Columbia Basin System Planning

SALMON and STEELHEAD PRODUCTION PLAN

GRAYS RIVER SUBBASIN

September 1, 1990

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Washington Department of Fisheries
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Olympia, Washington 98504

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Columbia Basin Fish and Wildlife Authority

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INTRODUCTION

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

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

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

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

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

PART I. DESCRIPTION OF SUBBASIN

Location and General Environment

The Grays River originates in southeast Pacific County and flows southwest through Wahkiakum County to its confluence with the Columbia River at River Mile (RM) 21. The lower six miles of the river are a slough subject to tidal influence. Dikes have been constructed in this area to protect the low-lying land. The next six miles flow through a wide, flat valley before entering the steep foothills. Most of the upper watershed flows through steep narrow canyons in the rugged Willapa Hills. The entire basin encompasses 124 square miles.

A number of natural and man-made barriers to fish migration were removed in the early 1950s under the Columbia River Fisheries Development Program. Prior to 1952 an 8-foot cascade in a narrow canyon at RM 13 was a barrier to most salmon. Steps were blasted in the falls in 1951 effectively opening the upper watershed to salmon. Falls were also modified on the East Fork Grays River, Mitchell and Hull creeks. Other projects included the removal of log jams and abandoned splash dams and construction of a salmon hatchery on the West Fork of the Grays River in 1960.

Water Resources

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. Early surveys include observations of evidence of water level fluctuations up to 20 feet in the narrow canyons of the upper tributaries (Bryant 1949).

Streamflow in the Grays River is directly dependent on rainfall and since there are no lakes, reservoirs, or impoundments in the system, effects of precipitation are immediate. Average annual precipitation in the subbasin is between 90 inches and 110 inches, approximately 80 percent of which falls in the rainy fall and winter months. The climate is dominated by moist Pacific marine air moderating the seasonal extremes. Winters are wet but mild, and summers are cool and relatively dry.

Land Use

There are 80,000 acres of forest and pastureland in the basin. Major landowners are forest product corporations, which own more than 70 percent of the total land area. Washington state owns about 15 percent and the remainder is privately owned land mainly located along the river floodplain.

Ninety-five percent of the land is forested and, as expected, the major land use is timber and forest products. Four percent of the land is residential, under cultivation or used for pastureland. Residential development is low with only two unincorporated towns of Grays River and Roseburg.

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 has 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 using 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 do 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, 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 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 Grays 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 Grays 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 Grays 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

Fisheries Resource

Natural Production

The size of historical runs of fall chinook in the Grays 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 logjams one-third of a mile in length, splash dams forming complete blockages and logging related landslides, siltation, and erosion. These impacts, coupled with harvest, combined to limit natural production in this period. These early surveys documented few chinook salmon.

In 1951 estimated escapement of fall chinook in the Grays River was 1,000 fish. Log jam removal, splash dam removal, and laddering or blasting of falls restored or extended chinook production to above the West Fork of the Grays River and into the East Fork and Mitchell Creek. Today, the most heavily spawned areas are in the six miles above tidewater (RM 8 to RM 14). Considerable spawning, depending upon annual flow variation, takes place in the 1.5 miles from the mouth of the West Fork to the hatchery. Low seasonal water flows have been a chronic problem for both natural and hatchery chinook production. Water levels in the West Fork Grays often limit the migration of salmon back to the hatchery rack.

Entry of adults into the subbasin occurs from early September to November. Natural escapement estimates for the Grays River has averaged 912 fish from 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 that hatchery origin fish are spawning with the natural fish. A comparison of tag ratios on the spawning grounds with those from the hatchery returns indicates the natural spawners are largely of natural descent. The run is predominately composed of 3-year-old fish and except for 2-year-olds, males and females are equally represented (Table 2).

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

	Sport Catch[1]		Natural Escpmnt[2]		Hatchery Escpmnt[3]		Total Return	
YEAR	JACKS	ADULTS	JACKS	ADULTS	JACKS	ADULTS	JACKS	ADULTS
1977	8	0	95	1,495	91	1,214	269	2,709
1978	20	64	0	2,685	111	2,420	131	5,169
1979	5	8	0	1,206	4	688	9	1,902
1980	17	10	12	185	6	91	35	286
1981	45	76	105	246	31	54	181	376
1982	32	163	0	422	26	675	58	1,260
1983	49	17	0	927	6	268	55	1,212
1984	5	73	98	242	68	169	171	484
1985	15	45	26	812	131	226	172	1,083
1986	20	210	173	901	253	1,215	446	2,326

[1] From Washington sport catch reports 1977-86.

[2] From WDF, unpublished data (note that the majority of naturally spawning fish are of hatchery origin).

[3] From Columbia River salmon hatchery returns, 1972-86 (Steven D. Kind, March 1987a).

Table 2. Size and age composition of Grays River fall chinook, 1982-1987 (WDF unpubl. data).

