing pond. Incubation facilities consist of concrete deep troughs, vertical incubators, and a few concrete shallow troughs.

Water is supplied by gravity flow from two intakes on the Elochoman River -- one located upstream of the hatchery and one at the barrier dam. Additional incubation water is supplied by gravity flow from an intake on Clear Creek. Also, the large dirt bottom pond receives water from a small creek (Hatchery Creek) on the hatchery grounds.

Adults are spawned without selectivity at a 1-1 ratio. In years where large returns of coho are present, the ratio can be 1-to-3. These practices are consistent with the Salmon Culture Spawning Guidelines and the Salmon Culture Genetics Policy.

Hatchery releases of Type-N and Type-S stocks are indicated in Tables 8 and 9, respectively.

Table 8. Hatchery production of Elochoman River Type-N coho, 1975-1985 brood years.

Brood Year	Number Released: Fry	Fingerling	Smolts
1975		1,344,067	1,311
1976		1,000,000	622
1977		1,872,367	778
1978		1,243,940	582
1979	161,660	893,270	56
1980	580,000	1,053,823	2,719,000
1981		145,256	2,655,000
1982	211,500	2,507,000	
1983	531,800	1,703,000	
1984	304,000	1,700,000	
1985	28,800	1,313,691	

Table 9. Hatchery production of Elochoman River Type-S coho, 1975-1985 brood years.

Brood Year	Number Released Fry	Fingerling	Smolts
1975			950,950
1976			2,697,541
1977			1,760,127
1978	245,000		2,610,836
1979		183,756	1,769,730
1980[1]			
1981			
1982			
1983			
1984			
1985		64,900	

[1] Type-S coho production suspended at the Elochoman Salmon Hatchery after 1979 brood releases.

Harvest

Harvest of coho originating from the Elochoman River Subbasin occurs primarily in ocean and mainstem fisheries. A small inriver sport catch is logged annually (Tables 6 and 7). Harvest rates have averaged 79 percent and 85 percent for Type-S and N stocks, respectively, between 1983 and 1987. Harvest of Type-S coho is occasionally constrained by one or more of the fall chinook stocks. Harvest of Type N is generally not constrained by weak stocks, hatchery escapement being the only management constraint.

Specific Considerations

- o Coho production areas downstream from Bonneville Dam on the Columbia River are managed for hatchery escapement requirements. Harvest rates can exceed 90 percent and natural production is an incidental bonus not actively managed for.

- o Anecdotal information on juvenile summer rearing densities indicate natural coho production is depressed and absent in some tributaries of the Elochoman that could be producing coho.

- o Hatchery rack returns over the last decade have generally been sufficient for the hatchery program needs at the Elochoman River Hatchery.

Objectives

Columbia River coho production (predominately from hatcheries) is a major contributor to the catches in Washington and Oregon ocean fisheries. Significant commercial net catch and recreational fishing occurs in the mainstem as well.

The overall approach to coho production advanced in this subbasin plan works within the context of existing harvest management regimes utilizing both hatchery and natural production opportunities.

The general objectives in order of priority for Elochoman River coho are:

1. To provide for increased catches in ocean recreational and commercial fisheries.

2. To provide for increased recreational opportunities in tributaries and mainstem fisheries.

3. To provide for increased mainstem commercial catch.

All of these general objectives are subject to current constraints on harvest rates set to meet escapement needs of critical Oregon and Washington hatchery coho stocks.

Biological Objective

Improve the productivity of the natural stock and utilize natural production potential of the subbasin.

Utilization Objective

Provide a total harvest of 25,500 fish. It is expected that ocean and mainstem fisheries will be the primary beneficiaries of additional harvest with a smaller portion available in the subbasin for a recreational fishery. Use of Type-S stock for a portion of the hatchery production will provide a group of fish for the recreational fishery in the subbasin.

Alternative Strategies

Alternative strategies are organized according to the level of artificial intervention in stock production. Strategy 1 addresses actions to improve natural production. Strategy 2 augments production with hatchery fish in ways that should lead to higher levels of natural production. Strategy 3 imposes traditional hatchery approachers to meeting the objective. Other combination strategies may also be listed.

Modeling results for each strategy are presented in Table 10 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 10. 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.

A number of alternative strategies are proposed and were modeled. Some of the strategies may not be feasible given the limitations in the subbasin. However, as a point of reference to begin assessing the effect of various production scenarios they are retained through this draft.

Estimated costs of the alternative strategies below are summarized in Table 11.

Type-S Coho

The Recreational Fishery Enhancement Plan of the Washington Department of Fisheries (WDF, November 1989), includes an action to reestablish Type-S production in the Elochoman. Five-hundred thousand Type-S smolts would be produced in lieu of the same number of Type-N smolts. This strategy is not new production and therefore was not modeled. It would however, mean a transfer of yield between fisheries. It is estimated that for every 0.5 million shift in production from Type N to Type S, Washington coastal fishery opportunity will be reduced by 1,300 fish while the inriver tributary recreational fishery will be increased by 10 percent to 15 percent of that loss.

Type-N Coho

STRATEGY 1: Natural Production. Proposed actions are designed to promote natural production of coho in the Elochoman River.

