Columbia Basin System Planning

SALMON and STEELHEAD PRODUCTION PLAN

COWLITZ RIVER SUBBASIN

September 1, 1990

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

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Many individuals, agencies and sport groups have provided input to this particular **subbasin** plan. To list all the people involved would take several pages. The core of individuals putting the plan together are listed below:

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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 Cowlitz Subbasin enters the Columbia River at River Mile (RM) 68 after draining the west slopes of the Cascade Mountains in southwestern Washington.. Drainage encompasses 2,480 square miles and major anadromous tributaries are the Toutle River, entering the Cowlitz River at RM 20, and the Coweeman River, entering the Cowlitz River at RM 1.7.

Subbasin topography is climaxed with the volcanic peaks of Mount Rainier, Mount Adams, and Mount St. Helens, each approaching or exceeding 10,000 feet. Accordant ridge crests of about 4,000 feet high are separated by deeply dissected valleys defined by narrow floodplains. The lower half of the subbasin flows through the Puget-Willamette lowland and has moderate relief with a broad floodplain; elevations seldom exceed 500 feet.

The upper subbasin is located in Washington's southern Cascades, which are made of andesite and basalt flows and associated breccias and tuffs. Areas adjacent to volcanic peaks are generally mantled with pumice deposits. Soils in alluvial deposits along the major west-flowing streams are typically coarse textured soils (Franklin and Dryness 1973). The lower half of the subbasin is generally comprised of Eocene basalt flows and flow breccia. Haplohumults (reddish brown lateritic soils) are the most common under forest vegetation: soils under grasslands are classed as Argixerolls (prairie soils).

Potentially severe erosion would occur on over 83 percent of Cowlitz Subbasin land if vegetative cover were removed. Over 81 percent of the land with severe to very severe erosion hazard is in commercial forest (USSCS 1974). The greatest erosion problems are from ground disturbance from road building and other activities associated with logging (USSCS 1974).

In May 1980, the violent eruption of Mount St. Helens destroyed much of the existing streambed and riparian zone habitat in the Toutle River and lower Cowlitz River. Large mud flows destroyed stream habitat as they buried the North Fork Toutle while smaller flows entered the South Fork Toutle and poured into the lower Cowlitz River, finally entering the Columbia River. Much of the timber in the Toutle watershed was blown down or died standing as a result of extreme heat from the eruption. Timber salvage efforts removed many of the dead trees. The depletion of potential instream large organic debris (LOD) may have long-term detrimental impacts to stream morphology conducive to fish production. A summary of the eruption's damage to fish habitat was detailed by Lucas (1986). Although the South

Fork Toutle appears to be rapidly recovering, much of the North Fork Toutle is a broad, braided stream of shifting channels carrying a heavy sediment load. For years, sediment from the North Fork Toutle has moved downstream into the Toutle and Cowlitz rivers, reducing habitat quality. A sediment retention structure on the North Fork Toutle was completed in 1988 to retain sediment. However, upstream of the sediment retention structure, the North Toutle still has erosion and sediment problems and is far from reaching historic salmonid production potential.

Climate in the subbasin is typical of the West Coast marine type. Winters are mild, wet and cloudy while summers are relatively cool and dry. Annual precipitation varies from 45 inches near Kelso to over 150 inches on Mount Rainier, Adams, and St. Helens. Most precipitation occurs between October 1 and March 31 as rain.

Above 3,500 feet, forests are generally Pacific silver fir with Douglas fir, western hemlock, western red cedar, noble fir, subalpine fir, mountain hemlock, and lodgepole pine as common associates. Understory is primarily huckleberry, fool's huckleberry and salal. Below 3,500 feet, climax species are western hemlock, Douglas fir, and western red cedar. Understory species include vine maple, huckleberry, salal, sword fern and devil's club. Hardwood species are concentrated in riparian areas along larger streams, creeks and rivers. The most common are alder, maple, willow and cottonwood.

Much of the subbasin riparian areas have been impacted through logging. In general, logging activities harvest and disturb vegetation that shades streams and reduces erosion, resulting in spawning and rearing habitat degradation. Logging also harvests trees destined to be large woody debris -- important instream structures for fish. The Coweeman River was classified as "temperature sensitive" due to intensive logging (Nunamaker 1986).

Livestock grazing occurs primarily in lower subbasin tributaries. Impacts are created by cropping and trampling streamside vegetation, resulting in a loss of fish habitat and increased stream temperatures and erosion.

Fisheries Resources

The Cowlitz River is managed for winter and summer steelhead, sea-run cutthroat, fall and spring chinook, and coho. Chum salmon were also once present (Stockley 1961). All salmon stocks are managed as hatchery stocks while steelhead and most sea-run cutthroat are managed as mixed hatchery and natural stocks.

The Cowlitz may be the most intensively sport fished subbasin in Washington. The Cowlitz River has been the top winter steelhead river in the state and the Toutle was in the top five before 1980. Both rivers are also popular summer steelhead streams. In good return years, the Cowlitz attracted immense angler effort for spring chinook. Both the Cowlitz and Toutle attracted considerable angler effort seeking fall chinook and coho. Upstream in Mayfield and Riffe reservoirs, anglers catch mostly coho juveniles and spend an average of 13,423 and 201,560 angler hours, respectively (Tipping 1988). Effort in Mayfield is expected to increase with the 1988 experimental introduction of tiger muskies, planted with the goal of creating a tiger muskie fishery and improving the salmonid fishery by preying upon predatory squawfish. Above the reservoirs, a popular legal trout program totaling about 150,000 fish annually is maintained to supplement natural production of resident fish.

Mayfield (RM 52) and Mossyrock (RM 65.5) dams on the Cowlitz River and the sediment retention structure on the North Fork Toutle (RM 11) are the primary dams in the subbasin impacting anadromous production, although a natural barrier exists on the Green River portion of the Toutle River about 25 miles above the confluence with the North Fork Toutle. Mayfield and Mossyrock dams flooded miles of spawning and rearing habitat in the Cowlitz and several tributaries. Mayfield Dam was completed by Tacoma City Light in 1962; anadromous runs were temporarily maintained by passing adults upstream and passing juveniles downstream through a migrant facility. A few years after the 1968 completion of Mossyrock Dam, upstream of Mayfield, attempts to maintain anadromous production in the upper watershed were abandoned due to insufficient juveniles being captured in Riffe Reservoir. Biologists identified reservoir residualism (failure of juveniles to find their way out of reservoirs), juvenile passage mortality, and squawfish predation as reasons why the runs failed above Mayfield Dam.

Until 1981, some spring chinook, coho and steelhead adults were trucked above Mayfield to the Tilton River, and above Mossyrock to the Cowlitz River, to provide a limited sport fishery. Sport harvest of transported fish was low (Stober 1986). In 1981, IHN virus (infectious hematopoietic necrosis) was detected in Cowlitz winter steelhead. Transport of steelhead and chinook above Mayfield was terminated so that the Cowlitz Salmon Hatchery water supply would not be contaminated with virus. Because coho have not been observed to host the virus in the Cowlitz, coho adults and jacks are usually planted annually into the Tilton River and upper Cowlitz.

A third major dam, Cowlitz Falls, has been licensed for construction by the Federal Energy Regulatory Commission (FERC). The Lewis County Pubic Utility District may start construction in

1991 or 1992. Because Cowlitz Falls Dam is designed to permit retrofitting of a juvenile screening and collection facility, the opportunity to reintroduce anadromous fish into the upper watershed is enhanced. An adult trap and sorting system already exists at the Cowlitz Salmon Hatchery below Mayfield Dam so adults could be trucked upstream to utilize habitat presently inaccessible. The reservoir behind the Cowlitz Falls Dam will be relatively small, reducing the risks of residualism and predation.

However, substantial problems remain before runs can be re-established in the upper Cowlitz Basin:

1) Financial responsibility for downstream screens at Cowlitz Falls is uncertain: Tacoma City Light built downstream dams that stopped upstream fish runs and has subsequently mitigated with two hatcheries.

2) Intake for the Cowlitz Salmon Hatchery water supply is upstream of the free anadromous zone and is currently virus free: moving chinook or steelhead above the water intake could jeopardize hatchery production while installation of a water treatment facility for the hatchery would be very costly.

3) Introduction of virus in the upper watershed could result in legal litigation if the private fish farms in the area were contaminated.

4) Mortality of juvenile salmonids in Mayfield Lake from sguawfish predation is severe, thereby limiting production from the Tilton River.

5) The legal trout program in the upper Cowlitz, popular with anglers and area businesses, would have to be moved to ponds and lakes so natural stream production would not be impacted by anglers seeking legal trout.

6) Natural resident trout production may decline with competition from anadromous fish in the upper Cowlitz.

7) A method for separating hatchery and natural salmon adults returning to the Cowlitz Salmon Hatchery must be developed. It is undesirable to release a mix of hatchery and natural adults into the upper basin. Hatchery fish introduced to the upper basin will not disperse well, and some may attempt to return down river. The hatchery fish may also have a lower genetic fitness for natural survival. Nor is it desirable to lose natural fish to hatchery egg-takes. Losses of natural fish must be kept to a minimum to successfully establish a natural run.

8) Harvest management of below Bonneville salmon stocks is based on hatchery harvest rates. Because of this, it may be difficult to establish large spawning populations within the Cowlitz.

There are several rearing facilities within the subbasin: the Cowlitz Salmon Hatchery, the Cowlitz Trout Hatchery, Beaver Slough rearing facility, Alder Creek rearing pond, and several cooperative rearing ponds. Each facility is described in detail in Part IV.

Water Resources

Mean flow in the Cowlitz Subbasin for 1980 through 1984 was a minimum of 8,693 cubic feet per second (cfs). The Cowlitz comprised 70.7 percent of the annual flow, the Toutle 24.3 percent, and the Coweeman 5 percent. Because much of the subbasin is below the normal snow line, peak river flows correspond to midwinter warm rains and possible snowmelt from foothills (Table 1). A flow increase usually occurs in spring associated with ice-melt. Low flows are generally encountered in late summer and fall.

Table 1. Mean flows (cfs) from the Cowlitz, Toutle, and Coweeman rivers (USGS records).

Mo.	1963-86 Cowlitz R. @ Mayfield Dam #14238000	1980-86 Toutle R. near Castle Rock #14242580	1951-84 Coweeman R. near Kelso #14245000
Jan	9,866	3,378	926
Feb	8,295	3,614	755
Mar	6,859	2,525	652
Apr	5,655	2,517	489
May	5,909	2,074	277
Jun	6,989	1,719	174
Jul	4,573	945	90
Aug	2,629	470	59
Sep	2,653	533	76
Oct	3,954	1,067	187
Nov	7,546	2,913	548
Dec	10,925	3,619	909
AVE	6,321	2,115	429

Cowlitz River flow is moderated by the two large upstream reservoirs. Annual monthly high-to-low flow ratio is about 4-to-l on the Cowlitz compared to about 8-to-1 on the Toutle and 16-to-1 on the Coweeman. The Coweeman originates from foothills below 3,000 feet and is rated as poor in summer water yield (USSCS 1974). Low flows have occasionally impeded migrations of fall chinook and coho in the Coweeman and Toutle rivers. Low flows reduce juvenile salmonid production by limiting habitat.

The mainstem Cowlitz River is temperature moderated by the two upstream reservoirs. Temperatures usually range from the low 40s Fahrenheit in winter to the high 50s F in summer. However, many small tributaries get considerably warmer. The Toutle River mainstem has approached 70 F (USGS data) as a result of loss of riparian habitat in the volcanic eruption. In July and August 1984 through 1986, average daily maximum temperatures in the Toutle tributaries of Herrington, Hoffstadt and Schultz creeks usually exceeded 68 F (Bisson et al. 1988). The Coweeman River has been classified as "temperature sensitive" by exceeding the summer daily ambient water temperature of 60 F for a seven-day period (Nunamaker 1986).

With exception of some of the headwater tributaries, gradients are generally low and usually range from 0.2 percent to 2.5 percent. Cowlitz River and tributary gradients are generally less than gradients in the Toutle and Coweeman rivers.

Substrates in the subbasin are generally sand and muck in the lower portions of streams while upstream sections are generally a mixture of cobble, gravel and sand with some bedrock. Substrate in the Toutle River is a combination of silt, gravel, and cobble although some areas have unstable channels.

Water chemistry in the subbasin has generally neutral pH and is low in dissolved solids and nutrients (Table 2), probably due to leaching of minerals caused by heavy annual rainfall. Turbidity fluctuates considerably. After 1980, dissolved solids, nutrients and turbidity increased in the Toutle River and lower Cowlitz, presumably due to the volcanic eruption. U.S. Geological Survey records for 1959 through 1967 (USSCS 1974) indicated the Cowlitz River near Toledo, the Toutle River near Castle Rock, and the Cowlitz near Kelso each had a pH of 7.2 and dissolved solids of 45 to 47 mg/l.

Table 2. Water chemistry characteristic in the Cowlitz Subbasin, average of samples taken in 1980-1986 (USGS records).

	Cowlitz River Mayfield Tailwater or Trout Hatchery inlet	Cowlitz River @ Kelso
pH	7.1	7.3
Specific Conductivity	57	105
Turbidity	4	54
Phosphorus (mg/l as P)	.02	.20

Irrigation consumes little water in the subbasin (USSCS 1974). Most agricultural acreage is hay and pasture land. Physical land limitations do not lend itself to economic irrigation. Municipal, rural, and industrial water needs were projected for the subbasin to reach 23 million gallons per day (mgd) in the year 2020, compared to 10.2 mgd in 1974 (USSCS 1974). Because most water consumption would occur in the lower river near the municipalities, the increase will probably have little impact on subbasin salmonid production.

Hydroelectric projects include Mayfield Dam on the Cowlitz River (Tacoma City Light): Mossyrock Dam above Mayfield (Tacoma City Light): Mill Creek Development at the impassable falls on Mill Creek (Lewis County PUD and private): Burton Creek Hydro on impassable falls on Burton Creek above Mossyrock Dam (private); and Packwood Lake Hydro, a diversion of water exiting Packwood Lake in the upper Cowlitz watershed (WPPSS). In addition, the U.S. Army Corps of Engineers constructed the sediment retention structure on the North Fork Toutle. Numerous other sites, above current anadromous zones, are under study or in the process of licensing.

The Corps of Engineers constructed a sediment retention structure (SRS) in 1988-1989 to catch volcanic sediment transported down the North Fork Toutle River. Dredging from the pool behind the dam is not planned and sediment may eventually fill the pool. A fish collection facility has been constructed on the North Fork Toutle about a quarter mile above the mouth of the Green River so adults can be trucked above the SRS. The collection site denies fish access to about two miles of river between the facility and the SRS unless fish can be passed between the two sites. The dam will inundate several miles of stream including parts of Alder, Hoffstadt, Bear, and Deer creeks. Downstream passage success of juveniles and adults will not be known until tests are conducted. Alder Creek rearing pond may not be usable as a result of the SRS; to mitigate the loss, another pond is proposed for construction on Devil's Creek.

Land Use

Forestry comprises most of the land use within the subbasin (Table 3). In the Cowlitz floodplain below Mayfield, agriculture and other uses made up only about 16 percent of use in 1974 (USSCS). The lower half of the watershed includes pasture, agriculture and built-up developed lands. With exception of upper headwaters and scattered tracts of state land, the Cowlitz Subbasin is privately owned.

Municipalities in the subbasin below Mayfield Dam include Longview, Kelso, Castle Rock, Toutle, Vader, Winlock, Toledo, and Ryderwood; rural residential developments include Lexington, Carrolls, Silver Lake, Mary's Corner, Evaline, Silver Creek, Ethel, and Salkum. Municipalities above Mayfield are Mossyrock, Morton, Randle and Packwood; rural residential developments are Winston, Harmony, Glenoma, and Silver Brook.

Table 3. Land use (percent) in the Cowlitz Subbasin (USSCS 1974).

	Cowlitz above Mayfield	Cowlitz below Mayfield	Toutle	Coweeman	Total
Commercial forest	71.7%	81.8%	90.2%	94.1%	78.2%
Non-commer. forest	12.8	0.7	3.0	0.0	7.5
Reserved forest	8.9	0.0	0.0	0.0	4.8
Cropland	1.7	10.5	2.3	1.4	4.1
Pasture	0.5	4.4	0.4	1.0	1.5
Rural non-farm	0.0	1.0	0.3	0.7	0.3
Built-up land	0.5	1.4	0.2	2.7	0.8
Barren land*	3.9	0.2	3.7	0.0	2.7

* Land in national parks or forests.

Parts of the upper Cowlitz River headwaters are in the Mount Rainier National Park, William 0. Douglas, Goat Rocks and Mount Adams wilderness areas. Timber harvest and roads are not allowed in the wilderness areas. Timber harvest is also prohibited in Mount Rainier National Park. The possible classification of the Cispus River and the North and South Fork Toutle rivers as "wild and scenic" rivers will preclude both timber harvest within a specified stream corridor and most road access to the rivers.