		SIZE			
		MALE		FEMALE	
AGE	PERCENT OF RUN	AVERAGE	RANGE	AVERAGE	RANGE
2	13.4	47.7	35-75	--	--
3	55.3	74.7	46-99	75.4	53-96
4	28.6	88.4	57-115	86.7	66-101
5	2.7	96.9	81-107	93.1	79-104
6	0.0	--	--	--	--

Hatchery Production

Hatchery releases of tule fall chinook began in 1947 when 100,000 fingerlings were released. This supplementation continued until 1960 when the Grays River Salmon Hatchery was constructed under the Lower Columbia River Fishery Development Program. Brood stock for these hatcheries were obtained from local stock or from transfers from other hatcheries.

Straying of lower river hatchery (LRH) fall chinook from a number of Oregon and Washington hatcheries is common and contributes to the natural production. The overall result of straying and transferring fall chinook at lower Columbia River hatcheries is the development of a widely distributed, blended hatchery stock.

Depending partly on early fall rains, recruitment to the hatchery is usually greatest during the middle of September. Returns of adults to the hatchery has averaged 702 fish from 1977 through 1986 (Table 1). Juvenile releases in this same period are presented in Table 3.

Table 3. Fall chinook hatchery (LRH) production for Grays River 1975-1985 brood years.

BROOD YEAR	NUMBER RELEASED		
	Fingerling	Fall Release	Yearling
1975	1,852,381	113,880	
1976	3,323,252	45,488	
1977	3,082,157		
1978	1,739,493		
1979	7,281,651		
1980	5,961,101	67,500	
1981	5,321,850		
1982	5,728,600		
1983	6,221,300	23,200	
1984	740,700	101,400	
1985	2,582,840	99,251	33,900

Harvest

Lower river hatchery (LRH) 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). It is suspected that additional fish are taken illegally during low water when they are concentrated in a deep pool at the confluence of the West Fork and the main Grays River.

__Specific Considerations__

- All production is considered to be from one stock (LRH), and straying of hatchery fish into natural production areas or the transfer of eggs between hatcheries is not a genetic concern.
- In many of the tributaries, relatively good habitat is available in the lower reaches for spawning and rearing.
- Their short-term rearing life history pattern make fall chinook a good candidate for pen rearing or other low capital investment production methods.
- Harvest rates for the most recent five-year period show a total exploitation of 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 uncertainty about benefits of increased freshwater production.
- Weyco Pond is currently not operated due to a shortage of funds and could be used to produce significant numbers of fall chinook smolts.
- Low streamflows sometimes inhibit movement of fall chinook to the hatchery.

Objectives

Fall chinook production from the lower Columbia River (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. Minor catches are recorded in individual tributary streams.

The overall approach to fall chinook production advanced in this subbasin plan complements the existing harvest management scenario and utilizes both hatchery and natural production opportunities. Low cost cultural practices (such as net pens) are used to increase production of fall chinook in a manner that will increase the probability for straying upon adult return. It is known that returning LRH adults stray into natural production areas, complementing existing natural populations. The tendency of net pen reared fish to stray should be more pronounced than full-term hatchery reared fish.

The general objectives in order of priority for Grays 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. Improve consistency of hatchery returns with a goal of taking 1,750,000 eggs annually.

2. Utilize natural production potential of the subbasin.

Utilization Objective

Provide a total harvest of 15,000 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.

Alternative Strategies

Alternative strategies are organized according to the level of artificial intervention in stock production. Strategy 1 always 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 4a.

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

ACTIONS: 1-6

1. Emphasize habitat protection through continuation and expansion of state regulatory programs, including RCW 75.20.100, 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 chinook are passed above the hatchery rack on the West Fork Grays River.

4. Remove logging debris from the West Fork Grays River to facilitate adult passage into the upper stream reaches.

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

6. 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. This strategy incorporates actions from Strategy 1 and proposes construction of net pen facilities.

ACTIONS: 1-7

1. -
2. -
3. -
4. -
5. -
6. -

7. Construct net pen facilities in the Grays River Salmon Pond and lower river for rearing an additional 600,000 fingerlings.

STRATEGY 3: Hatchery Production. This strategy assumes a doubling of the baseline hatchery smolt productions. It is unlikely that this level of hatchery production could be sustained due to the limited sources of additional water for the hatchery.

ACTIONS: 7, 8

7. -

8. Double natural production through use of net pen facilities (Action 7), facilities development, and production reprogramming (1.2 million fingerlings new production).

STRATEGY 4: Combination. This strategy combines actions from all strategies, but assumes a 30 percent loss of production to density-dependent estuarine conditions.

ACTIONS: 1-8 (see above)

STRATEGY 5: Supplementation. This strategy combines actions from Strategy 1 with a net pen program for 100,000 smolts.

ACTIONS: 1-6, 9

1. -
2. -
3. -
4. -
5. -
6. -

9. Construct net pens in the Grays River Salmon Pond and the lower river for rearing an additional 100,000 fingerlings.

Recommended Strategy

Strategy 5 is recommended for implementation. This suite of actions represents the greatest benefits within the realistic constraints to production in the watershed.

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

Utilization Objective:

Provide a total harvest of 15,000 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.