ACTIONS: 1-5

1. Emphasize habitat protection through continuation and expansion of state regulatory programs, including the Fisheríes code, the Shorelines Management Act, and the Forest Practices Act.

2. Develop a habitat risk assessment map for the watershed to be used by state and local agencies when reviewing and permitting forest practices (see Part II of this report).

3. Ensure coho are allowed upstream of the hatchery rack on the main Elochoman River and on Beaver Creek.

4. Identify and correct man-caused sources of sediment.

5. Evaluate the production potential of the watershed and the existing status of natural production, and develop proposals to ensure adequate juvenile recruitment through adult or juvenile releases.

STRATEGY 2: Supplementation. Based on a slightly lower harvest rate, the Type-S stock may be a better candidate for augmenting natural production than Type N. However, Type N may have an advantage since it migrates upstream during a period when streamflows are higher, allowing deeper penetration into the watershed.

ACTIONS: 1-6

1. -
2. -
3. -
4. -
5. -

6. Release enough adult or fry to adequately use the watershed smolt production potential to ensure natural seeding levels are at optimal levels. The current estimate of fry needed for this purpose is 1.2 million.

STRATEGY 3: Hatchery Production. This strategy will require improvements to facilities.

ACTIONS: 7

7. Improve facilities, principally altering the shape and outfall structures of existing ponds to produce 1 million additional smolts.

STRATEGY 4: Hatchery Production. This strategy consists of all of the previous actions.

ACTIONS: 1-7 (see above)

STRATEGY 5: Hatchery Production. Existing smolt production is doubled. It is unlikely that this kind of production could be sustained at the hatchery.

ACTIONS: 7, 8

7. -

8. Develop facilities and reprogram hatchery production.

Recommended Strategy

Strategy 4 is recommended for implementation. This suite of actions represents the greatest benefits within the realistic constraints and opportunities to production in the watershed.

Table 10. System Planning Model results for late-run coho in the Elochoman Subbasin. Baseline value is for pre-mainstem implementation, all other values are post-implementation.

Utilization Objective:
Provide a total harvest of 25,500 fish. It is expected that ocean and mainstem fisheries will be the primary beneficiaries of additional harvest with a smaller portion available in the subbasin for a recreational fishery. Use of Type-S stock for a portion of the hatchery production will provide a group of fish for the recreational fishery in the subbasin.

Biological Objective:
Improve the productivity of the natural stock and utilize natural production potential of the subbasin.

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	48 -N	4,483	4,766	14,260	0(1.00)
All Nat	99 -N	4,598	4,938	14,774	687(1.04)
1	99 -N	4,598	4,938	14,774	687(1.04)
2	99 -N	4,608	4,950	14,809	732(1.04)
3	68 -N	6,357	6,759	20,222	7,955(1.42)
4*	70 -N	6,538	6,951	20,797	8,723(1.46)
5	91 -N	8,583	9,126	27,306	17,405(1.91)

*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 production. Proposed actions are designed to promote natural production of coho in the Elochoman River. Pre Mainstem Implementation.
2. Strategy 1 plus supplementation. Pre Mainstem Implementation.
3. Hatchery production. Improve facilities. Pre Mainstem Implementation.
4. Strategies 2 and 3. Pre Mainstem Implementation.
5. Strategy 3 plus double smolt production at the hatchery. 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 11. Estimated costs of alternative strategies for Elochoman Type-N 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	4*	5
Hatchery Costs					
Capital[1]	0	69,000	1,644,500	1,713,500	1,644,500
O&M/yr[2]	0	7,500	178,750	186,250	178,750
Other Costs					
Capital[3]	0	0	100,000	100,000	100,000
O&M/yr[4]	0	0	5,000	5,000	5,000
Total Costs					
Capital	0	69,000	1,744,500	1,813,500	1,744,500
O&M/yr	0	7,500	183,750	191,250	183,750

* 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

Fisheries Resource

Natural Production

Chum salmon are native to the Elochoman River. Although natural production is much reduced over historic levels, a small remnant run still returns to spawn. Washington Department of Fisheries reports for the Lower Columbia River Fishery Development Program in 1951 estimated chum escapement in the Elochoman River to be about 1,000 fish, spawning mainly in the lower reaches of the main river above tidal influence. This was in the period when Columbia River chum stocks declined precipitously. In 1973, the Washington Department of Fisheries reported a small run to the river.

Directed spawning ground surveys are not conducted in the Elochoman River for chum and no estimates are available on current run size or biological characteristics of the stock. Similar data for Grays River chum should be applicable. Adults migrate into the river from mid-October through November with peak spawner abundance occurring in late November. Scale analysis indicates 3- and 4-year-old fish are the dominant age classes. A few fish return as 5-year-olds, but none as 2-year-old jacks. Males predominate in the 5-year-old class.

Recent stream enhancement work by the Washington Department of Fisheries in the Grays River watershed at Gorley Springs has been relatively successful and may increase basin chum production by providing a stable incubation environment. The same kind of project could support rebuilding the Elochoman River chum stock. It is expected that suitable sites are available for such projects.

Hatchery Production

Occasional releases of chum fry have been made in the basin. Egg-box programs in 1978, 1979 and 1980 released 50,000, 376,000 and 475,000 fry (Hood Canal stock), respectively. The present low numbers of chum in the Columbia River made it necessary to use stock from outside the area. No spawning ground surveys were conducted in subsequent years to determine the success of these releases.