The subbasin contains part of the administrative (150,000 acres) and legislative (110,000 acres) Mount St. Helens National Volcanic Monument areas, managed by the U.S. Forest Service. Only a small portion of the upper Cowlitz River tributaries are in the administrative monument. The pending land management plan for the administrative monument calls for regulated timber harvest along designated Class I, II, and III fishbearing streams with an objective of maximizing fish production.

Much of the upper Toutle River is within the legislative National Volcanic Monument Area. Management of streams within the legislated monument is currently being addressed in the development of a Fish and Wildlife Management Plan, which has been formulated in cooperation with the Washington departments of Wildlife and Fisheries. The Fish and Wildlife Management Plan will be amended to coordinate with other plans such as the subbasin plan. In the legislated monument, geological and ecological processes will be allowed to occur naturally for study and research, therefore fish habitat will not normally be enhanced. Timber harvest is not permitted. Dispersed recreational and research are acceptable activities.

The pending land management plan for the Gifford Pinchot National Forest is similar to that described for the administrative monument along with implementing habitat restoration and enhancement programs.

A relatively small amount of gold mining occurs in the upper watershed. Little other mining activity is found in the subbasin.

PART II. HABITAT PROTECTION NEEDS

History and Status of Habitat Protection

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

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

Federal

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

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

Washington State

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

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

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

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

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

6. Minimum Flow Program, Department of Ecology.

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

8. Flood Control Statutes, local government.

9. Forest Practices Act, Department of Natural Resources.

Constraints and Opportunities for Protection

Fish production in the Cowlitz Subbasin competes, primarily with timber interests. Fishery agencies work with other agencies and landowners through various federal, state, and local laws and agreements to identify and reduce practices impacting fish habitat. Although fishery habitat laws and agreements are well intentioned, the inherent topography, geology, soils, and climate as such would preclude most subbasin resource utilization without some habitat degradation.

In some 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 important to address this difficult management situation. Good interagency communication of goals and objectives within watersheds and cooperative administration and enforcement could improve habitat protection.

Resource managers are currently cooperating to protect riparian habitat through the Timber/Fish/Wildlife Agreement. Harvest plans are reviewed by an interdisciplinary team and decisions are based on cooperative research, monitoring, and evaluation. The goal is to provide protection for wildlife, fish and water quality while allowing forest management activities to occur at reduced levels and under controlled operating conditions. Methods, among others, are to maintain adequate stream shading, leave trees that will later contribute large woody debris to streams, and to create silt traps to reduce silt entry into streams.

The agencies listed below have statutory or proprietary interests to salmon and steelhead production within the subbasin.

Federal

U.S. Forest Service (USFS)
U.S. Geological Survey (USGS)
U.S. Soil Conservation Service (USSCS)
U.S. Fish and Wildlife Service (USFWS)
U.S. Army Corps of Engineers (COE)
U.S. National Park Service (USNPS)
Federal Energy Regulatory Commission (FERC)
National Marine Fisheries Service (NMFS)

State

Washington Department of Ecology (DOE)
Washington Department of Fisheries (WDF)
Washington Department of Wildlife (WDW)
Washington Department of Natural Resources (DNR)
Washington Department of Agriculture

Local

Lewis County PUD
Tacoma City Light (TCL)
Lewis County
Cowlitz County
Skamania County
Washington Public Power Supply (WPPS)

Habitat Protection Objectives and Strategies

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

Guidelines for habitat protection include:

1) No net loss of existing habitat.

2) No degradation of water quality

3) No decrease of surface water quantity

4) Increased security for existing habitat

5) Increased salmonid use of underutilized habitat.

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

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

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

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

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

2) Purchasing riparian property adjacent to critical habitat.

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

4) Publishing additional inventories of important habitat for specific stocks

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

PART III. CONSTRAINTS AND OPPORTUNITIES FOR ESTABLISHING PRODUCTION OBJECTIVES

Systemwide Considerations

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

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

As an extension of these objectives, subbasin plans should:

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

2) Work toward harvest stability within subbasins.

3) Provide equitable opportunity to each user group.

4) Maintain habitat and improve where possible.

5) Manage for the consistent escapement of escapement allowances.

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

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

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

Bonneville Dam. In some cases, such as Cowlitz spring chinook, the agreement is intimately tied to providing upriver opportunities to tribal fisheries.

Lower Columbia River production acts as a major producer for ocean fisheries in helping to provide maximum opportunity on a consistent basis. The Pacific Salmon Treaty, negotiated in 1985, has a large influence on ocean harvest. The major principles of the treaty attempt to 1) prevent overfishing and provide for optimum production, and 2) provide for each party to receive benefits equivalent to the production of salmon originating in its waters.

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

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

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

3) Annual variation in abundance of the stocks.

Local Considerations

Local constraints include existing habitat with associated problems with water temperatures, disease and siltation. Much habitat has been removed from access by dams while the eruption of Mount St. Helens has impacted some areas for many years. Existing fish rearing facilities are at capacity, although additional facilities or cooperative rearing programs could increase production.

The Washington Department of Wildlife has two agreements with Tacoma City Light to mitigate impacts of Mayfield and Mossyrock dams on the Cowlitz River. Intent of the 1986 agreement was to maintain an adult return of 38,600 steelhead and sea-run cutthroat through a Cowlitz Trout Hatchery program of 191,000 pounds of juveniles. The agreement provides that the Washington Wildlife Department shall select the numbers and kinds of species to rear and plant. Steelhead juveniles were to have a minimum length of 18 cm and cutthroat, 21 cm. Adult steelhead were to be measured by punch-card harvest, representing 70 percent of returns while hatchery rack counts were to represent 50 percent of sea-run cutthroat returns.

The 1988 Washington Department of Wildlife and Tacoma City Light agreement provides for Tacoma City Light to construct, operate and maintain an ozone water treatment facility at the

Cowlitz Trout Hatchery to treat up to 20 cfs of river water for control of _Ceratomvxa shasta_. Tacoma City Light will also maintain angler access facilities at the Cowlitz Salmon Hatchery and Cowlitz Trout Hatchery; make efforts to maintain Riffe Lake pool level above elevation 767 from June 1 through September 1; and conform to the following flow regime between December 1 and February 28.

Weekday Flows

A) 6 a.m. to 2 p.m.; Mayfield discharge not to exceed 12,800 cfs except when spill is anticipated or occurring.

B) 2 p.m. to 6 a.m.; Mayfield may be operated at full capacity.

Weekend and Holiday Flows

A) 5 a.m. to 2 p.m.: Mayfield discharge not to exceed 10,900 cfs except when spill is anticipated or occurring.

B) 2 p.m. to.5 a.m.; Mayfield may be operated at full capacity.

The Washington Department of Fisheries and Tacoma City Light mitigation agreement for Cowlitz River dams states mitigation for the Department of Fisheries operation of the Tacoma City Light-funded and maintained Cowlitz Salmon Hatchery was to return 8,300 fall chinook, 17,300 spring chinook, and 25,500 coho adults back to the hatchery.

A 1977 flow regulation schedule between the Washington departments of Wildlife and Fisheries, and Tacoma City Light generally states that the:

1) March 1 to July 15 minimum flow releases from Mayfield Dam are to be 5,000 cfs; if water is not available, efforts will be made to maintain as high and constant a release as possible.

2) July 16 to September 15 minimum flows are to be 2,000 cfs, as constant as possible.

3) September 16 to November 20 flows will be between 2,500 and 4,000 cfs at Mayfield Dam: if flows exceed 4,000 cfs before November 20, if possible, subsequent discharges will be provided to adequately cover existing salmon redds.

4) November 21 to February 28 flows are to be maintained at a level that will inundate existing redds except when conditions are beyond licensee's control.

PART IV. ANADROMOUS FISH PRODUCTION PLANS

WINTER STEELHEAD

<u>Fisheries Resource</u>

Natural Production

History and Status

Winter steelhead were historically abundant in the Cowlitz Subbasin. In the Cowlitz River, an estimated 22,000 winter steelhead were produced annually (Meigs, no date: Moore and Clarke, no date). Distribution was throughout the watershed. Adult catch was estimated at 3,000 fish caught by Columbia River commercial fishermen, 8,000 fish sport caught in the Columbia and Cowlitz rivers, and 11,000 fish that escaped to spawn. Counts of steelhead in 1961 through 1966 at the Mayfield Dam site averaged 11,087 fish (Thompson and Rothfus 1969). With losses created by Mayfield and Mossyrock dams, runs have been maintained through production at the Cowlitz Trout Hatchery, completed in 1967. Due to habitat loss, diseases and large hatchery programs, natural fish comprise a small part within the Cowlitz River component of the subbasin.

Prior to 1981, an annual average of 3,466 steelhead were trucked above Mayfield into the Tilton River to provide sport fishing opportunity although a few fish spawned naturally in the river (Stober 1986). Most fish dropped out of the river and sport catch averaged only 6.6 percent of transported adults. After 1981, steelhead were maintained below Mayfield due to concern of contaminating the Cowlitz Salmon Hatchery with IHN virus.

The 1980 volcanic eruption probably did not impact natural production of steelhead in the Cowlitz River except in the lower river where emigrating smolts may have encountered gill abrasion and thermal stress. Many returning adults, however, strayed to other rivers to spawn (Leider 1989).

In the Toutle River, little is known of the historic run size; fish were probably distributed throughout the watershed. The 1980 eruption of Mount St. Helens greatly affected steelhead production and some adults strayed to other rivers (Leider 1989). Habitat has improved and an average of 2,743 fish escaped to spawn between 1985 and 1989 (Lucas 1986 and 1987, Lucas and Pointer 1987, Lucas unpublished).

For natural steelhead in the Coweeman River, Lucas and Pointer (1987) and Lucas (unpublished) estimated that an average of 790 steelhead spawned in 1987 to 1989. Fish were distributed throughout the watershed. The volcanic eruption had little impact on Coweeman production except after fish entered the Cowlitz River, where gill abrasion and thermal stress may have occurred: some adults may have strayed to other rivers (Leider 1989).

Life History and Population Characteristics

Adult time of entry is generally from mid-November through May with peak numbers in March and April (Table 4). Spawning occurs from mid-March through early June (Lucas 1986 and 1987, Lucas and Pointer 1987). Emergence occurs from April through early July. Juvenile rearing generally lasts for two years prior to spring ocean emigration, although some juveniles emigrate after three years (Tipping et al. 1979; Schuck and Rurose 1982; Tipping 1984).

Table 4. Freshwater life history of Cowlitz Subbasin winter steelhead. The developmental stage timing represents basinwide averages. Local conditions may cause some variability.

Developmental Stages	Time of year	Peak occurrence
Adult immigration	November-May	March-April
Adult holding	December-May	March-April
Spawning	December-May	April-June
Egg/alevin incubation	December-June	May
Emergence	February-July	May-June
Rearing	Feb-April (26 mos.)	June-April (24 mos.)
Juvenile emigration	April-May	April-May

In the Cowlitz River, the natural run is presently small. For 1977-1978, 1978-1979, and 1983-1984, natural fish contributed an average of 1.7 percent of adult returns (Tipping et al. 1979; Tipping 1984). Using 1.7 percent of the estimated run for 1977 through 1979 and 1985 through 1989, estimated average return of naturally produced steelhead was 309 fish, even though large numbers of hatchery fish spawned naturally. In 1985, Cowlitz

River spawning escapement was estimated at 5,703 fish (Tipping et al. 1985).

In the Toutle River, run size of natural fish averaged 2,749 fish for 1987 through 1989 (Lucas 1986, Lucas 1987, Lucas and Pointer 1987, Lucas unpublished). Sport harvest averaged 256 fish for 1987 through 1989 (excludes November-December harvest, which was thought to be summer steelhead).

In the Coweeman River, an estimated 889, 1,088, and 392 natural fish spawned in 1987, 1988, and 1989, respectively (Lucas and Pointer 1987, Lucas unpublished). In addition, the 1989 punch-card data indicated 38.6 percent of the sport harvest was natural fish. Adding the sport catch to the spawning escapement results in an average run size of 1,030 fish.

A three-year mean for Cowlitz River juveniles found that 90.9 percent and 9.1 percent resided for two and three years, respectively, prior to emigrating to salt water (Tipping 1984; Tipping et al. 1979). For adults, including repeat spawners, ocean age structure was dominated by 2-year ocean fish (a-salts), although 34.5 percent were 3-year ocean fish (3-salts) (Table 5). Overall, females made up 63.6 percent of sampled fish. Mean length of all fish combined was 73.6 cm.

Table 5. Ocean age, sex, and length of Cowlitz River natural steelhead (Tipping et al. 1979; Tipping 1984).

	Ocean Age			
	1	2	3	4
Age Composition	0.0%	61.8%	34.5%	3.6%
Females	0.0%	58.8%	68.4%	100.0%
No. Fish	0	34	19	2
Mean Length (cm) Male	---	69.6	81.7	---
Mean Length (cm) Female	---	68.7	79.9	84.5

In the Toutle River, 86.5 percent of smolts emigrated at 2 years of age and 13.5 percent at 3 years (Schuck and Kurose 1982). Adults, including two male and two female repeat spawners, had an ocean age composition that included 72.2 percent

2-salts (Table 6). Overall, females comprised 55.5 percent of sampled fish. Mean length of all fish combined was 69.8 cm.

In the Coweeman River, age, length and sex ratio of fish was not available. This information was assumed similar to Cowlitz River natural fish.

Table 6. Ocean age, sex, and length of Toutle River natural steelhead (Schuck and Kurose 1982).

	Ocean Age					
	1	2	3	4	5	6
Age Composition	8.3%	72.2%	8.3%	5.5%	2.8%	2.8%
Females	0.0%	57.7%	100.0%	0.0%	100.0%	100.0%
No. Fish	3	26	4	2	1	1
Mean Length M	45.3	69.7	---	83.7	---	---
Mean Length F	---	68.5	81.4	---	81.0	79.8

Natural fish fecundity data for the Cowlitz Subbasin is meager. On the Toutle River, 49 females live-spawned with a mean length of 70.4 cm provided a mean of 3,900 eggs in 1988 (R. Lucas, WDW, pers. commun.). Schuck and Kurose (1982) live-spawned 26 fish that had a mean fecundity of 2,251 eggs per female. However, live spawning does not reflect true fecundity as some eggs are retained. Fecundity of 2-year ocean fish was estimated at 4,500 eggs while 3-year ocean fish was estimated at 5,000 eggs per female, similar to observed fecundity of hatchery fish.

Egg-to-smolt and smolt-to-adult survival rates for the Cowlitz River are unknown; however, egg-to-smolt survival is probably extremely poor in the mainstem Cowlitz due to disease. Tipping (1988) found mortality of hatchery fish reared at the Cowlitz Trout Hatchery from the protozoan Ceratomvxa shasta was 25.4 percent with many more fish so severely infected that survival was doubtful.

In the Toutle and Coweeman rivers, egg-to-smolt and smolt-to-adult survivals are unknown.

Table 7 lists three steelhead smolt production capacity estimates: 1) the Northwest Power Planning Council's, 2) Washington Department of Wildlife's gradient area flow methodology (GAFM), and 3) a revised GAFM estimate based on modifications due to C. shasta and the extreme habitat degradation from the volcanic eruption in the Toutle. Total smolt capacity was divided by half in areas where sympatric populations of winter and summer steelhead existed.

Table 7. Cowlitz Subbasin winter steelhead smolt capacity estimates.

Water	NPPC	WDW GAFM	REVISED GAFM
Cowlitz R.	29,027	33,132	21,747
Toutle R.	82,796	86,824	65,712
Coweeman R.	66,959	38,229	38,229
TOTAL	178,782	158,185	125,688

The Northwest Power Planning Council model was also used to estimate smolt production above Mayfield. Data on streams was acquired through Meekin (1962), Birtchet (1963), Rothfus and Thompson (1969), Easterbrooks (1980) and U.S. Forest Service personnel. The Tilton River and Winston Creek, both entering Mayfield Lake, could produce a total of 57,993 smolts. Above Cowlitz Falls, an estimated 193,128 smolts could be produced, resulting in 251,100 above Mayfield. Streams flowing into Riffe Lake below Cowlitz Falls are no longer available to steelhead since there is no way to capture smolts once in Riffe. However, because of problems mentioned in Part I regarding re-establishing anadromous fish above Mayfield, attempts to do so are not addressed as a strategy to reach objectives.

The downstream migrant facility at Mayfield Dam enumerated steelhead produced from spawning steelhead in the Tilton and from fingerling plants into Mayfield Lake. Numbers observed were relatively small although, interestingly, they persist (Table 8). Plants averaging 3,466 adult steelhead (1967-1980) to the Tilton River and 410,900 juveniles (1976-1977) into Mayfield Lake were terminated after 1981.