Biological Objective:

1. Improve consistency of hatchery returns with a goal of taking 1,750,000 eggs annually. 2. 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	241 -C	1,589	2,006	12,391	0(1.00)
All Nat	367 -C	1,505	2,039	12,617	258(1.02)
1	367 -C	1,505	2,039	12,617	258(1.02)
2	695 -C	1,607	2,481	14,936	3,020(1.21)
3	868 -C	1,823	2,894	17,063	5,559(1.39)
4	378 -C	1,788	2,364	14,281	2,247(1.16)
5*	545 -C	1,552	2,269	13,826	1,698(1.12)

*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. Pre Mainstem Implementation.
4. Strategies 2 and 3. Pre Mainstem Implementation.
5. Strategy 1 plus net pen rearing 100,000 smolts for supplementation. Pre Mainstem Implementation.

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

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

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

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

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

Table 4a. Estimated costs of alternative strategies for Grays River 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*
Hatchery Costs					
Capital[1]	0	0	0	0	0
O&M/yr[2]	0	15,000	30,000	30,000	2,500
Other Costs					
Capital[3]	30,000	210,000	180,000	210,000	60,000
O&M/yr[4]	0	60,000	60,000	60,000	10,000
Total Costs					
Capital	30,000	210,000	180,000	210,000	60,000
O&M/yr	0	75,000	90,000	90,000	12,500

* 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 Grays River, but no population estimates were made. Portions of the watershed were being logged, and splash dams, log and debris jams, and logging through the streams had probably already adversely affected fish production. Under the Columbia River Fisheries Development Program some of these problems were addressed on an ad hoc basis and production was extended by removing natural and man-made barriers. In 1951, escapement was estimated at 2,500 fish.

A hatchery was built on the West Fork Grays River in 1960 and subsequent harvest management for hatchery productivity in the region has been a dominating factor affecting natural production. Coho are thought to spawn in all available tributaries though escapement figures are unknown. Natural spawning is presumed through anecdotal information to be quite low and subsequent juvenile production well below stream potential.

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's hatchery stocks are generally referred to as early-returning (Type-S) and late-returning (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 Grays 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. 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. In the absence of any data, this value was selected based on escapement studies from the Cowlitz River (DeVore 1987).

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. Specific data on sex ratios and fecundity must be inferred from Grays River hatchery Type-S coho. Approximately 74 percent of the run returns as 3-year-old fish with the 2-year-old component exclusively precocious males. The adult return is composed of nearly 48 percent females whose fecundity averaged 2,413 eggs between 1978 and 1982 (WDF, unpublished data). Subbasin natural production potential was estimated to be 125,874 smolts using the Smolt Density Model.

Hatchery Production

Grays River Hatchery is located 2.5 miles upstream from State Highway 4 on the West Fork Grays River. The hatchery is 21 miles from the mouth of the Columbia River. An earthen rearing pond, the Grays River Salmon Pond (formerly Alder Creek or Weyco Pond), is located on land leased from the Weyerhauser Company, approximately 12 miles east of the town of Grays River. Grays River Hatchery is the sixth hatchery constructed under the Columbia River Fisheries Development Program beginning operation in 1961. Funding is administered through the National Marine Fisheries Service. Feed and manpower costs for Grays River Salmon Pond were funded by Washington state (currently no funding is available).

The hatchery has 10 standard concrete raceways, two large adult holding ponds that double as juvenile release ponds, and one large earthen juvenile release pond. Incubation facilities include concrete deep troughs, some vertical incubators, and two concrete shallow troughs. Water is supplied by gravity flow from an intake approximately 0.33 miles upstream from the hatchery on the West Fork Grays River. There is also one well that supplies water to the incubators and four raceways.

Today, production of coho at the Grays River Salmon Hatchery is limited by the need to rear fish for the Toutle River program, whose hatchery was destroyed in the Mount St. Helens eruption; water quantity; and lack of room for holding smolts until a favorable release time in May or June. Coho smolts are now released in April from the Grays River Salmon Hatchery. Returns of Type-S coho to the hatchery averaged 2,353 fish between 1977 and 1986 (Table 5). The current program calls an egg-take of 2,830,000 Type-S coho eggs and an on-station smolt release of 600,000 fish. There is no program to use Grays River Salmon Pond. Approximately 800,000 (at 35 fish per pound) are to be transferred to the Toutle River. Table 6 lists recent release numbers.

Table 6. Hatchery production of Grays River Type-S coho, 1975-1985 brood years.

BROOD YEAR	NUMBER RELEASED Fry	Fingerling	Smolts
1975		1,076,452	25,311
1976		452,609	850,707
1977			956,599
1978	93,000	396,869	1,076,515
1979		1,162,640	863,137
1980	59,500	1,004,175	505,998
1981			396,200
1982		225,400	405,600
1983			264,797
1984		992,600	228,300
1985		604,200	430,400
1986		581,500	

Harvest

Harvest of coho originating from the Grays River Subbasin occurs primarily in ocean and mainstem fisheries. A small inriver recreational fishery exists (Table 5). Total 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, escapement to hatcheries being the only management constraint.

Specific Considerations

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

- o Anecdotal information on juvenile summer rearing densities indicate natural coho production occurs at extremely low levels and is absent in some tributaries of the Grays that could be producing coho.

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

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 general utilization objectives in order of priority for Grays River coho production 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 coho stocks.

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

Biological Objectives

1. Improve consistency of hatchery returns with a goal of taking 4 million eggs annually to supply an enlarged hatchery program and a consistent fry supplementation program for Grays River tributaries and nearby tributaries to the mainstem Columbia River.