The Elochoman River Salmon Hatchery does not raise chum and planners anticipate that any future supplementation of the run would be through the use of portable egg incubators and direct release of emergent fry or short-term rearing (up to one month) in portable raceways and on-site release of the fed fry. To preserve the remaining stock, planners recommend that any future supplementation be done with either entirely Grays River stock or a cross of Willapa Bay females (Nemah River) with Grays River males.

Harvest

Maximum historical chum landings for the Columbia River have been estimated at 697,000 fish in 1928 (Northwest Power Planning Council 1986). In 1942 landings were 425,000 fish, but by 1955 they had diminished to 10,000 fish. It is impossible to determine what portion of those catches might have been of Elochoman River origin. Today, chum are harvested in mainstem gill net fisheries primarily from late October through the first half of November. Harvest of chum is incidental to directed coho and fall chinook fisheries. Since 1965, commercial landings have been less than 2,000 fish (Columbia River Fish Runs and Fisheries 1988).

No tributary harvest of chum occurs and the species is not a desired recreational subject. Harvest is generally constrained in main river gill net fisheries by the presence of winter steelhead. However, the early to middle portion of the run can be harvested along with Type-N fall coho and lower river hatchery (LRH) fall chinook.

Harvest rates on chum are difficult to determine since the escapement portion of the composite Columbia River run is difficult to enumerate. Local biologists familiar with the fisheries and the spawning ground assessments in Washington suggest the harvest rate approximates 35 percent to 50 percent.

Specific Considerations

- The Columbia River is near the southernmost extreme of the distribution of chum salmon. As such, environmental perturbations may have had particularly significant effects. Conversely, habitat enhancement projects may have significant beneficial effects.
- Columbia River chum stocks are less than 0.5 percent of historic levels (Northwest Power Planning Council 1986).
- Chum are harvested incidentally to coho and fall chinook in mainstem commercial gill net fisheries.

- Currently no donor stocks exist for supplementation, however, opportunities are available at Abernathy Salmon Technology Center to develop a stock for release in tributary streams. It may take several generations to establish a sizeable stock.

Objectives

The overall approach to chum production advanced in this subbasin plan utilizes hatchery and natural production opportunities. It is proposed that a donor stock be established at the Abernathy Salmon Technology Center for reintroduction and enhancement of other Columbia River chum stocks, including the Elochoman River. Simultaneously, the existing run would be enhanced through habitat improvement projects designed to improve intragravel survival.

Biological Objective

Rebuild the Elochoman River chum run with a stock that has an appropriate genetic background.

Utilization Objective

Provide a total harvest of 4,500 fish. It is expected that most of these fish would be taken by mainstem Columbia River gill net fisheries.

Alternative Strategies

Three alternative strategies are presented for consideration. Strategies were not modeled for chum using the System Planning Model. However, because the stock has a relatively simply harvest distribution and because of the location of the subbasin in the Columbia River drainage, projections of benefits are relatively simply. Planners did not estimate costs for the following strategies.

STRATEGY 1: Natural Production. Proposed actions are designed to promote natural production of chum in the Elochoman River. This strategy relies on the resiliency of the natural run to rebuild using new spring-fed, off-channel spawning sites. It is assumed that the development of these sites will encourage colonization by spawning adults and that intragravel and survival of their progeny will be significantly improved.

ACTIONS: 1-4

1. Emphasize habitat protection through continuation and expansion of state regulatory programs, including the Fisheries code, the Shorelines Management Act, and the Forest Practices Act.

2. Develop a habitat risk assessment map for the watershed to be used by state and local agencies when reviewing and permitting forest practices (see Part II of this report).

3. Identify and remedy man-caused sources of sediment.

4. Develop two spring-fed natural spawning and incubation channels. One site is the Gorley Spring channel that could be expanded and improved; another good site exists on Crazy Johnson Creek.

STRATEGY 2: Supplementation. This strategy assumes that existing habitat conditions are acceptable for chum production and relies on releases of a donor stock alone to rebuild the run.

ACTIONS: 5

5. Introduce chum fry to selected tributaries of the Elochoman River through the use of 1) on-site streamside incubators (Fuss and Seidel 1987) or 2) off-site incubation and short-term, on-site rearing for imprinting size advantage.

STRATEGY 3: Combination. This strategy consists of all the previous actions. It assumes the value of improved habitat conditions to promote efficient natural production. It also assumes the most rapid way to rebuild the run would be to combine releases of a donor stock and improve the habitat.

ACTIONS: 1-5 (see above)

Recommended Strategy

Strategy 3 is recommended for implementation. This combination of actions should promote rebuilding the Elochoman River chum run in a sustainable way and promote long-term productivity of the stock.

SUMMER STEELHEAD

Fisheries Resource

Natural Production

No historical records of natural production exist for this stock in the Elochoman River. Prior to 1983, summer steelhead in the Elochoman River were hatchery strays.

Hatchery Production

Hatchery releases of summer steelhead began in the Elochoman River in 1982. An average of 39,514 fish have been planted annually (Table 12).

Table 12. Releases of hatchery steelhead into the Elochoman River, 1977-1989 (WDW hatchery release records).