Table 8. Steelhead smolts through the Mayfield migrant trap (Tipping, WDW, unpublished).

Year	Number of smolts	Year	Number of smolts
1978	3,398	1984	no data
1979	1,302	1985	664
1980	2,481	1986	1,163
1981	5,114	1987	509
1982	1,376	1988	202
1983	293		

Schreck et al. (1986) looked at stock identification of various Columbia River steelhead, including the Coweeman and South Toutle stocks, using cluster analysis of meristic and electrophoretic features and concluded geographical proximal stocks were similar.

Supplementation History

Hatchery fish have been planted into the subbasin since 1933 using a multitude of stocks. A hatchery existed on the Tilton River below Morton from 1915 to 1921 and was used as an egg-taking station. On the Cowlitz River since 1967, fish planted have been almost exclusively Cowlitz stock (Appendix D). As part of the Washington Department of Wildlife/Tacoma City Light mitigation agreement, the Wildlife Department is managing for 750,000 smolts, which are to provide a return of 22,000 adults and a sport catch of 15,400 fish. Supplementation performance is described under hatchery production.

Releases into the Toutle and Coweeman rivers were to supplement sport catches of natural steelhead. Since 1970, Chambers Creek, Elochoman River and Cowlitz River stocks were frequently used. Because of mixed hatchery and natural fish in the sport catch, performance of supplementation is unknown. In the Toutle River, the number of smolts planted in the 1970s exceeded 100,000 fish. For 1981 through 1987, however, only 13,635 smolts and 23,325 fingerlings were planted. Future hatchery plants are not anticipated.

In the Coweeman River for 1970 through 1988, an average of 49,500 smolts were planted while anticipated supplementation is about 40,000 smolts.

Fish Production Constraints

Specific production constraints include lack of habitat, the pathogen C. Shasta, inter- .and intraspecific competition from large hatchery plants, and habitat degradation in the Toutle River from the volcanic eruption. General constraints include sedimentation, warm water temperatures, lack of large organic debris (LCD) and riparian vegetation, and low flow (Table 9). Another constraint is lack of mature timber to provide LOD recruitment and to moderate water temperatures.

Hatchery Production

Cowlitz River

On the Cowlitz River, the Cowlitz Trout Hatchery is the only facility producing winter steelhead. Located at RM 42 on the Cowlitz River, the hatchery has 104 hatching troughs, eight 10' X 100' intermediate raceways, 24 20' X 90' raceways, and four five-acre rearing ponds. Water source consists of nine wells providing up to 5.5 cfs and pumped river water up to 50 cfs flow. The disease ceratomyxosis, transmitted in river water but not infective directly from fish to fish, has limited production so severely that Tacoma City Light agreed to install by 1990 an ozone water treatment system to disinfect the water. Production from 1980 through 1986 averaged 485,159 smolts, 64.7 percent of the mitigation level. Mitigation goal of winter steelhead is 750,000 smolts (125,000 pounds) with a minimum length of 18 cm. Production goal, including summer steelhead and sea-run cutthroat is 1,050,000 smolts (191,100 pounds). The planned ozone system is to provide up to 20 cfs of water from July 1 through October, the C. shasta infective period. Existing facilities are large enough to greatly exceed mitigation goals if C. shasta were controlled.

Table 9. Habitat constraints in Cowlitz Subbasin.

Section of Subbasin	Species*	Habitat Constraints
Cowlitz R. Mainstem mouth to Toutle	1-6	Disease, sedimentation, temps, interspecific competition,, lack of gravel, pool/riffle ratios, lack of LOD, lack of riparian vegetation.
Cowlitz R. Mainstem Toutle to barrier	1-6	Disease, sedimentation, temps, interspecific competition, lack of LOD, lack of riparian vegetation.
Cowlitz R. tributaries	1-3,6	Sedimentation, temperatures, low flows, gravel quality.
Coweeman R. drainage	1,3,4,6	Sedimentation, temperatures, cover, gravel quality.
Toutle R. Mainstem	l-6	Sedimentation, temperatures, pool/riffle ratio, cover, water quality, gravel quality, lack of LOD, lack of riparian vegetation.
N. Fk. Toutle	1-6	Sedimentation, temperatures, insufficient edge habitat, gravel quantity, water quality, unstable channel, lack of LOD, lack of riparian vegetation.
Green R.	l-6	Temperatures, gravel quantity and quality, cover, passage blocked @ RM 25, lack of LOD, lack of riparian vegetation.
S. Fk Toutle	1-6	Cover, sedimentation, lack of edge habitat, lack of LOD, lack of riparian vegetation.

* l-Winter steelhead
2-Summer steelhead
3-Sea-run cutthroat
4-Fall Chinook
5-Spring Chinook
6-Coho

Brood stock source is the Cowlitz River via rack returns. Steelhead selected for spawning are those sexually mature in December through February, although some are taken in May. Many large fish (3-salts) are used because they return and are sexually mature a little sooner than smaller 2-salt fish, allowing more time to rear juveniles to desired smolt size. In the 1970s, size selection of brood stock was attempted to increase body size of subsequent generations: in 1972 and 1973 about one-fourth of progeny were from brood stock over 76 cm. By 1977 and 1978 all progeny were from adults over 81 cm in length. Ovarian fluid is tested from females for IHN virus and eggs from positive females were usually discarded until 1989 when all eggs were treated in iodophor and retained.

Run size of Cowlitz River hatchery fish was estimated to be 98.3 percent of returns for 1977-1979 and 1985-1989. Since average returns were estimated at 18,214 fish, hatchery fish totaled 17,904 steelhead.

Although beginning and ending times are similar, peak adult time of return, time of spawning, incubation period, and emigration time is about two months sooner for hatchery fish than Cowlitz natural steelhead. Fecundity of steelhead kill-spawned from 1981 through 1987 averaged 5,257 eggs (n=1,899) per female. Smolts emigrate after about 14 months, about one year sooner than natural fish. Saltwater age composition of adults was 0.4 percent, 61.9 percent, 36.7 percent, and 1.1 percent for age I, II, III, and IV, respectively (Tipping et al. 1979; Tipping 1984). Females comprised 7.1 percent, 33.2 percent, 69.4 percent, and 50 percent of each age class, respectively, and 46.6 percent of the total. Mean length of steelhead, which includes a small portion of natural fish, was 74.2 cm for years after 1973 (Table 10).

Egg-to-fry survival rate in the hatchery averaged 89 percent. Fry-to-smolt survival was only 41.5 percent (Tipping et al. 1985) due primarily to C. Shasta, resulting in an egg-to-smolt survival of 36.9 percent. The ratio of sport-caught fish to smolts planted for 1982 through 1985 releases averaged 2.54 percent. Dividing the ratio of smolts planted to adults harvested by the 1985 observed harvest rate (71.1 percent) and adding in a 5 percent pre-spawning mortality, results in a smolt-to-adult return rate of 3.57 percent.

Milner et al. (1980) did an electrophoretic profile of Cowlitz winter steelhead along with other Columbia River stocks to examine the feasibility of using biochemical genetic variation for estimating composition of mixed-stock fisheries. They concluded sufficient genetic differentiation existed to do so. Schreck et al. (1986) looked at stock identification of various Columbia River steelhead, including the Cowlitz, using cluster analysis of meristic and electrophoretic features and concluded geographical proximal stocks tend to be like each other. Thorgaard (1977) looked at chromosome counts of Cowlitz River hatchery winter steelhead and found that fish with different chromosome numbers are present in different proportions in the February and May spawning populations, suggesting influence of Chambers Creek stock introductions.

Table 10. Length of Cowlitz hatchery winter steelhead (Tipping, unpub. data: Young 1971; Young 1974; Tipping 1984; Tipping et al. 1979).

Year	Male (n)	Female (n)	Both (n)
1970-71		--	69.0 (641)
1971-722	--	--	69.0 (786)
1972-732	--	--	73.2 (389)
1977-783	74.0 (546)	73.0 (527)	73.4 (1,073)
1978-793	74.5 (506)	75.9 (475)	75.1 (981)
1979-804	73.3 (93)	79.6 (266)	78.0 (359)
1983-845	70.4 (639)	73.8 (350)	71.6 (1,148)
1985-864	70.7(2,335)	71.0(2,267)	70.8 (4,602)
1986-874	75.7(5,106)	76.5(5,918)	76.1(11,024)

No additional production facilities are planned in the Cowlitz River component of the subbasin. The major constraint at the Cowlitz Trout Hatchery is the protozoan C. Shasta. However, a planned ozone water treatment facility is expected to alleviate the problem. Bird predation at the hatchery, even though active, has not been viewed as a major problem because birds have probably been feeding on weakened C. shasta infected fish that would otherwise have died.

Actions that could improve production include enlargement of the ozone system. An additional 700,000+ smolts (115,000+ pounds) could be reared if C. shasta infection was precluded. Adding netting over the five-acre rearing ponds to stop bird predation would also improve production, especially after the ozone system is installed.

Toutle River

On the Toutle River, Alder Creek rearing pond is a dirt bottom pond of about 1.5 acres with about 5-cfs flow. up to 100,000 fish (17,000 pounds), of which 50 percent were winter steelhead from Beaver Creek Hatchery, were reared from February through April each year and released as yearling smolts into the Toutle watershed. However,. Alder Creek Pond may eventually be flooded by the sediment retention structure and is currently not used. Construction of a collection facility on the pond's outlet would allow its continued use if the pond is not flooded.

A raceway exists on the South Fork Toutle near the mouth of Jordan Creek with dimensions of 10' X 50' X 7' with a flow of about 5 cfs. About 25,000 smolts can be reared in the facility, which has been used primarily for summer steelhead.

Brood stock source for Alder Creek and the South Toutle raceway has been Chambers Creek, Toutle, Cowlitz, and Elochoman stocks. Cowlitz stock has not been used since 1980. Chambers Creek and Elochoman stocks are spawned at random from fish entering the Chambers Creek and Elochoman traps, although eggs from IHN positive females are destroyed.

Adult time of return, spawning time, incubation period, and smolt emigration time was similar to Cowlitz hatchery fish. Information on hatchery return numbers and smolt-to-adult survival was not known. Fecundity of Elochoman stock steelhead are probably similar to hatchery returns on the Toutle and Coweeman rivers since that has been the donor stock. Randolph (1986) found that mean fecundity of Elochoman fish was 3,810 eggs per female for 1983 through 1985 and mean length of spawned females was 67.7 cm. Age, sex, and length profiles for both Toutle and Coweeman hatchery fish are thought to be similar to Kalama hatchery fish (Table 11) since all have the same parent stock.

Table 11. Ocean age, sex and length of initial migrant Kalama River hatchery steelhead (Leider et al. 1986).

	Ocean Age		
	1	2	3
Age Composition	2.0%	86.8%	11.3%
Percent females	31.7%	48.2%	73.4%
Mean Length (cm) Male	56.4	68.9	81.2
Mean Length (cm) Female	63.6	66.8	79.2
Total number of fish	41	1,821	237

A possible additional rearing facility is anticipated for the Toutle River -- a 0.75-acre dirt bottom pond on Devil's Creek, a Green River tributary. The facility may open in 1990 and be able to rear about 80,000 to 100,000 steelhead smolts, although only summer steelhead are planned to be reared there. Another possible pond site is on the North Fork Toutle near the sediment retention structure where water could be diverted and a pond constructed.

Coweeman River

Although about 30,000 smolts are trucked in from Beaver Creek Hatchery, a 0.25-acre pond has been used to rear about 10,000 steelhead from February through April. Flow is about 0.75 cfs and fish are released into the Coweeman through an outlet pipe. The pond has been operated in cooperation with a sport club, the first release year being 1985. Elochoman stock has been used and the program goal is to enhance sport harvest. Most data on the biology of Coweeman hatchery fish is not available, although it is probably similar to Toutle and Cowlitz fish. The ratio of smolts planted to adults harvested has averaged about 1.3 percent with sport catch estimated to harvest about 50 percent of adults, resulting in an estimated return rate of 2.6 percent.

No additional rearing facilities are anticipated for the Coweeman River. Constraints have been the size of the rearing facility and bird predation. Bird netting could alleviate bird predation.

Harvest

For 1977 through 1979, harvest averaged 18,518 fish with a total of 75.1 percent occurring in the Cowlitz River,, 21.3 percent in the Toutle, and 3.6 percent in the Coweeman (Table 12). For 1985 through 1989, harvest averaged 12,958 fish in the Cowlitz River, 256 in the Toutle (open 1987-1989) and 728 fish in the Coweeman.

Harvest rate in the Cowlitz River in the only year determined (1985) was 71.1 percent. In the Toutle, the harvest rate has been 10.3 percent for 1987 through 1989. Combined harvest rate for Cowlitz and Toutle natural fish was 17 percent. Coweeman harvest rate was estimated at 50 percent on hatchery and 23.4 percent on natural fish.

Few steelhead are harvested in the ocean, although the ocean drift net fishery may have intercepted some in recent years. Harvest of winter steelhead in the Columbia River was estimated at 6.2 percent in the System Planning Model.

Harvest management goals in the subbasin are for a harvest of 15,400 fish in the Cowlitz, 300 fish in the Toutle, and 600 fish in the Coweeman. A mitigation agreement between Washington Department of Wildlife and Tacoma City Light states that runs to the Cowlitz are to be 38,600 steelhead and cutthroat. The Washington Wildlife Department is managing for 22,000 winter steelhead; sport harvest is to represent 70 percent (15,400 fish) of the return. No harvest agreements exist for the Toutle or Coweeman.

Management procedures for harvest within the subbasin consists of regulation through the Department of Wildlife's sport harvest restrictions. The general management goal is to emphasize harvest of hatchery origin fish while ensuring adequate escapement of natural steelhead. Harvest activity can be further restricted or closed as required. Harvest is monitored through sport punch-card returns. Enforcement activities consist of Washington Department of Wildlife personnel checking for compliance with harvest restrictions.

On the Cowlitz, a two-fish limit is imposed with no time restriction. Limited harvest capability of the sport fishery allows adequate spawners to seed the watershed. Most fish entering the Cowlitz Trout Hatchery or the barrier dam separator are recycled back to the river to increase harvest opportunity (Young 1974, Tipping 1980).

After 1983 on the Toutle, only the South Fork has been open for a limited time with a one-fish limit. The season has been open from January 1 through April 15 on Fridays and Saturdays only.

The Coweeman is open upstream to Mulholland Creek until March 31 with a two-fish limit. In 1989, "wild steelhead release" regulations were imposed for 1990 so only marked hatchery fish can be retained by anglers.

Table 12. Cowlitz Subbasin winter steelhead adult harvest and spawning escapement.

	Cowlitz R. Escapement[1]	Cowlitz R. Harvest	Toutle R. Escapement	Toutle R. Harvest	Coweeman R. Escapement[2]	Coweeman R. Harvest
1977	4,285	10,542	N/A	2,919	N/A	546
1978	7,366	18,122	N/A	4,779	N/A	1,069
1979	5,319	13,086	N/A	4,075	N/A	415
1985	6,503[3]	16,124	3,955	0	N/A	1,035
1986	4,473	11,004	3,047	0	N/A	735
1987	7,026	17,286	2,588	285[4]	1,335	727
1988	4,765	11,724	2,566	288[4]	1,382	479
1989	3,516	8,651	1,558	195[4]	799	663

[1] Assumes the 71.1 percent harvest rate observed in 1985.
[2] Assumes 50 percent harvest rate on hatchery fish and remainder spawn.
[3] Includes 800 fish spawned at the hatchery.
[4] Excludes November-December harvest as summer steelhead.

Specific Considerations

Management goals emphasize sport harvest of hatchery fish, allow adequate escapement of natural fish, and protect habitat. The subbasin contains three rivers each with a different management goal. The Cowlitz River is dominated by hatchery fish. The Toutle River is managed for natural fish only, and the Coweeman is managed for mixed hatchery and natural fish, although only hatchery fish can be harvested. Smolt capacity was estimated at 178,782 fish.

As part of the Washington Department of Wildlife and Tacoma City Light agreement on the Cowlitz River, the Wildlife Department is managing for 22,000 adult winter steelhead, measured by a sport harvest of 15,400 fish. Returns have been below mitigation levels, but should be corrected soon. With large numbers of relatively large fish present, the Cowlitz River has been the top sport winter steelhead stream in Washington. For 1982 through 1985 releases, an average of 2.54 percent of smolts planted were sport caught as adults while an observed harvest rate in 1985 was 59.8 percent. Natural production in the Cowlitz River and its tributaries (except the Toutle and Coweeman) is limited since most habitat is above Mayfield Dam. Fish sampled in the Cowlitz were an average of 98.3 percent hatchery origin. Cowlitz River stock of hatchery fish are somewhat resistant to *C. shasta* infection. Spawning escapement in many tributaries was adequate, but was comprised of an unknown percent of hatchery fish.