2. Utilize natural production potential of the subbasin to produce Type-S juvenile coho at optimum levels.

Utilization Objective

Provide a total harvest of 18,000 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.

Alternative Strategies

Alternative strategies are organized according to the level of artificial intervention in stock production. Strategy 1 always 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 7 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 7. 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 7a.

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

ACTIONS: 1-6

1. Emphasize habitat protection through continuation and expansion of state regulatory programs, including RCW 75.20.100, 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 coho are passed above the hatchery rack on the West Fork Grays River.

4. Remove logging debris from the West Fork Grays River to facilitate adult passage into the upper stream reaches.

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

6. 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 they migrate upstream during a period when streamflows are higher, allowing deeper penetration into the watershed.

ACTIONS: 1-7

1. -
2. -
3. -
4. -
5. -
6. -

7. Release enough adults or fry to adequately utilize 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. Baseline hatchery smolt production was doubled during model simulation. It is unlikely that this level of production could be sustained due to limitations on potential water augmentation.

ACTIONS: 8

8. Double hatchery production through facilities improvement and production reprogramming (600,000 yearlings new production).

STRATEGY 4: Combination. This strategy incorporates actions from Strategies 1, 2 and 3. It is unlikely that hatchery production could be sustained at these levels due to limitations on potential water augmentation.

ACTIONS: 1-8 (see above)

STRATEGY 5: Combination. This strategy incorporates the actions in Strategy 1 plus a net pen operation for fall chinook to allow holding of coho until favorable release conditions.

ACTIONS: 1-6, 9

1. -
2. -
3. -
4. -
5. -
6. -

9. Construct enough net pens for fall chinook in the Grays River Salmon Pond or the lower river to allow holding of coho until a favorable release time in May or June (1.2 million fry).

Recommended Strategy

Strategy 5 is recommended for implementation. This suite of actions represents the greatest benefits within the realistic constraints 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's Columbia River Basin Fish and Wildlife Program.

Table 7. System Planning Model results for early run coho in the Grays Subbasin. Baseline value is for pre-mainstem implementation, all other values are post-implementation.

Utilization Objective:
Provide a total harvest of 18,000 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.

Biological Objective:
1. Improve consistency of hatchery returns with a goal of taking 4 million eggs annually to supply an enlarged hatchery program and a consistent fry supplementation program for Grays River tributaries and nearby tributaries to the mainstem Columbia River. 2. Utilize natural production potential of the subbasin to produce Type-S juvenile coho at optimum levels.

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	113 -N	3,463	3,758	11,252	0(1.00)
All Nat	77 -N	3,601	3,868	11,580	437(1.03)
1	77 -N	3,601	3,868	11,580	437(1.03)
2	277 -N	3,499	3,961	11,860	810(1.05)
3	74 -N	6,975	7,416	22,204	14,610(1.97)
4	76 -N	7,094	7,542	22,582	15,114(2.01)
5*	170 -N	5,232	5,678	17,000	7,667(1.51)

*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 Grays River. Pre Mainstem Implementation.
2. Strategy 1 plus supplementation. Pre Mainstem Implementation.
3. Hatchery production. Double hatchery production through facilities improvement and production reprogramming. Pre Mainstem Implementation.
4. Strategies 2 and 3. Pre Mainstem Implementation.
5. Strategy 1 plus net pen rearing of smolts for supplementation. Pre Mainstem Implementation.

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

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

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

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

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

Table 7a. Estimated costs of alternative strategies for Grays River coho. Cost estimates represent new or additional costs to the 1987 Columbia River Basin Fish and Wildlife Program; they do not represent projects funded under other programs, such as the Lower Snake River Compensation Plan or a public utility district settlement agreement. (For itemized costs, see Appendix C.)

	Proposed Strategies				
	1	2	3	4	5*
Hatchery Costs					
Capital[1]	0	69,000	989,000	1,058,000	0
O&M/yr[2]	0	7,500	107,500	115,000	7,500
Other Costs					
Capital[3]	30,000	30,000	0	30,000	210,000
O&M/yr[4]	0	0	0	0	60,000
Total Costs					
Capital	30,000	99,000	989,000	1,088,000	210,000
O&M/yr	0	7,500	107,500	115,000	67,500

* 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.

CHUM SALMON

Fisheries Resource

Natural Production

The Grays River was once noted for its large runs of chum salmon. In 1936, 6,286 spawning or spawned-out chum were counted below the falls at (RM 13), and an additional 1,388 chum were counted in the West Fork of the Grays River (Bryant 1949). Logging of the watershed and the resulting landslides, erosion and channel changes caused serious damage to salmon spawning habitat. Today the Grays River chum run is a fraction of its historic size. Peak fish counts for Grays River chum salmon for 1977 through 1988 ranged from 107 to 1,370 fish (Table 8). Under favorable survey conditions, peak fish counts may account for 80 percent of total escapement (H. Fiscus, pers. commun.).

Survey results from the Grays River indicate a small, but relatively stable population of chum. Recent stream enhancement work by the Washington Fisheries Department in Gorley Springs (RM 12) has been relatively successful and may increase basin chum production by providing a stable incubation environment. The average peak count from the mainstem Grays River from 1977 through 1986 was 263 fish while the 1986 count from Gorley Springs alone was 403 fish. Other areas such as Crazy Johnson Creek can be quite productive if water flows are adequate.