Release Year	Winter Run	Summer Run
1977	93,988	
1978	102,016	
1979	115,894	
1980	99,964	
1981	0	53,694
1982	120,870	54,116
1983	272,359	83,992
1984	106,220	53,917
1985	96,447	10,005
1986	107,053	34,304
1987	110,023	16,850
1988	97,995	25,680
1989	105,093	23,070

Harvest

Since the 1983-1984 harvest season, about 20 percent of the steelhead harvested in the Elochoman River have been summer runs (Table 13). The summer run fishery peaks in June and July.

Table 13. Recreational harvest of steelhead in the Elochoman River, 1977-1986 (WDW punch-card estimates).

Harvest Year	Winter Run	Summer Run
1977-78	3,050	18
1978-79	2,406	25
1979-80	4,655	27
1980-81	3,816	24
1981-82	2,004	17
1982-83	2,948	28
1983-84	4,318	309
1984-85	6,056	600
1985-86	2,858	1,280
1986-87	3,377	1,141
Average	3,549	347

Specific Considerations

- Summer-run steelhead are not indigenous to the Elochoman River and there is no management desire to promote natural production.
- With heavy releases, competition between summer and winter run juveniles could be a problem.
- There is a gradual loss of public fishing access and trend toward fee-only fishing on private land.

Objectives

The general objective for summer steelhead in the Elochoman is to provide a consistent recreational fishing opportunity for anglers to catch and keep a steelhead.

Utilization Objective

Provide 1,200 summer steelhead for sport harvest.

Biological Objective

Reduce potential for competition between hatchery summer and native winter run steelhead in the natural habitat.

Alternative Strategies

Alternative strategies are organized according to the level of artificial intervention in stock production. Strategy 1 addresses actions to improve natural production. Strategy 2 augments production with hatchery fish in ways that should lead to higher levels of natural production. Strategy 3 imposes traditional hatchery approaches to meeting the objective. Other combination strategies may also be listed.

Modeling results for each strategy are presented in Table 14 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 14. 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 15.

STRATEGY 1: Natural Production. Since summer-run steelhead are not indigenous to the Elochoman River and there is no management intent to promote natural production, which could compete for limited habitat with the native winter run, this strategy is not seriously promoted in the subbasin. Even though a few summers, most likely of hatchery descent, would benefit from a natural strategy, it is not seriously proposed for the stock.

ACTIONS: 1-4

1. Emphasize habitat protection through continuation and expansion of state regulatory programs, including the Fisheries code, the Shorelines Management Act and the Forest Practices Act.

2. Develop a habitat risk assessment map for the watershed to be used by state and local agencies when reviewing and permitting forest practices (see Part II of this report).

3. Identify and correct man-caused sources of sediment.

4. Pass all summer steelhead above trap at tidewater.

STRATEGY 2: Supplementation. This strategy includes the above actions and calls for the release all the existing production from an acclimation pond.

ACTIONS: 1-5

1. -
2. -
3. -
4. -

5. Construct an acclimation facility for existing hatchery smolts.

STRATEGY 3: Hatchery Production.

ACTIONS: 6

6. Increase existing hatchery smolt releases by 30,000 smolts, using typical off-station release methods.

STRATEGY 4: Combination.

ACTIONS: 6, 7

6. -

7. Construct acclimation facilities to accommodate all summer steelhead smolt releases.

Recommended Strategy

Strategy 2 is recommended for implementation. This strategy represents the best combination of production potential, management policy and feasibility. The objectives are met with this strategy.

Table 14. System Planning Model results for summer steelhead (A's) in the Elochoman Subbasin. Baseline value is for pre-mainstem implementation, all other values are post-implementation.

Utilization Objective:
Provide a harvest of 1,200 fish to the recreational fishery annually.

Biological Objective:
Reduce potential for competition between hatchery summer and native winter run steelhead in the natural habitat.

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	913 -N	219	1,156	28	0(1.00)
All Nat	924 -N	208	1,155	29	1(0.00)
1	924 -N	208	1,155	29	1(0.00)
2*	1,026 -N	231	1,283	32	130(1.11)
3	1,516 -N	280	1,827	45	688(1.58)
4	1,707 -N	293	2,033	50	898(1.76)

*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 production. Pre Mainstem Implementation.
2. Strategy 1 plus supplementation. Pre Mainstem Implementation.
3. Hatchery production. Increase smolt releases. Pre Mainstem Implementation.
4. Strategy 3 plus construct acclimation facilities. 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 15. Estimated costs of alternative strategies for Elochoman 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	0	138,000	138,000
O&M/yr[2]	0	0	15,000	15,000
Other Costs				
Capital[3]	0	120,000	0	120,000
O&M/yr[4]	0	5,000	0	5,000
Total Costs				
Capital	0	120,000	138,000	258,000
O&M/yr	0	5,000	15,000	20,000

* 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

Historic winter steelhead distribution occurred throughout the mainstem above tidal areas and in accessible tributary streams. The river has good spawning areas above the first five kilometers and in the lower parts of most tributaries. Logging-related habitat problems reduced productivity of the watershed.

Howell et al. (1985) reported that the wild stock enters the river from January to May, with the peak occurring in March. Heavy fishing pressure directed at hatchery origin adults, which return in December and January may have eliminated the earlier returning segment of the wild run.