The Toutle River is managed for natural winter steelhead. Harvest has been restricted for a quality, low kill, sport fishery. The sediment retention structure (SRS) trap on the North Fork Toutle will allow segregation of hatchery or summer fish from above the SRS. Habitat and natural production is recovering after the catastrophic volcanic eruption.

On the Coweeman River, management emphasizes harvest of hatchery fish and escapement of natural fish. Natural fish will provide recreation through catch and release only.

Critical Data Gaps

No data was found for egg-to-smolt survival and smolt-to-adult survival. Hatchery and natural composition of steelhead in Cowlitz River tributaries needs to be determined so adult natural fish can be estimated. Hatchery and natural composition of sport caught steelhead in the Toutle and Coweeman rivers needs to be determined so run totals of each can be accurately obtained.

Presence and severity of *C. shasta* in Cowlitz River tributaries needs to be ascertained to see if production constraints exist due to disease. In-subbasin smolt mortality needs to be investigated to determine if significant mortality sources can be identified.

Objectives

Stock: Cowlitz Winter Steelhead

Utilization Objective: 15,400 fish. The utilization objective has priority over the biological objective within the Cowlitz River.

Biological Objective: Maintain biological characteristics of existing stock including large body size, return timing, and ***C. shasta*** resistance.

Returns to the Cowlitz River component of the subbasin have averaged about 18,214 fish. After calibrating the System Planning Model, the Cowlitz River was modeled with the projected production anticipated after the planned 1990 installation of the water treatment facility (750,000 smolts). An additional 10,287 hatchery fish would be expected back to the river for a total of 28,428 fish. At the observed harvest rate, objectives would be exceeded. Consequently, no alternative strategies are offered.

Stock: Toutle Winter Steelhead

Utilization Objective: 250 fish for sport harvest.

Biological Objective: Maintain biological characteristics of existing stock. A minimum spawning escapement of 2,500 fish is needed. The biological component has priority within the Toutle River.

Objectives for the Toutle River are presently being met and consequently, no alternative strategies are offered.

Stock: Coweeman Natural Winter Steelhead

Utilization Objective: 0 (catch and release only).

Biological Objective: Maintain biological characteristics of the existing natural population. The biological component has priority for this stock within the Coweeman River. Maximum sustained population is desired for spawning escapement.

Objectives for the Coweeman natural stock are presently being met and consequently, no alternative strategies are offered. The System Planning Model indicated the recent "wild release" regulations will increase river returns by 82 fish.

Stock: Coweeman Hatchery Winter Steelhead

Utilization Objective: 700 fish for sport fishery. The utilization objective has priority for this stock within the Coweeman River.

Biological Objective: Maintain differential run timing from natural stock.

Existing hatchery fish harvest is about 446 fish. Objectives for the Coweeman hatchery stock will require an additional 500 fish to the river at existing harvest rates.

Alternative Strategies

Strategies to obtain objectives are generally first approached using the most natural techniques with the least genetic impacts, progressing to less natural methods, and ending with hatchery only. Steelhead in the Coweeman River are managed as two separate stocks to minimize hatchery genetic impacts on the natural stock. Differential run timing is maintained and ideally all hatchery fish would be harvested. Because the objectives involve a hatchery stock only, only hatchery alternatives are offered. Production from the Cowlitz and Toutle rivers are included in Table 13.

Modeling results for each strategy are presented in Table 13 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 13. 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 14.

STRATEGY 1: Hatchery Production. This strategy seeks to achieve the objectives solely through traditional hatchery production. Only those actions necessary for maintenance of the hatchery program are included.

Underlying Hypothesis: By increasing the number of hatchery smolts produced, additional adults will return.

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

Numeric Fish Increases: The System Planning Model indicates this strategy would increase returns to the Coweeman by 509 hatchery fish at current harvest rates, meeting the objectives. Total production increase would be 372 fish at MSY.

ACTIONS: 1

1. Increase hatchery smolt plants by 25,000 fish.

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

Underlying Hypothesis: Rearing pond smolt quality would be improved compared to raceway reared smolts and liberation would be less stressful.

Assumptions: This strategy was modeled with the assumption that the relative smolt survival of hatchery fish would be increased from 0.68 to 0.71.

Numeric Fish Increases: The System Planning Model indicated this strategy would increase returns to the Coweeman by 42 hatchery fish at current harvest rates. Total production increase would be 37 fish at MSY.

ACTIONS: 2

2. Construct a rearing pond on the Coweeman, but maintain current hatchery smolt numbers.

STRATEGY 3: Hatchery Production. This strategy seeks to achieve the objectives solely through traditional hatchery production. Only those actions necessary for maintenance of the hatchery program are included.

Underlying Hypothesis: Rearing pond smolt quality would be improved compared to raceway reared smolts and liberation would be less stressful. By increasing the number of hatchery smolts produced, additional adults will return.

Assumptions: This strategy was modeled with the assumption that the relative smolt survival of hatchery fish would be increased from 0.68 to 0.71. This strategy also assumes increased smolt production will result in commensurate adult returns.

Numeric Fish Increases: The System Planning Model indicated this strategy would increase Coweeman returns by 573 hatchery fish at current harvest rates. Total production increase would be 430 fish at MSY.

ACTIONS: 1, 2 (see above)

Recommended Strategy

The recommended alternative is Strategy 3, a combination of increasing hatchery smolt numbers and culturing fish in a rearing pond rather than trucking and releasing smolts. A rearing pond also adds an important tool for management. Because fish home to a pond more acutely than a trucked release, higher harvest rates may be achieved. The Washington Department of Wildlife seeks to harvest all hatchery fish in the Coweeman and a pond would aid in that goal. This recommendation is supported by the SMART analysis (Appendix B).

Table 13. System Planning Model results for winter steelhead in the Cowlitz Subbasin. Baseline value is for pre-mainstem implementation, all other values are post-implementation.

Utilization Objective:
Based on perceived needs a harvest of 15,400 fish is needed on the Cowlitz River, 250 natural fish on the Toutle, and 700 hatchery fish on the Coweeman.

Biological Objective:
To maintain the biological characteristics of natural fish, spauning escapement needs are 3,154 natural fish in the Toutle and 1,132 natural fish in the Coweeman. The large size and C. Shasta resistance of Cowlitz River steelhead should be maintained. Differential run timing of hatchery and natural stocks should also be preserved.

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)
Basel ine	32,819 -N	9,293	42,601	2,816	0(1.00)
All Nat	32,819 -N	9,293	42,601	2,816	0(1.00)
1	33,191 -N	9,461	43,150	2,852	585(1.01)
2	32,856 -N	9,291	42,636	2,819	38(1.00)
3*	33,249 -N	9,462	43,209	2,856	648(1.01)

*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. Add 25,000 Hatchery Smolts. Pre Mainstem Implementation.
2. Baseline plus a rearing pond. Pre Mainstem Implementation.
3. Baseline plus 1 and 2. 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 Colunbia 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 0 is the strategy's total production divided by the baseline's total production.

Table 14. Estimated costs of alternative strategies for Cowlitz 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*
Hatchery Costs			
Capital[1]	115,000	0	115,000
O&M/yr[2]	12,500	0	12,500
Other Costs			
Capital'	0	250,000	250,000
O&M/yr[4]	0	5,000	5,000
Total Costs			
Capital	115,000	250,000	365,000
O&M/yr	12,500	5,000	1'7,500

* 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 nunber and depth of the wells.

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

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

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

SUMMER STEELHEAD

Fisheries Resource

History and Status

The Cowlitz Subbasin historically produced few summer steelhead. In the Cowlitz River, only 75 of 54,044 steelhead counted past Mayfield Dam from 1962 through 1966 were observed from July through October (Thompson and Rothfus 1969). The Toutle and Coweeman rivers also had few summer steelhead. Skamania stock (Washougal River) summer steelhead were successfully introduced in 1966 and 1968 in the Toutle and Cowlitz rivers, respectively.

Summer steelhead provide productive sport fisheries although few natural fish are present. Distribution is throughout the Toutle River and up to Mayfield Dam on the Cowlitz River. Summer steelhead generally do not hold in small tributaries in summer and fall, but may move into them in winter and early spring to spawn. The Coweeman River is not managed for summer steelhead although a few, probably strays, are sport caught.

Life History and Population Characteristics

Adult time of entry is generally April through October with peak numbers in July (Table 15). Spawning occurs from December through May with fry emergence from March through May. Juveniles generally rear for two years prior to ocean emigration although a few migrate after three years.

Table 15. Freshwater life history of Cowlitz Subbasin summer steelhead. The developmental stage timing represents basinwide averages, local conditions may cause some variability.

Developmental Stages	Time of year	Peak occurrence
Adult immigration	April-October	July
Adult holding	April-November	July-November
Spawning	December-May	February-March
Egg/alevin incubation	December-May	March-April
Emergence	February-July	April-May
Rearing	Feb-April (26 mos.)	April-April (24 mos.)
Juvenile emigration	April-May	April-May

In the Cowlitz River, the natural run is presently small. For 1980 and 1981, natural fish contributed a mean of 8.7 percent of sampled adults (Tipping 1981 and 1982). Most fish, however, were sampled below the Toutle River and may have included Toutle fish. If the mean 1977 through 1986 sport catch (3,350 fish) represents 60 percent of the total run, natural fish made up a maximum of 486 fish.

In the Toutle River, natural fish comprised 6.9 percent of sampled fish in 1981 (Schuck and Kurose 1982). However, the number of natural fish now present is estimated at about 50 fish due to the eruption.

For 1980-1981 Cowlitz River juveniles, 81.8 percent and 18.2 percent resided for two and three years, respectively, prior to ocean emigration (Tipping 1981 and 1982). Including one female repeat spawner, ocean age was dominated by 2-salt fish (Table 16). Overall, females made up 63.6 percent of sampled fish. Mean length of all fish combined was 77.2 cm.

Table 16. Ocean age structure, length and sex of Cowlitz summer natural steelhead (from Tipping 1981; Tipping 1982).

	Ocean Age				
	1	2	3	4	5
Age Composition	0.0%	81.8%	9.1%	0.0%	9.1%
Females	0.0%	55.5%	100.0%	0.0%	100.0%
No. Fish	0	9	1	0	1
Mean Length (cm) M	---	77.0	---	---	---
Mean Length (cm) F	---	73.2	81.0	---	94.0

In the Toutle River, all smolts emigrated at two years of age (Schuck and Kurose 1982). Ocean age composition of a limited sample of adults was 62.5 percent 2-salts and the remainder 3-salts (Table 17). No repeat spawners were sampled. Overall, females comprised 50.5 percent of sampled fish. Mean length of all fish combined was 75.2 cm.

No fecundity information was found for naturally produced summer steelhead in the Cowlitz Subbasin. However, fecundity of Cowlitz hatchery summer steelhead with a mean length of 72.2 cm was 4,617 eggs per female (n=698).

Table 17. Ocean age structure, length and sex of Toutle summer natural steelhead (from Schuck and Kurose 1982).

	Ocean Age 2	Ocean Age 3
Age Composition	62.5%	37.5%
Females	60.0%	33.3%
No. Fish	5	3
Mean Length (cm) Male	66.9	84.8
Mean Length (cm) Female	74.7	73.7

Egg-to-smolt and smolt-to-adult survivals for the subbasin are unknown. However, egg-to-smolt survival is probably poor in the mainstem Cowlitz as previously discussed for winter steelhead. Mortality of hatchery fish at the Cowlitz Trout Hatchery from C. shasta was 68.6 percent to 81.2 percent with many more severely infected (Tipping 1988).

Table 18 lists three steelhead smolt capacities: 1) Northwest Power Planning Council's, 2) Washington Department of Wildlife's GAFM, and 3) a revised GAFM based on modifications due to C. shasta and habitat degradation from the eruption of Mount St. Helens. Also, summer steelhead will not be transported above the sediment retention structure on the North Fork Toutle.

Table 18. Smolt production estimates of summer steelhead in the Cowlitz Subbasin.

Water	NPPC	WDW GAFM	REVISED GAFM
Cowlitz R.	29,103	33,132	21,747
Toutle R.	76,156	49,480	43,754
TOTAL	105,259	82,612	65,501

Supplementation History

Summer steelhead in the Cowlitz Subbasin are an introduced stock. Summer steelhead have been planted into the Cowlitz River since 1968 using Skamania stock with the goal of providing a sport fishery and enough escapement to the hatchery to maintain it (Appendix D). Brood stock for the 1972 and subsequent releases were collected on the Cowlitz River. Subtracting 8.7 percent natural fish contribution and assuming a 60 percent harvest rate, smolt-to-adult return averaged 5.66 percent. Current hatchery program is 220,000 smolts, as managed by Washington Department of Wildlife as part of the Tacoma City Light mitigation agreement, but has averaged 91,459 smolts for 1980 through 1988.

On the Toutle River, Skamania stock summer steelhead have been successfully planted since 1966 to provide a sport fishery. Managers first released Skamania stock into the Green River on the Toutle in 1950, but no adults returned (Lavier 1952). Brood stock collection has remained at Skamania Hatchery. Anticipated supplementation on the Toutle is about 130,000 smolts. After subtracting 6.9 percent natural contribution, an average of 2.05 percent of 1974 through 1977 planted smolts were sport caught as adults.

Fish Production Constraints

Specific production constraints for summer steelhead in the subbasin are similar to those previously mentioned (Table 9).

In the Toutle River, the ratio of smolts planted to adults harvested was 2.05 percent prior to 1980. Harvest of summer steelhead will reduce competition for spawning and juvenile rearing habitats with natural winter steelhead. Because management upstream of the sediment retention structure (SRS) is for winter steelhead only, the SRS trap will allow summer fish to be excluded. The possible loss of Alder Creek rearing pond will impede production although possible use of Devil's Creek pond should mitigate the loss.

Critical Data Gaps

No data was found for egg-to-smolt survival and smolt-to-adult survival of natural steelhead for this subbasin.

Presence and severity of **C. shasta** in Cowlitz River tributaries needs to be ascertained to determine if production constraints exist due to disease.

Data is needed on hatchery and natural composition and age composition of sport caught steelhead. Spawning escapement estimates for summer steelhead are needed so total run size can be better estimated.

In-subbasin smolt mortality needs to be investigated to determine if significant mortality sources can be identified.

Objectives

Stock: Cowlitz Hatchery Summer Steelhead

Utilization Objective: 15,000 fish for sport harvest. The utilization objective has priority in the Cowlitz River.

Biological Objective: Maintain biological characteristics of existing hatchery stock including resistance to *C. shasta*.

Sport harvest has averaged 3,105 fish. This objective will increase harvest by 11,895 fish and require about 25,000 fish to the river. After calibrating the System Planning Model with current production, the Cowlitz River was modeled to assume the 1990 water treatment facility would allow the mitigation number of smolts (220,000) to be produced. This would increase the number of returning adults by 10,323 fish, for a total river return of 16,253 fish.

Stock: Toutle Hatchery

Utilization Objective: 3,000 fish for sport harvest. The utilization objective has priority in the Toutle River.

Biological Objective: Maintain biological characteristics of existing hatchery stock.

Sport harvest has averaged 972 fish. This objective will increase harvest by 2,028 fish and require about 5,000 fish to the river.

Alternative Strategies

Strategies to obtain objectives are generally first approached using the most natural techniques, then the less natural methods, and ending with hatchery only. The Cowlitz subbasin has a potential opportunity to reestablish steelhead above Mayfield Dam and this strategy was also modeled.

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

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

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

Estimated costs of the alternative strategies below are summarized in Table 20.

STRATEGY 1: Habitat Base Increase. This strategy seeks to increase by providing passage into inaccessible areas.

Hypothesis: By making new habitat available, additional smolts would be produced.

Assumptions: This strategy would assume the many difficult problems identified in Part I regarding passage over Mayfield could be overcome. The technical feasibility of this strategy is doubtful. An estimated 251,100 smolts could be produced. However, inbasin smolt survival for those fish was assumed to be 75 percent due to capture and transportation difficulties. Also, adult pre-spawning mortality was increased to 15 percent to compensate for increased hauling stress.

Numeric Fish Increases: This strategy would increase subbasin returns by 936 fish at existing harvest rates and result in a decrease in total production by 10 fish at maximum sustained yield.

ACTIONS: 1

1. Reestablish anadromous production above Mayfield and Mossyrock dams.

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

Hypothesis: Production of additional hatchery smolts would increase adult returns.

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

Numeric Fish Increases: The System Planning Model indicated subbasin returns would increase by 43,830 fish (4,311 increase on the Toutle and 39,519 on the Cowlitz) at existing harvest rates while total production would increase by 33,292 fish at MSY. Objectives would be met.

ACTIONS: 2, 3

2. Expand the ozone water treatment system being developed at the Cowlitz Trout Hatchery to rear an additional 550,000 smolts.