Table 8. Escapement of chum salmon in Grays River Basin, 1977-1988 (WDF unpublished data).

Year	Escapement
1977	400
1978	285
1979	126
1980	107
1981	25[1]
1982	756
1983	126
1984	372
1985	448
1986	920
1987	758
1988	1370
Average[2]	515

[1] Water conditions precluded complete surveys.
[2] Excluding 1981 survey results.

The lack of stable spawning habitat is considered the primary physical limitation on chum production today. Development of other spring-fed spawning areas such as Gorley Springs could improve subbasin chum production. Seasonal low flows sometimes restrict access of chum to preferred off-channel spawning areas, confining them to less stable mainstem reaches. Some mainstem reaches where chum spawn are subject to frequent channel shifts and bedload deposition or scour, all of which reduce intragravel survival.

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 (Table 9). A few fish return as 5-year-olds, but none as 2-year-old jacks. Males predominate in the 5-year-old class.

Fecundity for Grays River chum is not available, but the Sea Resources Hatchery on the Chinook River reported fecundity between 2,028 and 2,534 eggs per female between 1980 and 1984, averaging 2,241 eggs per female. Sex ratios of Grays River Chum are provided in Table 10.

Table 9. Size and age composition of Grays River chum salmon, 1982-1988.

AGE (Total)	PERCENT OF[1] AGE	SIZE[2] MALE AVERAGE	MALE RANGE	FEMALE AVERAGE	FEMALE RANGE
3	14.3	75	69-86	66	57-73
4	79.9	79	66-92	70	60-83
5	5.8	84	76-92	74	64-80

[1] From WDF unpublished data.
[2] From average fork length in cm.

Table 10. Sex ratio and fecundity of Grays River chum salmon, 1982-1988.

AGE (TOTAL)	SEX RATIO[1] M:F	FECUNDITY[2]
3	1.05:1.0	N/A
4	.90:1.0	N/A
5	2.25:1.0	N/A

[1] From WDF unpublished data.
[2] Not available - suggest use of Nemah River Hatchery values.

Hatchery Production

Managers have attempted several times to augment natural chum production by releasing fed fry or fry from egg boxes directly into the stream. The Grays River and West Fork Grays have both been recipients of intermittent releases since 1972 (Table 11). The present low numbers of chum in the Columbia River made it necessary to use stock from outside the area. In 1976 approximately 1.1 million 1975 brood chum fry from Hokkaido, Japan (Mokoto stock) were released into the West Fork Grays River. These releases have apparently had little effect on adult returns.

Table 11. Release of non-Columbian River stock chum salmon in the Grays River.

BROOD YEAR	RELEASE YEAR	NUMBER[1] RELEASED	TYPE	STOCK
1971	1972	638,500	Fed fry	Hood Canal
1972	1973	563,600	Fed fry	Quilcene (Hood Canal)
1973	1974	612,300	Fed fry	Quilcene (Hood Canal)
1974	1975	1,126,000	Fed fry	Hokkaido, Japan

The Grays River Salmon Hatchery does not raise chum and it is anticipated 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 existing genetic integrity of the run, 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 as high as 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 these catches might have been of Grays River origin. Historically chum were harvested in the mainstem by a variety of methods. 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 annually (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 fall chinook.

Harvest rates on chum are difficult to determine since the escapement portion of the composite Columbia River run is hard to enumerate. Local biologists familiar with the fisheries and the spawning ground assessments in Washington suggest the harvest rate may approximate 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 and, conversely, habitat enhancement may show substantial benefits.
- Columbia River chum stocks are less than 0.5 percent of historic levels (Northwest Power Planning Council 1986).
- Columbia River chum runs contribute fairly narrowly in the overall Pacific salmon fisheries picture. However, they are a species that contribute to locally important fisheries, can be produced with little capital investment, are assumed to pose no competitive threat to other salmonids, and once were produced in large numbers from the Columbia River Basin.

- 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 Grays River. Simultaneously, the existing run would be enhanced through habitat improvement projects designed to improve intragravel survival. Special care will be taken to protect genetic integrity of the existing natural stock by appropriate choice and development of a donor stock.

Biological Objective

Maintain genetic integrity of the Grays River chum run while rebuilding it to levels that will utilize available habitat at optimum levels.

Utilization Objective

Provide a total harvest of 5,000 fish. It is expected that these fish would be taken in Columbia River gill-net fisheries.

Alternative Strategies

Alternative strategies were not modeled for chum salmon due to uncertainties in stock parameters and harvest rates. Planners did not estimate costs for the following alternatives.

STRATEGY 1: Natural Production. Proposed actions are designed to promote natural production of chum in the Grays 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 a 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 Grays River through the use of on-site streamside incubators (Fuss and Seidel 1987) or 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 suite of actions should promote rebuilding the Grays River chum run in a sustainable way and promote long-term productivity of the stock.