Estimates for total run size are somewhat lacking, however, Watson (1964) provided estimates for the area above the weir for run year 1962-1963 and to the mouth of the river for run year 1963-1964 based on creel and trapping operations -- 2,947 fish and 2,537 fish, respectively. For run year 1963-1964, Watson calculated the run size above the weir to be 2,259 fish, slightly lower than the previous year's estimate. Lavier (1970) cites total returns of 3,410 and 3,588 fish for the same run years as Watson. A rough estimate of average total run size (7,850 fish) was made for 1963 through 1967 based on an average spawning escapement estimate for those years (5,200 fish) and an average harvest for those years (2,650 fish). These numbers include both hatchery and wild fish.

Adult winter steelhead spawn between February and June, peaking in April and May. Wild steelhead spawn throughout the mainstem Elochoman, the East, North, and West forks, and in the lower reaches of Beaver Creek between March and June (Howell et al. 1985). The majority of wild smolts migrate in April and May, peaking in early May at an age of 2 years and a size of 160 mm (Howell et al. 1985).

The Beaver Creek juvenile trap began operation in 1961 and has operated on an annual basis since. Trapping data suggests that fish are emigrating throughout the year, but that the majority move out beginning in March, peaking during April and May. Lucas (pers. commun.) indicates return rates of hatchery smolts planted since 1979 have averaged 2.8 percent return rate to the creel.

Hatchery Production

Two hatcheries are located within the Elochoman Subbasin -- the Beaver Creek Hatchery (steelhead and cutthroat) and the Elochoman Salmon Hatchery (coho and fall chinook). Beaver Creek Hatchery is located on Beaver Creek several hundred yards upstream from its confluence with the mainstem Elochoman River.

The winter steelhead stock used at Beaver Creek Hatchery was originally from Chambers Creek. The stock was developed during the 1940s from predominantly native Chambers Creek steelhead. The adult return timing of this stock is from mid-November through February, with a strong peak in December and early January. Fecundity of the average size female that has spent two years in the ocean is 4,060 eggs per female (Randolph 1986). Returns to the Beaver Creek Hatchery are composed of 9.3 percent, 83.6 percent, 6.7 percent and 0.2 percent ocean ages 1, 2, 3 and 4, respectively.

Harvest

Recreational harvest on the Elochoman river is primarily a December and January fishery. The use of Chambers Creek Hatchery stock has contributed to the establishment of this winter fishery. Prior to the hatchery, recreational harvest occurred between December and March, with peak harvest often occurring in March.

Prior to the hatchery program, which began in 1955, the four-season average harvest was about 850 fish. The four-year average after hatchery releases increased to about 1,500 fish (LaVier 1960). The hatchery program increased throughout southwest Washington, including the Elochoman River where harvest exceeded 5,000 fish by the early 1970s. More recently, harvests in the range of 2,000 to 4,000 fish have been commonplace.

The hatchery program developed a highly concentrated fishery immediately below the hatchery as well as a few other select locations along the river where fish hold. Currently, fishermen concentrate in the three to four miles of river between Beaver Creek Hatchery and the river's mouth. Attempts to stock fish upstream of the hatchery to spread out the fishing pressure have met with limited success.

Tagging studies during the late 1950s and early 1960s indicate that hatchery origin fish were consistently contributing about 25 percent to the overall harvest of fish in the system. Run size estimates for the 1962 and 1963 run years suggested that sport harvest was taking 86 percent and 68 percent of the total return for those same years, respectively (Lavier 1969).

Specific Considerations

- Current return rates, while not well documented, are felt to exceed those described historically.
- Current harvest rates exceed any documented rates prior to the initiation of supplementation in the 1950s.
- Inadequate access currently limits the full utilization of returning hatchery steelhead.
- An extended period of holding in an upstream area, such as provided by an acclimation pond, could provide for a more desirable distribution of returning adults.
- Wild release regulations are in effect for the subbasin.

Objectives

Stock: Elochoman Natural Winter Steelhead

Utilization Objective: Zero; catch and release only. The utilization component is secondary to the biological component in the subbasin.

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

Stock: Elochoman Hatchery Winter Steelhead

Utilization Objective: 4,000 fish for sport harvest. The utilization objective has priority over the biological objective for this stock within the subbasin.

Biological Objective: Maintain the biological characteristics of the hatchery stock including differential run timing compared to the natural stock. More evenly distribute returning hatchery fish throughout the watershed. The biological objective is secondary to the utilization objective for this stock within the subbasin.

Alternative Strategies

Alternative strategies are organized according to the level of artificial intervention in stock production. Strategy 1 addresses actions to improve natural production. Strategy 2 augments production with hatchery fish in ways that should lead to higher levels of natural production. Strategy 3 imposes traditional hatchery approaches to meeting the objective. Other combination strategies may also be listed.

Modeling results for each strategy are presented in Table 16 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 16. 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 17.

STRATEGY 1: Natural Production. Proposed actions are designed to promote natural production of winter steelhead in the Elochoman River.

ACTIONS: 1-5

1. Emphasize habitat protection through continuation and expansion of state regulatory programs, including the Fisheries code, the Shorelines Management Act and the Forest Practices Act.