3. Increase plants on the Toutle River by 60,000 fish, bringing it to 128,300 smolts.

Recommended Strategy

The recommended strategy for Cowlitz Subbasin summer steelhead is Strategy 2, hatchery enhancement of 550,000 smolts on the Cowlitz and 60,000 on the Toutle. Summer steelhead in the subbasin are an introduced stock and as such are intended to be hatchery oriented to allow high sport harvest rates. This management philosophy should assist in minimizing interactions with habitat intended for winter steelhead. The Cowlitz Trout Hatchery is presently installing a water treatment system to correct disease problems. The hatchery has room to greatly expand current programs if the water treatment system was expanded about 50 percent. This recommendation is supported by the SMART analysis (Appendix B).

Strategy 1, reestablishing steelhead above Mayfield is recognized as an alternative, but results in many legal, financial, and technical difficulties along with considerable financial risks and mediocre adult return potential. Costs could exceed $100 million with returns amounting to 936 fish. However, because of spawning needs, harvest may not be allowed above Mayfield, which would be difficult politically.

Table 19. System Planning Model results for summer steelhead (A's) in the Cowlitz Subbasin. Baseline value is for pre-mainstem implementation, all other values are post-implementation.

Utilization Objective:
Based on intense desires by anglers and economic benefits, a perceived harvest of 18,000 summer steelheed is needed in the Cowlitz subbasin. Harvest distribution would be 15,000 fish in the Cowlitz River and 3,000 fish in the Toutle.

Biological Objective:
Existing biological characteristics of this stock should be maintained. The C. shasta resistance of the Coulitz River hatchery stock, while susceptible to infection, should not be diluted.

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	14,773 -N	2,723	17,798	437	0(1.00)
All Nat	13,783 -N	4,340	18,626	458	848(1.05)
I	13,783 -N	4,340	18,626	458	848(1.05)
2*	54,867 -N	6,103	61,649	1,516	44,929(3.46)

*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.

I. Natural production reestablished above Mayfield Dam. Pre Mainstem Implementation.
2. Produce an additional 610,000 hatchery 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 uhere sustainable yield is maximized for the naturally spawning cunponent 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 0 is the strategy's total production divided by the baseline's total production.

Table 20. Estimated costs of alternative strategies for Cowlitz summer steelhead. Cost estimates represent new or additional costs to the 1987 Columbia River Basin Fish and Wildlife Program; they do not represent projects funded under other programs, such as the Lower Snake River Compensation Plan or a public utility district settlement agreement. (For itemized costs, see Appendix C.)

	Proposed Strategies	
	1	2*
Hatchery Costs		
Capital[1]	0	2,806,000
O&M/yr[2]	0	305,000
Other Costs		
Capital[3]	100,000,000	0
O&M/yr[4]	2,000,000	0
Total Costs		
Capital	100,000,000	2,806,000
O&M/yr	2,000,000	305,000

* 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.

Summer Steelhead – 54

SEA-RUN CUTTHROAT TROUT

<u>Fisheries Resource</u>

Natural Production

History and Status

Sea-run cutthroat trout in the Cowlitz Subbasin were historically abundant. Kray (1957) estimated a sport catch of 6,000 sea-run cutthroat above Mayfield and at least 20,000 caught on the river yearly. An average of 8,698 cutthroat were counted in 1962 through 1966 at the Mayfield Dam site (Thompson and Rothfus 1969). A minimum of 3,227 to 7,978 juvenile cutthroat were counted moving downstream of the site in 1964 through 1966 (Thompson and Rothfus 1969). Cutthroat were probably distributed throughout the watershed.

Present status of sea-run cutthroat within the Cowlitz River is bleak. After completion of Mayfield and Mossyrock dams, the Cowlitz Trout Hatchery has been used to maintain runs. The protozoan <u>C. shasta</u> decimated juveniles reared at the hatchery. Although some good production years were realized, the number of smolts produced declined to such low levels by 1988, the sport fishery had to be closed for the first time.

Little information was available for historic or present status of sea-run cutthroat in the Toutle River, although relatively good angling was reported. Lavier (1960) reported 74 sea-run cutthroat were captured at the Washington Department of Fisheries Green River Hatchery on the Toutle River in 1960. Many natural cutthroat observed in the lower Cowlitz River fishery may have originated from the Toutle River.

Historical information on Coweeman River sea-run cutthroat is lacking. Recent enhancement has improved the sport fishery, but anglers report most fish caught are marked hatchery fish.

Life History and Population Characteristics

Adult time of entry for the subbasin is generally from July though October with peak numbers in August and September (Table 21). Spawning occurs from November through March with fry emerging from March through June. Juveniles rear two or three years prior to spring ocean emigration although a few juveniles migrate after one or four years (Tipping and Springer 1980; Tipping 1981 and 1982).

Run size of naturally produced cutthroat is unknown in the subbasin. However, natural cutthroat in the Cowlitz below the

Toutle comprised 40.2 percent, 56.6 percent, and 23.8 percent of the sampled catch in 1979, 1980, and 1981, respectively. Harvest amounted to 2,019 fish in 1979, 70 fish in 1980, and 292 in 1981.

Sea-run cutthroat have a complex life cycle and not all fish mature upon re-entering fresh water. Cutthroat first return to fresh water in the fall after spring release: some do not spawn, but do so in subsequent years. Maturity of initial migrant cutthroat in 1979 was 64.3 percent and 53.3 percent for males and females, respectively (Tipping and Springer 1980). In 1980, maturity of initial migrants was 66.7 percent and 71.4 percent for males and females, respectively (Tipping 1981). To profile cutthroat, summers spent in salt water were not differentiated for spawning or non-spawning fish (Table 22). Overall, females made up 50.8 percent of sampled fish. Mean length of males and females was 34.7 cm and 34.5 cm, respectively and 34.6 cm overall.

Table 21. Freshwater life history of Cowlitz Subbasin sea-run cutthroat. The developmental stage timing represents basinwide averages, local conditions may cause some variability.

Developmental Stages	Time of year	Peak occurrence
Adult immigration	July-October	August-September
Adult holding	July-November	August-November
Spawning	November-April	February-March
Egg/alevin incubation	December-May	March-April
Emergence	February-June	April-May
Rearing	Feb-April (26 mos.)	April-April (24 mos.)
Juvenile emigration	April-May	April-May

No life history information was available for the Toutle or Coweeman rivers. Fish sampled in the Cowlitz probably reflect Toutle and Coweeman stocks since those fish were probably in the Cowlitz harvest.

No fecundity information was found for naturally produced sea-run cutthroat in the Cowlitz Subbasin. Egg-to-smolt and smolt-to-adult survival rates for the Cowlitz Subbasin are unknown.

Table 22. **Age,** length and sex of Cowlitz River natural sea-run cutthroat (Tipping and Springer 1980; Tipping 1982).

	Ocean summers 1	2	3	4	5
	61.7%	14.6%	7.4%	1.2%	0.3%
Females	47.0%	50.0%	58.3%	75.0%	100.0%
No. Fish	198	94	24	4	1
Mean Length (cm) M	32.3	39.1	41.9	43.0	----
Mean Length (cm) F	31.2	38.1	41.5	43.7	46.0

No estimate of habitat carrying capacity could be generated.

The downstream migrant facility at **Mayfield** Dam has been operated to enumerate emigrating juvenile cutthroat. Although no adult cutthroat have been planted in the **Tilton** River for many years, juveniles were planted into **Mayfield** Lake through 1980. In 1976-1977, an average of 18,540 juveniles were planted in Mayfield. A few smolts are still observed (Table 23).

Table 23. Cutthroat smolts through the **Mayfield** migrant trap (Tipping, unpubl. data).

Year	Number of smolts	Year	Number of smolts
1978	213	1984	no data
1979	60[1]	1985	327
1980	**536**[2]	1986	812
1981	**2,382**[3]	1987	804
1982	88	1988	271
1983	78		

[1] trap closed in May
[2] trap closed end of May
[3] legal sea-run cutthroat planted in **Tilton** R. and Winston Ck.

Supplementation History

Sea-run cutthroat have been planted in the Cowlitz Subbasin since 1966 (Appendix D). Through 1976 in the Cowlitz River, brood stock was a mixture of Elochoman River and Cowlitz fish. After 1976, most smolts planted in the Cowlitz were from Cowlitz brood stock. The purpose of the program was to maintain the run and provide a sport fishery. Return of 1979 marked fish was a minimum of 3.4 percent (Tipping 1981) while 1982 and 1983 experiments showed smolts (more than 21 cm) returned at 12.8 percent (Tipping 1986). Return to the hatchery averaged 7.19 percent for 1981 through 1986 releases.

Sea-run cutthroat have not been planted in the Toutle River. Coweeman River plants began in 1966 and have continued using Elochoman River stock with the goal of supplementing natural fish in the sport fishery. Performance of plants has not been evaluated.

Fish Production Constraints

Production constraints for sea-run cutthroat in the subbasin are similar to that previously mentioned (Table 9). Because cutthroat utilize upper reaches of streams, they are more sensitive to habitat degradation.

Hatchery Production

Cowlitz River

On the Cowlitz River, the previously described Cowlitz Trout Hatchery is the single production facility. Program objectives were to maintain the run and provide a sport fishery. Production from 1980 through 1988 averaged 46,224 smolts with a minimum length of 21 cm. This is 57.8 percent of the mitigation goal of 80,000 smolts (17,700 pounds). Many smaller fish were also released, but many were heavily infected with *C. shasta* and probably did not survive. Mitigation goal of all species at the hatchery is 1,050,000 smolts (191,000 pounds). The planned ozone system should allow production to reach mitigation goals. Existing facilities are large enough to greatly exceed mitigation goals but production was restricted due to heavy losses from *C. Shasta*.

Brood stock source is the Cowlitz River via hatchery rack returns or returns seven miles upstream at the salmon hatchery barrier dam separator. Fish selected for spawning are primarily those sexually mature in November through February. If returns are numerous, only larger, repeat migrant fish are spawned. Ovarian fluid is tested from females for IHN virus and eggs from positive females have been discarded, although if availability of eggs is inadequate, eggs are treated in iodophor and retained. Although juveniles suffer heavy losses from C. Shasta, the Cowlitz hatchery stock has some resistance.

Hatchery run size was not determined because catch estimates were incomplete or did not differentiate hatchery from natural fish. Also, estimates of hatchery fish spawning naturally was not ascertained. Returns to the hatchery for 1967 through 1988 averaged 2,620 fish (Table 24). Sport harvest represented a minimum of 23.5 percent and 48.6 percent (36.1 percent average) of total returns for the 1982 and 1983 releases, respectively (Tipping 1986). Adding 36.1 percent to the hatchery return would give an approximate average hatchery run size of 3,566 fish. The mitigation goal calls for a 5,000 fish rack count, which is to represent 50 percent of the hatchery return.

Table 24. Returns of sea-run cutthroat to the Cowlitz Trout Hatchery.

Year	Return	Year	Return
1967	5,573	1978	3,235
1968	3,743	1979	4,111
1969	2,565	1980	1,689
1970	2,239	1981	4,577
1971	2,546	1982	6,103
1972	1,495	1983	3,282
1973	4,217	1984	3,323
1974	2,652	1985	1,385
1975	764	1986	965
1976	816	1987	508
1977	1,465	1988	390
		AVE	2,620

Adult time of return and emigration time are similar to Cowlitz natural sea-run cutthroat. Peak spawning time, egg incubation and emergence has been advanced about two months compared to natural fish. Fecundity of cutthroat spawned from 1982 through 1986 averaged 1,044 eggs per female (n=1,878).

Smolts emigrate after about 16 months. Summers in saltwater age composition of adults (n=578) was 79.9 percent, 18.2 percent, 1.9 percent, and 0.3 percent for age I, II, III, and IV, respectively (Tipping and Springer 1979; Tipping 1981 and 1982). Females comprised 43.5 percent, 51.4 percent, 36.4 percent, and 50 percent of each age class, respectively, and 45 percent of the total. Maturity of initial migrants males was generally greater than females and averaged 80.4 percent compared to 60.3 percent for females (Table 25). Mean length was 33.9 cm and 33.1 cm for males and females, respectively, and 33.5 cm overall.

Table 25. Maturity of initial migrant (percent) Cowlitz hatchery sea-run cutthroat (Tipping 1980 and 1986).

	Initial Migrant Maturity	
Year	Males	Females
1979	47.8	31.3
1980	100.0	62.5
1981	85.2	63.6
1982	87.1	74.0
1983	82.1	70.0

Egg-to-fry survival in the hatchery was 83.2 percent in 1987 (Janson 1988). However, fry-to-smolt survival was 40.4 percent for 1980 through 1985 (Tipping et al. 1985) due primarily to C. Shasta, resulting in an egg-to-smolt survival of 36.4 percent. In 1987, only 1.9 percent of fry survived to smolts (Janson 1988).

Smolt-to-adult return of 1979 marked fish was a minimum of 3.4 percent (Tipping 1981) while 1982 and 1983 experimental groups returned at a minimum of 12.8 percent (Tipping 1986). Return to the hatchery averaged 7.19 percent for 1981 through 1986 releases and if a 36.1 percent harvest rate is assumed, 9.79 percent overall.

Some electrophoretic work was done on Cowlitz Hatchery cutthroat where seven enzymes were profiled and compared to cutthroat in streams above Mayfield Dam (Tipping 1982). Results did not implicate genetic subdivisions among populations.

Interest has been expressed by a sports club for cooperative projects to rear additional fish in the Cowlitz River. However, no programs have been outlined at this time. Major constraints and actions that could improve production at the Cowlitz Trout Hatchery were previously described.

Toutle River

No hatchery plants of sea-run cutthroat have been made in the Toutle River and none are anticipated.

Coweeman River

On the Coweeman River, a small rearing pond is used to rear sea-run cutthroat. The pond is about one-fourth acre with a dirt bottom, and uses about 300 gallons per minute of diverted Turner Creek water. About 8,000 to 10,000 Elochoman River stock pre-smolt cutthroat are placed in the pond in February and smolts are released at the site in late April. The program is a cooperative project with a sport club with the goal of supplementing sport catch. An additional 5,000 to 7,000 smolts are planted from Beaver Creek Hatchery. Supplementation for the Coweeman in 1985 through 1987 averaged 15,200 smolts and a similar planting level is anticipated.

Information on biology or performance of fish from this program is unknown, however, catch rate and angler participation has increased noticeably. No additional rearing facilities are anticipated. Present constraint is the size of the rearing facility.

Harvest

Harvest distribution in the subbasin is unknown. However, in the Cowlitz River, minimum sport harvest was estimated at 5,014 fish, 123 fish, and 1,226 fish for 1979, 1980, and 1981, respectively (Tipping and Springer 1980; Tipping 1981 and 1982). Some areas of the river were not censused and consequently, harvest was underestimated. Devore (1987) estimated catch at 3,644, 3,724, and 5,592 fish for 1983, 1984, and 1985, respectively. Harvest rate of marked hatchery fish for the 1982 and 1983 releases was a minimum of 36.1 percent (average of 23.5 percent and 48.6 percent).

Few sea-run cutthroat are harvested in the ocean. Of the tags recovered from the sport fishery from marked 1982 and 1983 releases, 31.5 percent were caught on the Columbia River (Tipping 1986).

Harvest management goals in the subbasin are for an escapement of 10,000 fish to the Cowlitz, 5,000 fish to the Toutle and 2,500 fish to the Coweeman. The Washington Department of Wildlife/Tacoma City Light mitigation agreement states that runs to the Cowlitz are to be 38,600 adult anadromous game fish. The agreement provides that the Washington Wildlife Department shall select the numbers and kinds of species to rear and plant. Currently, the Department of Wildlife is managing for 10,000 sea-run cutthroat. The agreement stipulates sport harvest would represent 50 percent (5,000 fish) of the return and rack returns, 50 percent (5,000 fish). No harvest agreements exist for the Toutle or Coweeman.

Management procedures for harvest within the subbasin consists of regulation through Department of Wildlife sport harvest restrictions. The general goal in management is to emphasize harvest of hatchery fish while ensuring adequate escapement of natural cutthroat. Enforcement activities consist of Washington Department of Wildlife personnel checking anglers for compliance with harvest restrictions. On the Cowlitz, an eight-fish limit is imposed with no season restrictions. However, harvest was closed in 1988 due to poor hatchery production. Cutthroat fishing on the Toutle has been closed since 1981. The Coweeman is open from June 1 through March 31 with a two-fish limit, 12-inch minimum size. In 1989 for the 1990 season, a new "wild cutthroat release" was implemented, restricting harvest to marked hatchery fish only.

Specific Considerations

Management goals emphasize sport harvest of hatchery cutthroat, allow adequate escapement of natural fish, and protect habitat. Sea-run cutthroat use the upper reaches of tributaries and therefore, protection of habitat in those reaches is vital to the fish.

A major fish management problem is the lack of measured sport harvest; punch-card estimates of sport harvest are not available. Consequently, fluctuations in populations are not usually detected, although on the Cowlitz River, hatchery rack returns are used. Also, total run sizes have not been determined because spawning surveys are lacking.