WINTER STEELHEAD

Fisheries Resource

Natural Production

Steelhead abundance in the Grays River during the 1920s and 1930s was estimated to be around 2,000 fish (WDG 1936). Bryant (1949) provides reports of several hundred steelhead holding in the pool below the Grays River falls (RM 13) in 1945 and 1946. Steelhead were reported to be able to ascend these falls in high water. During this period there were other numerous blocks to fish migration, both natural and man-made. Log and debris jams, a product of the intense logging occurring in the watershed, as well as splash dams blocked fish migration into many tributaries.

Blasting of the Grays River Falls in 1957 and removal of other obstructions during the 1950s improved steelhead access to upper stream reaches. But by this time the upper watershed had been completely logged and widespread damage to habitat had already occurred.

Winter steelhead migrate upstream from December through May and spawn primarily in April and May. Eggs incubate during the ensuing months with fry recruitment to the stream in June and July. Juveniles rear an average of two years in the streams before migrating to the ocean. Age composition, fecundity and sex ratios are not available for the wild stock, but data for the Kalama wild run may be appropriate (Table 12). Using the Smolt Density Model, planners estimated that the watershed can produce 45,300 smolts.

Table 12. Age composition, sex ratios and fecundity assumed for Grays River winter steelhead. Data is for Kalama River wild winter steelhead (Leider et al. 1985).

	Ocean Age			
	1	2	3	4
Age composition	0.033	0.710	0.257	0.0
Proportion female	0.076	0.475	0.688	0.0
Fecundity[1]	3,000	4,500	4,500	4,500

[1] See Kalama Subbasin Plan for derivation.

Today a small, but persistent run of wild winter steelhead returns to the Grays River. The precise distribution of the stock is not known, but the fish do penetrate high into the watershed and local biologists estimate the escapement is between 400 and 600 fish annually. Wild release regulations are in effect for the river and an interim escapements goal of 1,400 fish has been set by the Washington Department of Wildlife.

Hatchery Production

Hatchery releases began in 1957 with a release of about 20,000 smolts. The river was initially stocked with Chambers Creek fish, but in the mid-1960s the late winter Cowlitz stock was introduced in an attempt to supplement the dwindling wild run. The Chambers Creek stock performed poorly initially, but in more recent years has returned well and created a popular December and January fishery. Releases have averaged about 45,000 smolts from the Beaver Creek Hatchery (Chambers Creek stock) in the neighboring Elochoman River drainage during the last 10 years (Table 13).

Table 13. Releases of hatchery winter steelhead smolts in the Grays River, 1982-1986.

Release Year	Number Released	Size at Release
1977	36,278	
1978	40,738	
1979	41,052	
1980	50,347	
1981	45,587	
1982	50,243	6.0/lb.
1983	29,893	
1984	47,099	
1985	37,510	
1986	58,002	
1987	65,240	4.8/lb.
1988	44,430	4.7/lb.
1989	45,025	4.8/lb.

Harvest

Releases of Chambers Creek stock created a new fishery in December and January that exceeded the historical March catch of the wild stock. Between the harvest years 1960-1961 and 1966-1967, the December, January, and February catch far outnumbered the March and April catch, but the catches became more equal once the Cowlitz stock was introduced in the mid-1960s.

Agency management today emphasizes separation of the hatchery and wild returns so the early-returning Beaver Creek fish are the stock of choice for hatchery releases. Wild release regulations are intended to promote maximum returns to promote the greatest recreational opportunity. The harvest rate on the hatchery stock is estimated to be as high as 70 percent (Lucas WDW, pers. commun.). Average catch in the last 10 years, which spans the change to wild release regulations, has been 579 fish (Table 14).

Table 14. Recreational harvest of Grays River winter steelhead, 1977-1986.

Year	Winter run	Summer run
1977-78	639	0
1978-79	292	20
1979-80	735	6
1980-81	670	51
1981-82	573	11
1982-83	561	15
1983-84	472	4
1984-85	1,031	9
1985-86	407	27
1986-87	409	14
Average	579	16

Specific Considerations

- Wild stocks were depleted from habitat degradation and overfishing prior to wild release regulations.
- An evenly distributed fishery is desirable and may be possible to attain through the use of an acclimation facility.
- It is desirable to keep the hatchery and wild returns as separate in timing as possible.

Objectives

The general objective for winter steelhead in the Grays River is to provide increased recreational fishing opportunity in the terminal area. Strategies work within the existing harvest management regime and make use of natural and hatchery opportunities.

Since winter steelhead will not be managed for MSY harvest rates, a more realistic way to model the stock would be to hold harvest rates at those levels expected to occur under observed or planned fisheries. In this plan, the model results are reported based on the output at combined MSY harvest rates.

Stock: Washougal Natural Winter Steelhead

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

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

Stock: Washougal Hatchery Winter Steelhead

Utilization Objective: 900 fish for sport harvest. The utilization objective has priority within the subbasin for this stock.

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

Alternative Strategies

Alternative strategies are organized according to the level of artificial intervention in stock production. Strategy 1 always 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 15 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 15. 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 15a.

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

ACTIONS: 1-6

1. Emphasize habitat protection through continuation and expansion of state regulatory programs, 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. Remove logging debris from the West Fork Grays River to facilitate adult passage into the upper stream reaches.