2. Develop a habitat risk assessment map for the watershed to be used by state and local agencies when reviewing and permitting forest practices (see Part II of this report).

3. Identify and correct man-caused sources of sediment.

4. Evaluate the production potential of the watershed, the existing status of natural production.

5. Continue wild fish release harvest management.

STRATEGY 2: Supplementation. Proposed actions are designed to promote natural production and achieve an even distribution and consistent returns of hatchery fish. Historically, attempts to return adult fish to other parts of the basin have shown only limited success. This was attempted by simply stocking in upstream areas. Inadequate imprinting to that environment or late releases and consequential imprinting only to the hatchery water source may have contributed to the low success.

ACTIONS: 1-6

1. -
2. -
3. -
4. -
5. -

6. Construct an acclimation pond near the confluence of the main river and the North Fork to be used for acclimation and release of 50,000 smolts of existing production.

STRATEGY 3: Supplementation. Proposed actions are designed to promote natural production, achieve an even distribution and consistent return of hatchery fish.

ACTIONS: 1-5, 7

1. -
2. -
3. -
4. -
5. -

7. Construct acclimation facilities to accommodate all smolts released.

STRATEGY 4: Hatchery Production. Proposed actions are designed to increase the number of fish returning to the subbasin through hatchery releases only.

ACTIONS: 8, 9

8. Release an additional 50,000 smolts annually from the Beaver Creek Hatchery, using typical on-station release methods.

9. Renovate the Beaver Creek Hatchery.

Recommended Strategy

Strategy 2 is recommended for implementation. This strategy represents the best combination of production potential, management policy and feasibility. The objectives are met with this strategy.

Table 16. System Planning Model results for winter steelhead in the Elochoman Subbasin. Baseline value is for pre-mainstem implementation, all other values are post-implementation.

Utilization Objective: Provide a harvest of 4,000 fish to the terminal recreational fishery.

Biological Objective: Maintain biological characteristics of the natural stock.

Strategy[1]	Maximum[2] Sustainable Yield (MSY)	Total[3] Spawning Return	Total[4] Return to Subbasin	Out of[5] Subbasin Harvest	Contribution[6] To Council's Goal (Index)
Baseline	3,590 -N	1,261	4,917	325	0(1.00)
All Nat	3,593 -N	1,262	4,921	325	4(1.00)
1	3,593 -N	1,262	4,921	325	4(1.00)
2*	3,784 -N	1,263	5,113	338	209(1.04)
3	4,029 -N	1,345	5,445	360	562(1.11)
4	4,920 -N	1,476	6,474	428	1,660(1.32)

*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 production. Pre Mainstem Implementation.
2. Strategy 1 plus supplementation. Construct acclimation ponds. Pre Mainstem Implementation.
3. Strategy 1 plus supplementation. Construct more acclimation ponds. Pre Mainstem Implementation.
4. Hatchery 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 17. Estimated costs of alternative strategies for Elochoman 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	0	0	230,000
O&M/yr[2]	0	0	0	25,000
Other Costs				
Capital[3]	0	120,000	120,000	100,000
O&M/yr[4]	0	5,000	5,000	10,000
Total Costs				
Capital	0	120,000	120,000	330,000
O&M/yr	0	5,000	5,000	35,000

* 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

Fall Chinook

Reduce pre-spawning mortality of hatchery fish; improve the productivity of the natural stock and utilize natural production potential of the subbasin; and provide a total harvest of 25,000 fish. It is expected that ocean and mainstem fisheries will be the primary beneficiaries of additional harvest with a smaller portion available for harvest in a subbasin recreational fishery. Planners recommend Strategy 6. This suite of actions represents the greatest benefits within the realistic constraints and opportunities to production in the watershed.

Coho

More evenly distribute returning hatchery fish throughout the watershed; provide the maximum opportunity for recreational fishermen to catch and release a wild fish; and provide a harvest of 4,000 fish to the terminal recreational fishery. Planners recommend Strategy 4 for implementation. This suite of actions represents the greatest benefits within the realistic constraints and opportunities to production in the watershed.

Chum

Rebuild the Elochoman River chum run with a stock that has an appropriate genetic background, and provide a total harvest of 4,500 fish. Planners recommend Strategy 3. The combination of these actions will produce the most rapid and sustainable improvement of chum runs.

Summer Steelhead

Reduce potential for competition between hatchery summer and native winter run steelhead in the natural habitat, and provide a harvest of 1,200 fish to the recreational fishery annually. Planners recommend Strategy 2 for implementation. This strategy represents the best combination of production potential, existing management policy and feasibility. The objectives are met with this strategy.

Winter Steelhead

More evenly distribute returning hatchery fish throughout the watershed; provide the maximum opportunity for recreational fisherman to catch and release a wild fish; and provide a harvest of 4,000 fish to the terminal recreational fishery. Planners recommend Strategy 2. This strategy represents the best combination of production potential, management policy and feasibility. The objectives are met with this strategy.

Implementation

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

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

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APPENDIX A
NORTHWEST POWER PLANNING COUNCIL
SYSTEM POLICIES

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

1) The area above Bonneville Dam is accorded priority.

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

2) Genetic risks must be assessed.

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

3) Mainstem survival must be improved expeditiously.