Sport harvest of sea-run cutthroat in the subbasin has great potential for enhancement. In the Cowlitz River, estimated smolt-to-adult return was 9.79 percent while minimum sport harvest was estimated at 36.1 percent.

In the Cowlitz River, as part of a Washington Department of Wildlife and Tacoma City Light mitigation agreement, the Wildlife

Department is managing for 10,000 adult sea-run cutthroat, measured by hatchery rack returns, representing 50 percent of the total or 5,000 fish. Juveniles in the hatchery often suffer heavy losses from C. shasta although they have some resistance to the pathogen. Most adult returns are hatchery fish while natural production in the Cowlitz River is limited because most habitat is above Mayfield Dam. Much of the existing habitat is suboptimum due to low stream gradients, low flows, and silt.

In the Toutle River, little is known of the cutthroat population: hatchery cutthroat have not been planted. Currently, habitat is being protected against additional impacts after the volcanic eruption. The Toutle will probably not open for cutthroat harvest for years. Concern for adequate escapement may change harvest regulations in the lower Cowlitz to a natural fish release program. Construction of the sediment retention structure on the North Fork Toutle may improve downstream conditions by precluding some of the downstream sediment movement. However, the dam could impede upstream migration of adults and downstream movement of juveniles and flood out some stream sections. The dam will require adults moving above the sediment retention structure be trapped and hauled.

In the Coweeman River, little is known of the population except that catch is dominated by hatchery fish. Protection of the watershed will be essential in maintaining natural cutthroat production. Harvest has been recently restricted to marked hatchery fish only. Future harvest may be impacted by loss of angler access.

Critical Data Gaps

No data was found for egg-to-smolt survival and smolt-to-adult survival of natural sea-run cutthroat. No catch estimates on most of the subbasin or spawning escapement data exists. Consequently, total run estimates are lacking.

Presence of C. shasta in Cowlitz River tributaries needs to be ascertained to see if production constraints exist due to disease. Investigations need to be conducted to determine if significant sources of smolt mortality exist within the subbasin.

Objectives

Stock: Cowlitz Hatchery Sea-Run Cutthroat Trout

Utilization Objective: 10,000 fish for sport catch. The utilization objective has priority within the Cowlitz River for this stock.

Biological Objective: Maintain existing biological characteristics of the hatchery stock including resistance to ***C. shasta***.

Stock: Cowlitz Natural Sea-Run Cutthroat Trout

Utilization Objective: 0 (catch and release only).

Biological Objective: Maintain existing biological characteristics of the natural stock. The biological objective has priority within the Cowlitz River for this stock.

Stock: Toutle Natural Sea-Run Cutthroat Trout

Utilization Objective: 0 (catch and release only).

Biological Objective: Maintain existing biological characteristics of the natural stock. The biological objective has priority within the Toutle River for this stock.

Stock: Coweeman Natural Sea-Run Cutthroat Trout

Utilization Objective: 0 (catch and release only).

Biological Objective: Maintain existing biological characteristics of the natural stock. The biological objective has priority within the Coweeman River for this stock.

Stock: Coweeman Hatchery Sea-Run Cutthroat Trout

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

Biological Objective: Maintain existing biological characteristics of the hatchery stock.

The Cowlitz hatchery stock objective of a 10,000 fish sport harvest is not being met. This goal is a doubling of the Washington Wildlife/Tacoma City Light mitigation agreement. Cowlitz Trout Hatchery returns have averaged 2,620 fish and with a 36.1 percent harvest rate, about 4,100 fish have entered the river. The objective will require a return to the river of about 25,000 fish.

The Cowlitz natural component objective has been exceeded, but harvest will probably be reduced to the utilization level through regulations in the next few years. The Toutle and Coweeman natural stock objectives are currently being met.

The Coweeman hatchery stock objective is estimated to be about 400 fish greater than existing harvest. Presently, about 15,600 hatchery smolts are released and with a 8 percent smolt-to-adult survival (discounted for some fish being trucked at release) and 40 percent harvest rate, 500 fish would be caught. This will require about 1,000 more hatchery fish back to the river to increase the sport harvest by 400 fish, assuming a 40 percent harvest rate.

Alternative Strategies

Strategies start with the most natural methods to meet objectives and become progressively more artificial. However, because the objectives seek hatchery enhancement, only strategies to enhance hatchery fish are offered. Planners did not model strategies for sea-run cutthroat trout, nor did they estimate costs.

STRATEGY 1: Hatchery Production. This strategy seeks to achieve the objectives solely through traditional hatchery production. Only those actions necessary for maintenance of the hatchery program are included.

Hypothesis: Increased numbers of hatchery smolts will result in increased adult returns.

Assumptions: This strategy assumes increased smolt production will result in commensurate adult returns. Smolt-to-adult survival is estimated at 9.79 percent on the Cowlitz and 7 percent on the Coweeman, assuming additional hatchery smolts will be trucked from Beaver Creek Hatchery for the Coweeman. Harvest rate on the Cowlitz is assumed to increase to 50 percent with a large increase in adult numbers, which should attract large numbers of anglers.

Numeric Fish Increases: Cowlitz River returns would be anticipated to be 20,000 fish compared to the average of 2,620 fish, with a sport harvest of 10,000 fish, an increase of about 8,000 fish. Coweeman returns would be expected to increase about 1,050 fish with an increased sport harvest of 400 fish.

ACTIONS: 1, 2

1. Expand the Cowlitz Trout Hatchery production to 205,000 smolts from 46,224 smolts.

2. Increase hatchery smolt plants on the Coweeman River by 15,000 fish.

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

Hypothesis: Increased numbers of hatchery smolts will result in increased adult returns. Using a rearing pond will increase smolt quality and reduce stress of planted smolts.

Assumptions: In addition to the assumptions made in Strategy 1, the use of a rearing pond on the Coweeman River will increase hatchery smolt-to-adult survival to 9.79 percent.

Numeric Fish Increases: Cowlitz River returns would be expected to increase about 17,000 fish. Coweeman River returns would be expected to increase about 1,750 fish, which would increase harvest by about 700 fish.

ACTIONS: l-3

1. -
2. -

3. Construct a rearing pond on the Coweeman River for the hatchery smolt production.

Recommended Strategy

Strategy 2 is recommended for Cowlitz Subbasin cutthroat. Natural stocks in the subbasin either are or will be protected from harvest through regulations. Hatchery enhancement provides the harvest opportunity within the subbasin and is deemed the prudent management alternative. A rearing pond on the Coweeman will also assist management by possibly increasing the harvest rate on fish homing to the pond.

FALL CHINOOK SALMON

Fisheries Resource

Natural Production

History and Status

Fall chinook in the subbasin were historically abundant. The Washington Department of Fisheries (1951) estimated Cowlitz River escapement at 11,400 fish distributed as 10,900 fish in the Cowlitz and 500 fish in the Tilton River. In 1961 through 1966, an average of 5,992 adult and 2,543 jack fall chinook were counted at Mayfield Dam (Thompson and Rothfus 1969). Redd counts in 1961 through 1966 for the Cowlitz River indicated 37 percent were found above Mayfield. Based on that redd distribution, returns to the Cowlitz River would have been 23,067 fish. Distribution was from near the mouth to upper major tributaries such as the Ohanapecosh River, many miles above Mayfield and Mossyrock dams (Thompson and Rothfus 1969). Above Mayfield, only a minor run existed in the Tilton River in 1964, although a substantial run was reported in the 1940s (Thompson and Rothfus 1969); difficult log jams and a small power dam may have impacted production (WDF 1951).

Presently, fall chinook within the Cowlitz River are dominated by hatchery fish. The Cowlitz Salmon Hatchery was completed in 1967 to mitigate for upstream habitat losses with a hatchery return goal of 8,300 adults. For 1983 through 1985, Devore (1987) estimated an average of 1,661 natural fish returned to the Cowlitz, 12.8 percent of the total.

In 1951, the Washington Fisheries Department estimated escapement of fall chinook in the Toutle River at 6,500 fish with an estimated 80 percent of spawning occurring in the lower five miles of the river. Natural spawners (hatchery and natural origin) averaged 6,573 fish for 1964 through 1979 (Kreitman 1981), with a distribution of 4.8 percent Toutle River, 3.8 percent South Fork Toutle, 49.4 percent North Fork Toutle, and 42 percent Green River (Table 26). The Toutle Hatchery was located near the junction of the Green River and North Fork Toutle. Spawning escapement estimates after 1980 were uncertain due to river turbidity.

The Washington Department of Fisheries (1951) estimated escapement of fall chinook in the Coweeman River at 5,000 fish even though splash dams present probably impacted production. For 1977 through 1986 fall chinook escapement averaged 90 fish (Kreitman 1981). LeFleur (1985, 1986, 1987) considered Coweeman fish to be a lower Columbia River hatchery stock.

Life History and Population Characteristics

Adult time of entry is generally August and September (Table 27). Spawning occurs from September through November. Emergence occurs from January through March. Juvenile rearing generally lasts through June although some fish rear into fall. Juvenile emigration peaks in June through August although some occurs through December.

Table 26. Distribution of Cowlitz **Subbasin** naturally spawning hatchery and natural fall chinook (Kreitman and **LeFleur,** WDF, annual memorandums).

	Toutle	N.Toutle	S.Toutle	Green R.	Cowlitz	Coweeman
1964	353	2,201	215	2,375	3,380	371
1965	330	2,057	201	1,482	6,560	86
1966	386	2,406	235	1,350	4,880	110
1967	224	1,397	136	1,701	5,900	108
1968	180	374	42	2,640	2,450	140
1969	790	838	390	2,650	5,680	118
1970	263	2,515	289	4,244	10,550	111
1971	180	11,380	578	5,268	23,345	296
1972	355	9,408	440	6,654	22,610	212
1973	738	1,250	178	908	8,740	54
1974	255	4,784	261	1,292	7,800	42
1975	413	6,909	114	634	5,070	94
1976	155	2,587	313	1,480	4,050	74
1977	235	1,465	143	948	6,210	86
1978	115	1,450	302	6,488	5,190	62
1979	188	455	158	4,418	9,190	88
1980	37			0	2,690	56
1981	62	10	81	10	4,820	38
1982			9		3,150	76
1983				-	3,695	40
1984		-	-	-	2,606	164
1985		-	9		4,800	168
1986		-	0		3,711	124

Table 27. Freshwater life history of fall chinook. The developmental stage timing represents basinwide averages, local conditions may cause some variability.

Developmental Stages	Time of year	Peak occurrence
Adult immigration	August-September	August-September
Adult holding	August-October	August-October
Spawning	October-November	October
Egg/alevin incubation	October-March	October-February
Emergence	January-March	January-March
Rearing	Jan-December (12 mos.)	Feb-June (5 mos.)
Juvenile emigration	June-December	June-August

Run size of naturally produced fall chinook in the Cowlitz River was estimated by Devore (1987) at 1,661 fish for 1983 through 1985, 12.8 percent of the total. For 1983 through 1985, 57.24 percent of the chinook run or 7,317 fish had returned to the rack. For 1981 through 1988, an average of 7,623 fish returned to the rack, which when divided by 0.5724 and then multiplied by 0.128 results in 1,705 natural fish.

Toutle River pre-eruption run size was estimated at 11,943 fish, based on an average 4,183 fish rack return, 6,573 natural spawners, and a sport catch of 1,187 fish. Applying the 12.8 percent natural fish component results in 1,528 natural fish.

On the Coweeman, 12.8 percent of the 90 fish spawning escapement was 12 fish.

Devore (1987) documented 1983 through 1985 age and sex structure for Cowlitz River naturally spawning (hatchery and natural origin) fall chinook, the only data available for the subbasin (Table 28). Length at age information was unavailable. All fish were assumed to have migrated as fingerlings. Overall, females made up 52 percent of the total.

No fecundity information was found for naturally produced fall chinook in the Cowlitz Subbasin. Egg-to-smolt and smolt-to-adult survival rates for the Cowlitz Subbasin are unknown.

Table 28. Ocean age and sex of Cowlitz River naturally spawning fall chinook (hatchery and natural origin) (Devore 1987).

	Ocean Age 1	2	3	4	5
Age Composition	5.1%	13.0%	68.3%	13.4%	0.2%
females	0.0%	19.2%	58.9%	67.7%	100.0%
No. Fish	570	1,440	7,581	1,487	23%

The Northwest Power Planning Council's model showed production capacity was 2,183,000 smolts for the Cowlitz River (below Mayfield); 2,799,000 in the Toutle; and 602,000 in the Coweeman; 5,584,000 smolts overall.

Above Mayfield, the Northwest Power Planning Council's model estimated 357,000 smolts could be produced from the Tilton River and 4,028,000 above Cowlitz Falls. Data on streams was acquired through Meekin (1962), Birtchet (1963), Thompson and Rothfus (1969), Easterbrooks (1980) and U.S. Forest Service personnel. Some fall chinook habitat is no longer available above Mayfield; Thompson and Rothfus (1969) estimated 28 percent of the spawning occurring above Mayfield was in the area inundated by Mayfield and Mossyrock pools. Easterbrooks (1980) estimated a maximum of 4,254,000 fall chinook smolts could be produced upstream of Cowlitz Falls. However, reintroducing anadromous fish above Mayfield is not the preferred option because of the problems mentioned in Part I of this document. If and when these problems are resolved, reintroduction of fall chinook may become a realistic option. However, this is not likely in the near future.

Supplementation History

Fall chinook have been planted into the Cowlitz Subbasin since at least 1951. The Cowlitz River received only one plant of fall chinook between 1951 and 1967 -- 203,769 Toutle River origin fingerlings in 1952 into the Tilton River. Brood stock for Cowlitz plants has subsequently been Cowlitz stock except for some of the fish planted in 1968 (Toutle), 1971 (Kalama), and 1981 (Big Creek, Kalama, Bonneville) (Appendix D). Since the Cowlitz Salmon Hatchery started operating, Cowlitz River production was managed primarily as a lower Columbia River hatchery stock. Purpose of the program was to maintain the run and provide fish for commercial and sport fisheries. Mean survival (ocean and river) of hatchery fish averaged 0.29 percent (range: 0.05 percent to 0.56 percent) for 1980 through 1983 brood years (A. Appleby, WDF, pers. commun.).

The Toutle River has been stocked since at least 1951 with 1 million to 6 million fingerlings released annually until 1980. After 1967, the stock used was primarily Toutle although some other stocks were used in 1967 (Spring Creek and Big Creek), 1979 (Kalama), and 1987 (Washougal and Kalama). Toutle fall chinook were managed primarily as a lower Columbia River hatchery stock. Seidel and Mathews (1977) found June-released (2 to 3 grams) Toutle fall chinook fingerlings survived at a minimum of 0.20 percent while October (19 g), January (27 g) and April (57 g) releases survived at a minimum of 1.02 percent, 2.86 percent and 10.01 percent, respectively. The Washington Department of Fisheries uses 0.44 percent fingerling-to-adult survival for Toutle fall chinook. The Toutle Hatchery was destroyed in the 1980 eruption of Mount St. Helens. Toutle production is presently being supplemented with annual production of about 2.5 million fingerlings from Beaver Slough on the Green River.

The Coweeman River received plants of fall chinook from at least 1951 to 1979. Since 1967, stocks included Spring Creek, Washougal, and Toutle. Performance of plants was not evaluated.

Fish Production Constraints

Production constraints for fall chinook in the subbasin are somewhat similar to that previously mentioned for winter steelhead (Table 9). Sedimentation and temperature problems, commonly associated with logging and farming activities, were most frequently mentioned.

Hatchery Production

Cowlitz River

On the Cowlitz River, the Cowlitz Salmon Hatchery is the only production facility rearing fall chinook. The hatchery has 4,320 Heath incubation trays with a capacity of 30 million eggs: stratified egg-takes increase egg capacity to over 40 million. There are also 18 5' X 100' kettles with about 500 gpm flow each, and 36 20' X 100' Burrows ponds with 1,800 to 3,000 gpm flow each. Six to seven of the Burrows ponds are used for adults with about 3,000 gpm flow, and juveniles in the remainders with 1,800 to 2,400 gpm. Production from 1977 through 1987, excluding 1980, averaged 6,508,515 fingerlings and in 1988 totaled 168,000 pounds. Objectives of the program were to maintain a hatchery return of 8,300 fish while providing fish for commercial and sport fisheries. Mitigation goal of all species at the hatchery includes 8,300 fall chinook, 17,300 spring chinook, and 25,500 coho. Original hatchery designs called for 10 million fall chinook juveniles amounting to 66,400 pounds. Production for all programs amounts to about 600,000 pounds while design capacity was 494,810 pounds.

Brood stock source is the Cowlitz River via hatchery rack returns. Males and females are spawned at a l-l ratio. Ovarian fluid is tested from females for IHN virus and eggs are water hardened in iodophor. Eggs from IHN positive females are planted as fry in the lower river.