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

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

6. Continue wild fish release harvest management.

STRATEGY 2: Supplementation. Proposed actions are designed to promote natural production and achieve an even distribution and consistent return of hatchery smolts that are planted in the basin.

ACTIONS: 1-7

1. -
2. -
3. -
4. -
5. -
6. -

7. Construct and operate an acclimation pond for existing levels of hatchery smolt releases.

STRATEGY 3: Hatchery Production. Proposed actions are designed to achieve an even distribution and consistent return of hatchery fish and increase the level of hatchery fish returns through higher increased releases of hatchery smolts.

ACTIONS: 7, 8

7. -

8. Release 40,000 additional hatchery smolts directly into the river without acclimation.

STRATEGY 4: Hatchery Production. Proposed actions are designed to achieve an even distribution and consistent return of hatchery fish and increase the level of hatchery return through higher release numbers.

ACTIONS: 7-9

7. -
8. -

9. Construct additional acclimation facility to accommodate the 40,000 additional hatchery smolts released in Strategy 3.

Recommended Strategy

Strategy 2, supplementation is recommended for implementation. This suite of actions accomplishes the objective and is in accord with agency management philosophy. The marginal benefits provided by Strategy 4 are not considered worth the additional risk to important long-term wild stock management.

Table 15. System Planning Model results for winter steelhead in the Grays Subbasin. Baseline value is for pre-mainstem implementation, all other values are post-implementation.

Utilization Objective: Provide a harvest of 900 fish to the terminal recreational fishery.

Biological Objective: Preserve the genetic integrity and viability of the existing wild 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	663 -N	456	1,143	76	0(1.00)
All Nat	719 -N	437	1,179	78	38(1.03)
1	719 -N	437	1,179	78	38(1.03)
2*	778 -N	453	1,255	83	119(1.10)
3	1,212 -N	593	1,836	121	738(1.61)
4	1,276 -N	597	1,904	126	811(1.67)

*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 winter steelhead in the Grays River. Pre Mainstem Implementation.
2. Strategy 1 plus supplementation. Pre Mainstem Implementation.
3. Hatchery production. Release additional 40,000 smolts at hatchery. Pre Mainstem Implementation.
4. Strategy 3 plus construct additional acclimation facility for 40,000 additional 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 15a. Estimated costs of alternative strategies for Grays River winter steelhead. Cost estimates represent new or additional costs to the 1987 Columbia River Basin Fish and Wildlife Program; they do not represent projects funded under other programs, such as the Lower Snake River Compensation Plan or a public utility district settlement agreement. (For itemized costs, see Appendix C.)

	Proposed Strategies			
	1	2*	3	4
Hatchery Costs				
Capital[1]	0	0	184,000	184,000
O&M/yr[2]	0	0	20,000	20,000
Other Costs				
Capital[3]	30,000	150,000	120,000	120,000
O&M/yr[4]	0	5,000	5,000	5,000
Total Costs				
Capital	30,000	150,000	304,000	304,000
O&M/yr	0	5,000	25,000	25,000

* 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

Improve consistency of hatchery returns with a goal of taking 1,750,000 eggs annually; utilize natural production potential of the subbasin; and provide a total harvest of 15,000 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. Planners recommend Strategy 5, which combines actions to promote natural production with a net pen program for rearing 100,000 smolts.

Coho

Utilize natural production potential of the subbasin to produce Type-S juvenile coho at optimum levels, and provide a total harvest of 18,000 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. Planners recommend Strategy 5, which incorporates actions to promote natural production with a net pen operation for fall chinook to allow holding of coho until favorable release conditions.

Chum

Maintain genetic integrity of the Grays River chum run while rebuilding it to levels that will utilize available habitat at optimum levels. Specific utilization objectives for the Grays River subbasin are to increase the spawning escapement to 5,000 fish. Assuming a harvest rate of 35 percent, approximately 2,415 additional fish would be returned to mainstem commercial fisheries. Total Grays River run size would approximate 7,700 adults at these levels. Planners recommend Strategy 3, promoting natural production and introducing chum fry into selected tributaries.

Winter Steelhead

Preserve the genetic integrity and viability of the existing wild stock and more evenly distribute returning hatchery origin adults to accommodate heavy fishing pressure. Also provide a harvest of 900 fish to the terminal recreational fishery, and provide maximum opportunity for sports fishermen to catch a wild fish. It is estimated that this will require rebuilding to an escapement of about 1,400 fish. Planners recommend Strategy 2, which promotes natural production and proposes to construct and operate an acclimation pond for existing levels of hatchery smolt releases.