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

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

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

5) Harvest management must support rebuilding.

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

6) System integration will be necessary to assure consistency.

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

7) Adaptive management should guide action and improve knowledge.

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

APPENDIX B
SMART ANALYSIS

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

1) Extent the subbasin objectives were met

2) Change in maximum sustainable yield

3) Impact on genetics

4) Technological and biological feasibility

5) Public support

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

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

SUBBASIN: Elochoman

STOCK: Fall chinook

STRATEGY: 1

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1 EXT OBJ	4	0.9	20	80	72
2 CHG MSY	5	0.9	20	100	90
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 540

DISCOUNT VALUE 486

CONFIDENCE VALUE 0.9

SUBBASIN: Elochoman

STOCK: Fall chinook

STRATEGY: 2

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	7	0.9	20	140	126
5 PUB SUPT	7	0.9	20	140	126

TOTAL VALUE 540

DISCOUNT VALUE 486

CONFIDENCE VALUE 0.9

SUBBASIN: Elochoman

STOCK: Fall chinook

STRATEGY: 3

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1 EXT OBJ	7	0.9	20	140	126
2 CHG MSY	8	0.9	20	160	144
3 GEN IMP	3	0.9	20	60	54
4 TECH FEAS	1	0.9	20	20	18
5 PUB SUPT	7	0.9	20	140	126

TOTAL VALUE 520

DISCOUNT VALUE 468

SUBBASIN: Elochoman

STOCK: Fall chinook

STRATEGY: 4

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1 EXT OBJ	7	0.9	20	140	126
2 CHG MSY	8	0.9	20	160	144
3 GEN IMP	3	0.9	20	60	54
4 TECH FEAS	1	0.9	20	20	18
5 PUB SUPT	7	0.9	20	140	126

TOTAL VALUE 520

DISCOUNT VALUE 468

CONFIDENCE VALUE 0.9

SUBBASIN: Elochoman

STOCK: Fall chinook

STRATEGY: 5

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1 EXT OBJ	4	0.9	20	80	72
2 CHG MSY	4	0.9	20	80	72
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 540

DISCOUNT VALUE 486

CONFIDENCE VALUE 0.9

SUBBASIN: Elochoman

STOCK: Fall chinook

STRATEGY: 6

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: Elochoman

STOCK: Type N coho

STRATEGY: 1

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1 EXT OBJ	4	0.9	20	80	72
2 CHG MSY	4	0.9	20	80	72
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 520

DISCOUNT VALUE 468

CONFIDENCE VALUE 0.9

SUBBASIN: Elochoman

STOCK: Type N coho

STRATEGY: 2

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

TOTAL VALUE 500

DISCOUNT VALUE 450

CONFIDENCE VALUE 0.9

SUBBASIN: Elochoman

STOCK: Type N 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	7	0.9	20	140	126
5 PUB SUPT	8	0.9	20	160	144

TOTAL VALUE 560

DISCOUNT VALUE 504

CONFIDENCE VALUE 0.9

SUBBASIN: Elochoman

STOCK: Type N coho

STRATEGY: 4

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: Elochoman

STOCK: Type N coho

STRATEGY: 5

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1 EXT OBJ	7	0.9	20	140	126
2 CHG MSY	7	0.9	20	140	126
3 GEN IMP	3	0.9	20	60	54
4 TECH FEAS	2	0.9	20	40	36
5 PUB SUPT	8	0.9	20	160	144

TOTAL VALUE 540

DISCOUNT VALUE 486

CONFIDENCE VALUE 0.9

SUBBASIN: Elochoman

STOCK: Summer steelhead

STRATEGY: 1

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1 EXT OBJ	4	0.9	20	80	72
2 CHG MSY	4	0.9	20	80	72
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	520	
DISCOUNT VALUE		468
CONFIDENCE VALUE		0.9

SUBBASIN: Elochoman

STOCK: Summer steelhead

STRATEGY: 2

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	8	0.9	20	160	144
5 PUB SUPT	8	0.9	20	160	144

TOTAL VALUE	580	
DISCOUNT VALUE		522
CONFIDENCE VALUE		0.9

SUBBASIN: Elochoman

STOCK: Summer steelhead

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: Elochoman

STOCK: Summer steelhead

STRATEGY: 4

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	8	0.9	20	160	144
5 PUB SUPT	8	0.9	20	160	144

TOTAL VALUE 620

DISCOUNT VALUE 558

CONFIDENCE VALUE 0.9

SUBBASIN: Elochoman

STOCK: Winter steelhead

STRATEGY: 1

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

TOTAL VALUE 540

DISCOUNT VALUE 486

CONFIDENCE VALUE 0.9

SUBBASIN: Elochoman

STOCK: Winter steelhead

STRATEGY: 2

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1 EXT OBJ	5	0.9	20	100	90
2 CHG MSY	4	0.9	20	80	72
3 GEN IMP	3	0.9	20	60	54
4 TECH FEAS	8	0.9	20	160	144
5 PUB SUPT	8	0.9	20	160	144

TOTAL VALUE 560

DISCOUNT VALUE 504

CONFIDENCE VALUE 0.9

SUBBASIN: Elochoman

STOCK: Winter steelhead

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	7	0.9	20	140	126
5 PUB SUPT	8	0.9	20	160	144