In the Cowlitz River, hatchery run size was estimated by Devore (1987) for 1983 through 1985 at 11,302 fish. For 1981 through 1988, run size of hatchery fish was estimated by taking the 1981 through 1988 average rack return (7,623 fish) and dividing it by the percent of fish entering the rack in 1983 through 1985 (57.24 percent from Devore 1987) and then subtracting 12.8 percent natural fish. This results in a total run size of 13,318 fish of which 11,613 were hatchery origin. A rack return of 8,300 adults would be equivalent to 10,061 fish (jacks and adults), which when divided by 0.5724 would result in a total run size of 17,577 fish.

Returns of adults to the hatchery increased substantially after 1986 to over 10,000 fish, but averaged 1,335 jacks and 6,288 adults in 1981 through 1988 (Table 29). Jacks comprised an average of 17.5 percent of hatchery returns in 1981 through 1988. When about 6,300 adults return to the rack, about 1,150 females are sold as excess fish.

Table 29. Return of fall chinook to the Cowlitz Salmon Hatchery.

Year	Jacks	Adults	Year	Jacks	Adults
1977	1,286	2,579	1983	498	5,969
1978	1,792	2,860	1984	586	5,117
1979	801	6,155	1985	3,348	6,434
1980	221	1,968	1986	1,923	10,757
1981	976	4,697	1987	1,267	11,693
1982	1,130	4,284	1988	953	13,931

Adult time of return, time of spawning, incubation period, and juvenile emigration time are similar to Cowlitz natural fall chinook. Fecundity of fall chinook spawned from 1982 through 1987 averaged 4,368 eggs per female (n=14,370). The production goal in 1988 was 6.5 million fingerlings released in June at 7.6 grams and 900,000 fingerlings released in September at 30.3 grams, a total of 168,333 pounds.

Freshwater age analysis for 1982 through 1987 hatchery fish found 91.7 percent of fish had migrated to the ocean as age-0 fingerlings while 8.3 percent migrated as yearlings. There was a large release of yearlings from the hatchery in 1981, a result of holding fish in the hatchery until river conditions improved after the volcanic eruption. Most of the adults with yearling freshwater age probably came from this group.

Saltwater age composition of hatchery fall chinook in 1982 through 1987 found a dominance of 2-ocean males and 3-ocean females (Table 30). Mean length of males and females was 72.4 cm and 81.4 cm, respectively, and 76.2 cm overall. Females comprised 42.1 percent of the total fish sampled.

Egg-to-fry survival in the hatchery was 92.9 percent for 1982 through 1986. Fry-to-smolt survival was 94 percent resulting in an egg-to-smolt survival of 87.3 percent. Smolt-to-adult survival of hatchery fish for 1980 through 1983 brood years averaged 0.29 percent with a range from 0.05 percent to 0.56 percent (A. Appleby, WDF, pers. commun.). Recent data indicates greater returns with releases of larger (more than 7.6 grams) fingerlings in June (P. Seidel, WDF, pers. commun.).

Table 30. Cowlitz Hatchery fall chinook ocean age, sex and length profile, 1982-1987 (WDF records, Battleground, WA).

	Ocean Age				
	1	2	3	4	5
Age Composition	9.6%	42.0%	44.1%	4.3%	.04%
Percent Female	0.0%	29.4%	60.4%	73.3%	100.0%
Length (cm) M	46.8	71.2	86.8	97.0	--
Length (cm) F	--	75.0	83.3	90.8	88.0

The genetic work described for winter steelhead by Milner et al. (1980) and Schreck et al. (1986) was also done for Cowlitz hatchery fall chinook.

The major constraint at the Cowlitz Salmon Hatchery is facility size. Within the hatchery, bacterial kidney disease (Renibacterium salmoninarum) has been rated the most severe pathogen affecting production, followed by low temperature disease (Cytophaga psychrophilia), bacterial hemorrhagic septicemia and enteric redmouth (Yersinia ruckeri). Actions that could improve production include facility enlargement or modification and disease control.

Toutle River

On the Toutle River, the Toutle Hatchery was destroyed in the May 1980 eruption of Mount St. Helens. The facility was comprised of 24 20' X 80' raceways with 125 to 140 gpm each; 4,870 square feet of adult holding ponds with 800 gpm flow; and Deer Springs pond, 0.3 acres with 6-cfs flow. Production exceeded 3 million fingerlings annually. Smolt-to-adult survival averaged 0.57 percent (A. Appleby, WDF, pers. commun.).

Present salmon culture facility on the Toutle is Beaver Slough with a 100' X 900' dirt bottom pond with 9,000 gpm flow. Also, a 50' X 100' pond is present. The facility was re-opened in 1986 after several years of being closed. In 1987, production was 902,400 fall chinook fingerlings (12,892 pounds) and 333,350 coho smolts (16,668 pounds), a total of 29,560 pounds. In 1988, production increased to 2,419,000 fall chinook (33,137 pounds) and 306,900 coho (21,921 pounds), a total of 55,058 pounds. Fall chinook fry have been trucked in from other stations in January and February and released as fingerlings in June. Brood stock has been a mixture of lower Columbia River sources -- Grays River, Big Creek, Kalama, and Washougal. Fry-to-fingerling survival was 99.6 percent and 98.4 percent for 1987 and 1988 releases, respectively.

After 1980, hatchery run size and hatchery returns of Toutle River fall chinook could not be enumerated since the hatchery was destroyed and turbidity precluded accurate spawning escapement. For 1972 through 1979, hatchery returns averaged 4,183 fish (King 1987) while naturally spawning fish averaged 6,573 fish. Jacks comprised 1.9 percent of hatchery returns.

Adult migration timing, age structure, sex ratio, time of spawning, fecundity, egg incubation time, smolt age, juvenile migration timing, and survival rates were not documented after 1980, but are thought to be typical of lower Columbia River hatchery stocks.

The genetic work described for winter steelhead by Milner et al. (1980) and Schreck et al. (1986) was also done for Toutle hatchery fall chinook.

Present constraints at the Beaver Slough facility include lack of manpower, lack of funds, a marginal water intake structure, high summer temperatures, disease, and facility size. Production improvements could be obtained via adequate funding to offset the aforementioned problems.

Coweeman River

No salmon rearing facility exists on the Coweeman River. However, interest has been expressed in evaluating potential rearing sites. Smolt-to-adult survival was estimated to be 0.25 percent (A. Appleby, WDF, pers. commun.).

Harvest

Cowlitz fall chinook are a lower Columbia River hatchery stock that contributes to ocean commercial and recreational fisheries. The System Planning Model used a combined ocean and Columbia River harvest rate of 87.1 percent. Natural fish in the subbasin may be underescaped due to high harvest rates of lower Columbia River hatchery stocks.

Within the subbasin, pre- (1977-1979) and post-eruption (1982-1986) harvest (jacks and adults) averaged 5,473 and 2,186 fish, respectively (Table 31). Post-eruption harvest has been solely in the Cowlitz River and harvest rate averaged 14.4 percent (from Devore 1987).

In 1980 and 1981, a commercial gill net fishery in the lower Cowlitz River harvested returning fall chinook and coho. Catch was 9,281 and 9,366 fish for 1980 and 1981, respectively.

Table 31. Cowlitz Subbasin fall chinook harvest and spawning escapement (escapements from Kreitman and LeFleur, WDF, memorandums: harvest from WDF punch-card data).

	1977	1978	1979	1980	1981
Spawning Escapement					
Cowlitz Hatchery	3,865	4,652	6,956	2,189	5,673
Toutle Hatchery	3,660	5,814	6,772	--	--
Natural/wild					
Cowlitz	6,210	5,190	9,190	2,690	4,820
Toutle	2,652	8,297	5,196	unk	unk
Coweeman	86	62	88	56	38
Subtotal	16,473	24,015	28,202	4,935+	10,531+
Subbasin Harvest					
Recreation Harvest					
Cowlitz	4,263	4,922	3,615	1,171	1,828
Toutle	166	1,325	2,071	0	0
Coweeman	3	54	0	12	0
Cowlitz Commercial Catch -				9,281	9,366
Total Harvest	4,432	6,301	5,686	10,464	11,194+
TOTAL INRIVER RUN	20,905	30,316	33,888	15,399+	21,725+

(continued)

Table 31 continued.

	1982	1983	1984	1985	1986
Spawning Escapement					
Cowlitz Hatchery	5,414	6,467	5,703	9,782	12,680
Toutle Hatchery	--	--	--	--	--
Natural/wild					
Cowlitz	3,150	3,695	2,606	4,800	3,711
Toutle	unk	unk	unk	unk	unk
Coweeman	76	40	164	168	124
Subtotal	8,640+	10,202+	8,473+	14,750+	16,515+
Subbasin Harvest (Recreational)					
Cowlitz	1,768	407	2,337	2,848	3,570
Toutle	0	0	0	0	0
Coweeman	0	0	0	0	0
Total Harvest	1,768	407	2,337	2,848	3,570
TOTAL INRIVER RUN	10,408+	10,609+	10,810+	17,598+	20,085+

In the Cowlitz River, the dam construction mitigation goal is based on an escapement of 8,300 adults to the Cowlitz Hatchery. This goal allows for hatchery egg-take needs, inriver sport harvest and some natural spawning. The Washington Department of Fisheries and Tacoma City Light mitigation goal can be heavily influenced by ocean and Columbia River harvest. The Department of Fisheries' harvest management goal is to allow only enough fish back to the hatchery to maintain production. Fish in excess of hatchery needs are usually sold. Therefore, most harvest of Cowlitz fall chinook is intended for the ocean and Columbia River. Consequently, existing harvest management practices by the Department of Fisheries are sometimes in direct conflict with Tacoma City Light's mitigation agreement for this species. Tacoma City Light has tentatively expressed a desire to reevaluate the mitigation package to seek a measurement of mitigation not based solely on adult returns to the hatchery.

In the Toutle River, management goals are to return production and harvest to pre-eruption levels. Toutle River fall chinook are anticipated to be managed as a hatchery stock.

Coweeman River fall chinook are presently managed as a lower Columbia River hatchery stock.

Management procedures within the subbasin consist of regulation through the Washington Fisheries Department's sport harvest restrictions. For fall chinook on the Cowlitz River, the daily limit is six salmon of lo-inch minimum size, of which two may exceed 24 inches. The-season runs from August 1 through March 31. Chinook over 28 inches must be released after October 1 above Blue Creek (about RM 40) to protect spawning fish. The Toutle River watershed is closed to salmon angling. The Coweeman is open from September 1 to December 31 downstream of the mouth of Mulholland Creek with a daily limit of six chinook or coho jacks of lo-inch minimum size. Enforcement activities consist of Washington Fisheries and Washington Wildlife personnel checking anglers for compliance with harvest restrictions.

specific Considerations

The Cowlitz Subbasin is managed as a lower Columbia River hatchery stock and consequently, escapement of natural fish, comprising 12.8 percent of the return, is not an active management goal. Most harvest of subbasin fish is intended for outside the subbasin since the inriver harvest rate is only 14.4 percent of the inriver run.

Mitigation level of fall chinook to the Cowlitz River is 8,300 adults to the Cowlitz Salmon Hatchery, which allows sport harvest opportunity and natural spawning escapement. The mitigation goal can be heavily influenced by ocean and Columbia River harvest. The Washington Fisheries Department's harvest management goal is to allow only enough fish back to the hatchery to maintain production. Present constraint on the Cowlitz River is hatchery production. The Cowlitz Hatchery juvenile fall chinook program is producing 253 percent of designed capacity (in pounds). Improved returns within the last several years suggest that within the parameters of the mitigation agreement, the fall chinook program should be reduced and replaced by spring chinook, which are returning below mitigation requirements. Survival of hatchery fingerlings averaged about 0.29 percent (1980-1983 broods). Recent data indicates improved survival of juveniles by releasing large fingerlings in June.

Natural production capacity in the Cowlitz River was estimated at 2,183,000 fingerlings. Habitat in the Cowlitz below the Toutle was severely impacted with the 1980 volcanic eruption and much of the rearing area for natural production may have been temporarily destroyed. Construction of the sediment retention structure on the North Toutle will reduce sedimentation in the lower Cowlitz, which should improve habitat and possibly sport harvest. However, habitat may not fully recover due to the diking, which occurred after the eruption to protect human property.

On the Toutle River, fall chinook are being reestablished primarily through hatchery production. Prior to 1980, hatchery fingerling survival was estimated at 0.57 percent. The Northwest Power Planning Council's model estimated 2,799,000 natural fingerlings could be produced. Current natural production will increase as habitat improves. The sediment retention structure will render about six miles of the North Fork Toutle and parts of several tributaries as unusable to fall chinook. Adults moving above the structure have to be trapped and hauled.

The Coweeman River has potential for natural production of 602,000 juveniles. Because of high harvest rates on lower Columbia River hatchery stocks, the Coweeman has probably been underescaped. Fingerling-to-adult survival was estimated at 0.25 percent. Management for adequate escapement for natural production in the Coweeman would probably result in large surpluses on the Cowlitz River and in the future, the Toutle River.

Critical Data Gaps

No data was found for egg-to-smolt survival and smolt-to-adult survival of natural fall chinook for this watershed. Data is needed on hatchery-to-natural ratios; age composition escapement data for the Toutle is lacking due to turbidity. Investigations are needed to determine if significant sources of smolt mortality exist within the subbasin.

Objectives

Stock: Cowlitz River Fall Chinook

Utilization Objective: 2,000 fish for sport harvest and support of out-of-basin harvests. The utilization objective **has** priority within the subbasin.

Biological Objective: Maintain biological stock characteristics such as size, timing, and age structure.

Fall chinook in the Cowlitz River have met this objective and consequently, no alternative strategies are offered.

Stock: Toutle River Fall Chinook

Utilization Objective: 1,800 fish for sport harvest and support of out-of-basin harvests. The utilization objective has priority within the subbasin.

Biological Objective: Maintain biological stock characteristics such as size, timing, and age structure of lower Columbia River hatchery fall chinook.

This level of fall chinook production would return the Toutle to pre-eruption levels. This would require 12,889 fish back to the river, which would provide an out-of-basin harvest of 87,181 fish, a total of 100,070 fish.

Stock: Coweeman River Fall Chinook

Utilization Objective: Support out-of-basin harvests. The utilization objective has priority within the subbasin.

Biological Objective: Maintain biological stock characteristics such as size, timing, and age structure of lower Columbia River hatchery fall chinook.

Existing subbasin returns are estimated at 13,318 fish in the Cowlitz River, 90 fish in the Coweeman River, and Toutle pre-eruption levels of 11,943 fish. For calibrating the System Planning Model, 70 percent of the Toutle pre-eruption level was used (7,290 hatchery and 1,070 natural) for a total return of 21,768 fish, representing a total production of 169,539 fish at existing harvest rates. The System Planning Model was calibrated to reflect sales of carcasses sold at the Cowlitz Salmon Hatchery.

Alternative Btratesies

Strategies for fall chinook have specific themes that try to meet objectives with natural production followed by less natural methods as necessary. Actions identified under each strategy are closely related to the theme. Strategy 1 has a natural production theme seeking to improve the productivity of the existing natural stock. Strategy 2 is a "benign" supplementation strategy, emphasizing actions to develop a single supplemented run with yet higher productivity. Strategy 3 relies on a traditional hatchery program to meet objectives. Only those actions necessary for the success of a hatchery program would be included in Strategy 3.

Modeling results for each strategy are presented in Table 32 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 32. 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 33.

STRATEGY 1: Natural Production. This strategy seeks to achieve the objectives by eliminating sources of direct mortality to natural fish, answering management questions and reducing risks of genetic modification of natural stocks.

This strategy provides for prudent stewardship of existing habitat and water quality in the historic distribution range through various existing laws and agreements. Streams in the subbasin need to be inventoried for summer temperature profiles: those exceeding temperature sensitivity criteria should be classified as such through the Department of Natural Resources so future impacts will be minimized. Riparian zones should be managed to provide a continuous recruitment of large organic debris into the subbasin system. Fishways should be maintained.

Hypothesis: Existing habitat, if properly managed, should provide a number of fingerlings toward the objectives.

Assumptions: This strategy assumes egg-to-smolt survival could be increased by a relative 10 percent in the System Planning Model.

Numeric Fish Increases: An additional 62 fish would return to the subbasin at existing harvest rates and total production would increase by 573 fish at maximum sustained yield.

ACTIONS: 1

1. Maintain at least current level of stream habitat quality and quantity. Seek improved water quality via reduction of sedimentation. Investigate to determine if significant sources of fingerling mortality exist within the subbasin.

STRATEGY 2: Supplementation. This strategy seeks to achieve the objectives by supplementing natural production with an appropriate existing hatchery stock or natural stock. Any actions identified in Strategy 1 necessary for the success of the supplementation program are also required.