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: Grays

STOCK: Fall chinook

STRATEGY: 1

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1 EXT OBJ	3	0.9	20	60	54
2 CHG MSY	4	0.9	20	80	72
3 GEN IMP	3	0.9	20	60	54
4 TECH FEAS	8	0.9	20	160	144
5 PUB SUPT	5	0.6	20	100	60

TOTAL VALUE 460

DISCOUNT VALUE 384

CONFIDENCE VALUE 0.83478260

SUBBASIN: Grays

STOCK: Fall chinook

STRATEGY: 2

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1 EXT OBJ	7	0.9	20	140	126
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 540

DISCOUNT VALUE 486

CONFIDENCE VALUE 0.9

SUBBASIN: Grays

STOCK: Fall chinook

STRATEGY: 3

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1 EXT OBJ	7	0.9	20	140	126
2 CHG MSY	6	0.9	20	120	108
3 GEN IMP	3	0.9	20	60	54
4 TECH FEAS	0	0.9	20	0	0
5 PUB SUPT	7	0.9	20	140	126

TOTAL VALUE 460

DISCOUNT VALUE 414

CONFIDENCE VALUE 0.9

SUBBASIN: Grays

STOCK: Fall chinook

STRATEGY: 4

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1 EXT OBJ	7	0.6	20	140	84
2 CHG MSY	6	0.9	20	120	108
3 GEN IMP	3	0.9	20	60	54
4 TECH FEAS	0	0.9	20	0	0
5 PUB SUPT	7	0.9	20	140	126

TOTAL VALUE 460

DISCOUNT VALUE 372

CONFIDENCE VALUE 0.80869565

SUBBASIN: Grays

STOCK: Fall chinook

STRATEGY: 5

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: Grays

STOCK: 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: Grays

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

TOTAL VALUE 540

DISCOUNT VALUE 486

CONFIDENCE VALUE 0.9

SUBBASIN: Grays

STOCK: Coho

STRATEGY: 3

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1 EXT OBJ	6	0.9	20	120	108
2 CHG MSY	7	0.9	20	140	126
3 GEN IMP	3	0.9	20	60	54
4 TECH FEAS	2	0.9	20	40	36
5 PUB SUPT	8	0.9	20	160	144

TOTAL VALUE 520

DISCOUNT VALUE 468

CONFIDENCE VALUE 0.9

SUBBASIN: Grays

STOCK: Coho

STRATEGY: 4

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1 EXT OBJ	6	0.9	20	120	108
2 CHG MSY	7	0.9	20	140	126
3 GEN IMP	3	0.9	20	60	54
4 TECH FEAS	2	0.9	20	40	36
5 PUB SUPT	8	0.9	20	160	144

TOTAL VALUE 520

DISCOUNT VALUE 468

CONFIDENCE VALUE 0.9

SUBBASIN: Grays

STOCK: Coho

STRATEGY: 5

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: Grays

STOCK: Winter steelhead

STRATEGY: 1

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	5	0.9	20	100	90
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: Grays

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	5	0.9	20	100	90
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: Grays

STOCK: Winter steelhead

STRATEGY: 3

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

TOTAL VALUE 640

DISCOUNT VALUE 576

CONFIDENCE VALUE 0.9

SUBBASIN: Grays

STOCK: Winter steelhead

STRATEGY: 4

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

TOTAL VALUE 640

DISCOUNT VALUE 576

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: Grays River
Stock: Fall Chinook

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:	30,000	30,000		30,000	30,000
	O&M/yr:	0	0		0	0
	Life:	50	50		50	50
Net Pens	Capital:		180,000	180,000	180,000	30,000
	O&M/yr:		60,000	60,000	60,000	10,000
	Life:		50	50	50	50
Hatchery Production	Capital:		[a]	[a]	[a]	[a]
	O&M/yr:		15,000	30,000	30,000	2,500
	Life:		50	50	50	50
TOTAL COSTS	Capital:	30,000	210,000	180,000	210,000	60,000
	O&M/yr:	0	75,000	90,000	90,000	12,500
	Years:	50	50	50	50	50
Water Acquisition		N	N	N	N	N
Fish to Stock	Number/yr:		600,000	1,200,000	1,200,000	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).

ESTIMATED COSTS FOR ALTERNATIVE STRATEGIES

Subbasin: Grays River
Stock: Type-S 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:	30,000	30,000		30,000	30,000
	O&M/yr:	0	0		0	0
	Life:	50	50		50	50
Net Pens	Capital:					180,000
	O&M/yr:					60,000
	Life:					50
Hatchery Production	Capital:		69,000	989,000	1,058,000	[a]
	O&M/yr:		7,500	107,500	115,000	7,500
	Life:		50	50	50	50
TOTAL COSTS	Capital:	30,000	99,000	989,000	1,088,000	210,000
	O&M/yr:	0	7,500	107,500	115,000	67,500
	Years:	50	50	50	50	50
Water Acquisition		N	N	N	N	N
Fish to Stock	Number/yr:		1,200,000	600,000	1,200,000	1,200,000
	Size:		F, 400/lb.	S, 14/lb.	F, 400/lb.	F, 400/lb.
	Years:				600,000 S, 14/lb.	

* 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).

ESTIMATED COSTS FOR ALTERNATIVE STRATEGIES

Subbasin: Grays River
Stock: Winter 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:	30,000	30,000		
	O&M/yr:	0	0		
	Life:	50	50		
Acclimation Ponds	Capital:		60,000	60,000	60,000
	O&M/yr:		5,000	5,000	5,000
	Life:		25	25	25
Hatchery Production	Capital:			184,000	184,000
	O&M/yr:			20,000	20,000
	Life:			50	50
TOTAL COSTS	Capital:	30,000	150,000	304,000	304,000
	O&M/yr:	0	5,000	25,000	25,000
	Years:	50	50	50	50
Water Acquisition		N	N	N	N
Fish to Stock	Number/yr:			40,000	40,000
	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.