TOTAL VALUE 580

DISCOUNT VALUE 522

CONFIDENCE VALUE 0.9

SUBBASIN: Elochoman

STOCK: Winter steelhead

STRATEGY: 4

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	4	0.9	20	80	72
5 PUB SUPT	7	0.9	20	140	126

TOTAL VALUE 500

DISCOUNT VALUE 450

CONFIDENCE VALUE 0.9

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: Elochoman River
Stock: Fall Chinook

Action	Cost Categories*	Proposed Strategies 1	2	3	4	5	6**
Habitat Enhancement	Capital:						
	O&M/yr:						
	Life:						
Net Pens	Capital:		150,000	150,000	150,000		30,000
	O&M/yr:		50,000	50,000	50,000		10,000
	Life:		50	50	50		50
Misc. Projects	Capital:			100,000	100,000	100,000	100,000
	O&M/yr:			10,000	10,000	10,000	10,000
	Life:			50	50	50	50
Hatchery Production	Capital:		[a]	690,000[b]	690,000[b]		230,000[c]
	O&M/yr:		12,500	87,500	87,500		27,500
	Life:		50	50	50		50
TOTAL COSTS	Capital:	0	150,000	940,000	940,000	100,000	360,000
	O&M/yr:		62,500	147,500	147,500	10,000	47,500
	Years:		50	50	50	50	50
Water Acquisition		N	N	N	N	N	N
Fish to Stock	Number/yr:		500,000	3,500,000	3,500,000		1,100,000
	Size:		J, 100/lb.	J, 100/lb.	J, 100/lb.		J, 100/lb.
	Years:		50	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] Estimated capital costs are associated with net pens, for which planners have calculated costs independently (see above).

[b] Capital costs calculated for 3 million fish only. The capital costs for producing the remaining 500,000 fish are covered under the net pen program.

[c] Capital costs calculated for 1 million fish only. The capital costs for producing the remaining 100,000 fish are covered under the net pen program.

ESTIMATED COSTS FOR ALTERNATIVE STRATEGIES

Subbasin: Elochoman River
Stock: Type-N Coho Salmon

Action	Cost Categories*	Proposed Strategies 1	2	3	4**	5
Habitat Enhancement	Capital:					
	O&M/yr:					
	Life:					
Screening	Capital:					
	O&M/yr:					
	Life:					
Barrier Removal	Capital:					
	O&M/yr:					
	Life:					
Misc. Projects	Capital:			100,000	100,000	100,000
	O&M/yr:			5,000	5,000	5,000
	Life:			50	50	50
Hatchery Production	Capital:		69,000	1,644,500	1,713,500	1,644,500
	O&M/yr:		7,500	178,750	186,250	178,750
	Life:		50	50	50	50
TOTAL COSTS	Capital:	0	69,000	1,744,500	1,813,500	1,744,500
	O&M/yr:		7,500	183,750	191,250	183,750
	Years:		50	50	50	50
Water Acquisition		N	N	N	N	N
Fish to Stock	Number/yr:		1,200,000	1,000,000	1,200,000	1,000,000
	Size:		F, 400/lb.	S, 14/lb.	F, 400/lb.	S, 14/lb.
	Years:		50	50	1,000,000 S, 14/lb.	50

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

** Recommended strategy.

ESTIMATED COSTS FOR ALTERNATIVE STRATEGIES

Subbasin: Elochoman River
Stock: Summer Steelhead

Action	Cost Categories*	Proposed Strategies 1	2**	3	4
Habitat Enhancement	Capital:				
	O&M/yr:				
	Life:				
Screening	Capital:				
	O&M/yr:				
	Life:				
Barrier Removal	Capital:				
	O&M/yr:				
	Life:				
Misc. Projects	Capital:		60,000		60,000
	O&M/yr:		5,000		5,000
	Life:		25		25
Hatchery Production	Capital:			138,000	138,000
	O&M/yr:			15,000	15,000
	Life:			50	50
TOTAL COSTS	Capital:	0	120,000	138,000	258,000
	O&M/yr:		5,000	15,000	20,000
	Years:		50	50	50
Water Acquisition		N	N	N	N
Fish to Stock	Number/yr:			30,000	30,000
	Size:			S, 5/lb.	S, 5/lb.
	Years:			50	50

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

** Recommended strategy.

ESTIMATED COSTS FOR ALTERNATIVE STRATEGIES

Subbasin: Elochoman River
Stock: Winter Steelhead

		Proposed Strategies			
Action	Cost Categories*	1	2**	3	4
Habitat Enhancement	Capital:				
	O&M/yr:				
	Life:				
Screening	Capital:				
	O&M/yr:				
	Life:				
Barrier Removal	Capital:				
	O&M/yr:				
	Life:				
Misc. Projects	Capital:		60,000	60,000	100,000
	O&M/yr:		5,000	5,000	10,000
	Life:		25	25	50
Hatchery Production	Capital:				230,000
	O&M/yr:				25,000
	Life:				50
TOTAL COSTS	Capital:	0	120,000	120,000	330,000
	O&M/yr:		5,000	5,000	35,000
	Years:		50	50	50
Water Acquisition		N	N	N	N
Fish to Stock	Number/yr:				50,000
	Size:				S, 5/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.