Hypothesis: Because of high harvest rates on lower Columbia River hatchery populations, the Coweeman is probably underseeded; with an egg-to-smolt survival of 50 percent and potential egg deposition of spawners, 17 percent of capacity is being used. Planted fingerlings would use existing habitat.

Expanding the Beaver Slough facility would increase the number of fingerlings produced to equal pre-eruption levels.

Assumptions: A total of 1 million fry would be planted into the Coweeman and these were assumed to have 50 percent initial survival.

Numeric Fish Increases: An additional 1,382 fish would return to the subbasin from these actions. Total production increase would amount to 9,938 fish at MSY.

ACTIONS: l-3

1. -

2. Plant the Coweeman watershed with 1 million fry.

3. Expand the Beaver Slough rearing facility on the Toutle River by 600,000 fingerlings.

STRATEGY 3: Hatchery Production. This strategy seeks to achieve the objectives solely through traditional hatchery production. Only those actions necessary for maintenance of the hatchery program are included.

Hypothesis: Increased production of fingerlings would increase the number of adults produced.

Assumptions: This strategy assumes that increased fingerling survival will result in commensurate adult increases.

Numeric Fish Increases:. This strategy would increase **subbasin** returns by 3,460 fish. Total production increase would be 24,823 fish at MSY. This strategy would meet objectives.

ACTIONS: 3, 4

3. -

4. Construct rearing facilities on the Coweeman River to produce 1 million fingerlings.

STRATEGY 4: Natural Habitat Expansion. This strategy seeks to achieve objectives by expanding accessible natural spawning and rearing habitat, and freshwater fishing areas.

This strategy restores fall chinook runs to the upper Cowlitz Basin by installing adult and juvenile collection and hauling facilities to pass fish around the dams. The Northwest Power Planning Council's smolt capacity model indicated about 4.4 million smolts could be produced above Mayfield.

Hypothesis: Increased habitat will increase natural production.

Assumptions: This strategy assumes that fall chinook will reestablish themselves in the newly available habitat. Problems concerning disease, hatchery and natural stock separation, financial responsibility, and harvest management issues need to be resolved. Also assumed is that dam passage will be achieved with a minimum of mortality and delay as a result of handling.

ACTIONS: 1, 5

1. -

5. Resolve technical and financial problems that currently prevent dam passage. Restore fall chinook runs starting with hatchery supplementation, and then develop self-sustaining runs.

Recommended Strategy

Strategy 3, hatchery enhancement, is the recommended strategy. Fall chinook in the subbasin are managed as a hatchery stock with associated high ocean and Columbia River harvest rates; relatively small inbasin harvest will be realized while out-of-basin harvest will be substantial. This strategy meets the objectives and also allows production on the Toutle River to reach pre-eruption levels. The SMART analysis supports this recommendation (Appendix B).

Table 32. System Planning Model results for fall chinook in the Cowlitz Subbasin. Baseline value is for pre-mainstem implementation, all other values are post-implementation.

Utilization Objective:
Provide a subbasin harvest of 2,000 fish in the Cowlitz River, 1,800 fish in the Toutle River and support out basin harvest from the Coueeman River.

Biological Objective:
Maintain biological characteristics of lower Columbia River hatchery 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	7,478 -C	12,499	21,366	143,955	0(1.00)
All Nat	7,712 -C	12,340	21,423	144,471	573(1.00)
1	7,712 -C	12,340	21,423	144,471	573(1.00)
2	9,073 -c	12,249	22,683	152,575	9,938(1.06)
3*	9,884 -C	13,344	24,711	165,433	24,823(1.15)
4	N/M				

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

[1] Strategy descriptions:

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

1. Aggressive habitat protection. Pre Mainstem Implementation.
2. Strategy 1 plus 1,000,000 hatchery fry and 600,000 hatchery smolts. Pre Mainstem Implementation.
3. Baseline plus 1,600,000 hatchery smolts increase smolt to smolt survival to 0.93. Pre Mainstem Implementation.
4. Strategy1 plus resolving technical and financial problems that currently prevent dam passage.

[2] MSY is the nunber 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 uhere 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 uhen 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 spauning 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 Pouer 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 33. Estimated costs of alternative strategies for Cowlitz 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
Hatchery Costs				
Capital[1]	0	713,000	368,000	0
O&M/yr[2]	0	21,250	40,000	0
Other Costs				
Capital[3]	0	0	0	0
O&M/yr[4]	30,000	0	0	30,000
Total Costs				
Capital	0	713,000	368,000	0
O&M/yr	30,000	21,250	40,000	30,000

* Recommended strategy.

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

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

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

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

SPRING CHINOOK SALMON

Fisheries Resource

Natural Production

History and Status

Historically, spring chinook in the subbasin were primarily found in the Cowlitz River. The Washington Fisheries Department (1951) estimated that 400 spring chinook entered the Toutle River. Escapement to the Cowlitz River was estimated at 10,000 fish. Distribution in the Cowlitz River was estimated to be 200 fish to the Tilton River, 8,100 to the Cispus River and 1,700 fish to the upper Cowlitz (WDF 1951). On the Cowlitz River for 1962 through 1966, an average of 8,720 adult and 1,208 jack spring chinook were counted at Mayfield Dam (Thompson and Rothfus 1969). Spawning surveys indicated all spawning occurred above Mayfield; Washington Fisheries (1951) indicated spawning in the Cowlitz occurred above Packwood and in the Cispus between Iron Creek and East Canyon Creek. In the Tilton River, Thompson and Rothfus (1969) indicated spring chinook were reported in 1945, but subsequent spawning in the Tilton has not been observed for years. The Cowlitz Salmon Hatchery was completed in 1967 to maintain the spring chinook run at a rack return of 17,300 adults.

From 1974 through 1980, an average of 2,838 spring chinook adults were trucked above Mayfield into the Tilton and upper Cowlitz rivers to provide sport fishing opportunity and natural production (Stober 1986). Since 1981, no spring chinook have been planted above Mayfield because of possible risk of IHN virus contamination of the water supply at the Cowlitz Salmon Hatchery.

Spring chinook in the Cowlitz River are currently a hatchery stock. Although some spring chinook spawn naturally in the river, few returning adults originate from natural spawning. Fall chinook spawn in the same areas and redd superimposition occurs.

Life History and Population Characteristics

The Northwest Power Planning Council's model estimated a smolt capacity of 329,400 smolts for the Cowlitz River below Mayfield and 788,400 smolts in the Toutle, 1,117,800 overall. Based on historic adult returns, the Toutle production estimate is an overestimate.

Above Mayfield, the Northwest Power Planning Council's model estimated 1.6 million smolts could be produced. Estimates excluded the Tilton River as spring chinook were not found in the Tilton after about 1950 (Thompson and Rothfus 1969). Data on streams was acquired through Meekin (1962), Birtchet (1963), Rothfus and Thompson (1969), Easterbrooks (1980) and U.S. Forest Service personnel. Some pre-dam habitat is no longer available due to inundation from the pools behind the dams. Easterbrooks (1980) estimated a maximum of 1,157,400 spring chinook smolts could be produced above Cowlitz Falls. However, reintroducing anadromous fish is not a preferred option because of the problems listed in Part I. Reintroduction above Mayfield is not likely in the near future.

Production from naturally spawning adult chinook and juvenile plants in the Tilton River was observed at the Mayfield Dam migrant facility (Table 34). An average of 260 adults were planted in the Tilton from 1975 through 1978 and none thereafter. Spring chinook juveniles were planted in the Tilton River until 1978 while the upper Cowlitz received plants through 1981. Tilton juvenile plants for 1974 through 1978 averaged 739,200 fish while 1979 through 1981 upper Cowlitz plants averaged 1,375,200 fish (Stober 1986).

Table 34. Spring chinook counts through the Mayfield Dam migrant facility (Tipping, unpubl. data).

Year	Number of smolts	Year	Number of smolts
1978	1,223	1982	282
1979	644	1983	4
1980	455	1984	no data
1981	24,648	1985	0

For the System Planning Model, a token 455 fish (373 Cowlitz and 82 Toutle) were assumed of natural origin in the subbasin. An average of 447 fish spawned in the Cowlitz River (Table 31). In the Toutle River, an estimated 164 fish, half of them natural in origin, were assumed present. This is 1.5 percent of the total return.

Supplementation History

A salmon hatchery was present in the upper Cowlitz River near the Clear Fork, but was abandoned in 1949 as a rearing station because water temperatures were too low. The station continued to take spring chinook eggs through 1950 (WDF 1951). Within a few years after the 1967 completion of the present Cowlitz Salmon Hatchery, all returns were considered hatchery in origin. Brood stock for the subbasin has been Cowlitz stock except for some Willamette brood stock in 1967. Purpose of the program was to maintain the run and provide fish for commercial and sport fisheries. For 1978 through 1986 releases, an average of 639,788 smolts were released (Appendix D). Mean performance of 1980 through 1983 brood year marked yearlings averaged 2.74 percent and ranged from 0.46 percent to 6.97 percent (A. Appleby, WDF, pers. commun.).

In the Toutle River, most plants were unfed fry and fingerling releases using Cowlitz stock from the Cowlitz Hatchery. Program purpose was to provide sport and commercial fish. No measure of performance was undertaken.

Fish Production Constraints

Production constraints for spring chinook in the subbasin are listed Table 9. Sedimentation and temperature problems commonly associated with logging were most frequently mentioned.

Hatchery Production

Cowlitz River

On the Cowlitz River, the previously described Cowlitz Salmon Hatchery is the single facility rearing spring chinook. Program objectives were to maintain a hatchery return of 17,300 adults while providing for commercial and sport fisheries. Mitigation goal of all species at the hatchery is 17,300 spring chinook, 8,300 fall chinook, and 25,500 coho. Original hatchery design called for 4 million spring chinook juveniles (fingerlings and yearlings) amounting to 196,590 pounds. Recent production of spring chinook has been 600,000 yearlings and 2.5 million fingerlings amounting to about 170,000 pounds. Production has been increased for 1990 to 1,056,000 smolts. Production of all hatchery programs totals about 600,000 pounds compared to the design capacity of 494,810 pounds.

Brood stock source is the Cowlitz River via hatchery rack returns. Fish are spawned randomly although fish in poor physical condition are excluded. Managers select fish based on hatchery arrival time; 33 percent of eggs are selected from April returns, 22 percent from early May, 22 percent from late May, 11 percent from June, and 11 percent from July arrivals. Males and females are spawned at a l-l ratio. Female ovarian fluid is tested for IHN virus and eggs are water-hardened in iodophor. Fry from IHN positive females are planted in the lower river.

In the Cowlitz River, hatchery run'size has averaged 29,699 fish from 1975 through 1987 (Table 35). Jacks averaged 36.7 percent of the total, although only 25 percent after 1978. Hatchery returns comprised 66.4 percent while sport catch averaged 32 percent and natural spawning 1.5 percent. With 13,000 adults to the rack, about 3,000 females are or used for other purposes: if 17,000 adults returned to the rack, about 5,000 females would be sold or used for other purposes.

Table 35. Cowlitz River returns of hatchery spring chinook (WDF records, Battleground, WA).

	Sport Catch		Natural Spawn		Hatchery Return		TOTAL	
Year	Adult	Jack	Adult	Jack	Adult	Jack	Adult	Jack
1975	4,103	13,361	285	166	17,277	10,048'	21,665	23,575
1976	6,501	13,399	636	439	19,509	13,478	26,646	27,316
1977	5,050	3,679	0	0	15,896	11,563	20,946	15,242
1978	4,253	4,032	193	365	9,329	17,570	13,775	21,967
1979	5,483	2,287	379	183	7,561	3,664	13,423	6,134
1980	7,723	5,686	166	31	15,860	3,041	23,749	8,758
1981	5,356	1,717	964	157	21,601	3,503	27,921	5,377
1982	6,892	2,921	209	70	11,536	3,857	18,637	6,848
1983	7,961	3,661	70	25	13,319	4,580	21,350	8,266
1984	7,535	599	147	14	13,645	1,334	21,327	1,947
1985	2,914	375	156	105	6,841	4,617	9,911	5,097
1986	2,205	1,119	467	492	4,653	4,906	7,325	6,517
1987	3,708	1,146	71	19	13,676	3,491	17,455	4,656
AVE	5,360	4,152	288	159	13,131	6,589	18,799	10,900

Adult time of return ranges from March through July (Table 36). Spawning time is August and September and fry emerge in November through March. Yearling fish are reared through the following March and released in April through June. Most fish are released as fingerlings in June after emergence. From 1982 through 1987, fecundity averaged 3,988 eggs per female (n=8,479).

Saltwater age composition of spring chinook returning to the hatchery in 1982 through 1987 showed a dominance of 2-year ocean fish (Table 37). Yearling smolts comprised most of the returns except for saltwater age-4 fish. Mean length of males and females was 69.1 cm and 77.6 cm, respectively, and 72.5 cm overall. Females comprised 40.3 percent of fish sampled.

Table 36. Freshwater life history of subbasin spring chinook. The developmental stage timing represents basinwide averages, local conditions may cause some variability.

Developmental Stages	Time of year	Peak occurrence
Adult immigration	March-July	May-June
Adult holding	March-September	May-August
Spawning	September-October	September
Egg/alevin incubation	September-January	September-December
Emergence	December-February	December-January
Rearing	Dee-April (17 mos.)	Jan-April (16 mos.)
Juvenile emigration	April-June	April-May

Table 37. Cowlitz Hatchery spring chinook age, sex and length profile, 1982-1987 (L. LaVoy, WDF, pers. commun.).

	Saltwater Age				
	0	1	2	3	4
Percent Age Composition	1.7%	16.2%	58.5%	22.9%	0.8%
Percent Female	0.0%	1.0%	43.5%	62.0%	69.6%
Male Length (cm)	31.6	55.2	73.2	85.7	86.9
Percent Yearling smolts	100.0%	92.0%	90.0%	84.9%	14.3%
Female Length (cm)	--	64.6	74.6	82.7	87.1
Percent Yearling smolts	--	100.0%	98.9%	88.6%	18.8%

Hatchery egg-to-fry survival was 92.9 percent for 1982 through 1986. Fry-to-smolt survival was 85.8 percent resulting in an egg-to-smolt survival of 79.7 percent. Smolt-to-adult survival of marked production fish for 1980 through 1983 brood years averaged 2.74 percent (A. Appleby, WDF, pers. commun.). However, 1982-1983 releases averaged 1.21 percent.

The genetic work described for winter steelhead by Milner et al. (1980) and Schreck et al. (1986) was also done for Cowlitz hatchery spring chinook.

The major constraint at the Cowlitz Salmon Hatchery is facility size. Within the hatchery, bacterial kidney disease (Renibacterium salmoninarum) has been rated the most severe pathogen affecting production, followed by erythrocytic inclusion bodies (EIBS) and associated low temperature disease (Cytophaga psychroohilia), bacterial hemorrhagic septicemia and enteric redmouth (Yersinia ruckeri). Actions that could improve production include facility enlargement by including large release ponds, modification of fry starting containers, disease control, and modification of outplanting facilities.

Initial inquiries of spring chinook cooperative rearing have recently been discussed with a sport club.

Toutle River

On the Toutle River, the previously described Toutle Hatchery was destroyed in the volcanic eruption. Most Toutle spring chinook were reared in Deer Springs Pond, which was later destroyed when a temporary flood control dam was breached in the winter of 1981-1982. Production in 1967 through 1980 averaged 33,800 fingerlings. Managers made one release of yearlings. Evaluation of plants was not conducted. However, returns to the subbasin were small: the 1977 through 1979 sport catch averaged 47 adults and 10 jacks. Adults were not captured at the hatchery.

Spring chinook are not presently reared in the previously described Beaver Slough facility, but could be at some level. Also, potential exists to restart the Deer Springs Pond.

Harvest

Subbasin harvest averaged 5,360 adult and 4,152 jack spring chinook for 1975 through 1987. Pre-eruption (1977-1979) harvest was distributed as 99 percent Cowlitz and 1 percent Toutle. The Toutle has been closed to harvest since the eruption. Harvest rate within the subbasin averaged 32 percent.

Ocean and Columbia River fisheries on Cowlitz spring chinook account for 43 percent of production (from the System Planning Model). Relatively little harvest occurs in the ocean while Columbia River commercial and sport comprise most of the harvest.

In the Cowlitz River, the dam mitigation goal is based on an escapement of 17,300 adult.fish to the Cowlitz Hatchery, which represents a return to the river of 31,241 adults and jacks combined. This allows for hatchery egg needs, sport fishing opportunity, some natural spawning, and obligations to the United States vs. Oreaon agreement. This mitigation goal can be influenced by Columbia River harvest. The Washington Fisheries Department's harvest management goal is to seek maximum utilization of returning adults. Fish entering the hatchery in excess of hatchery needs are usually sold. Harvest has been split among ocean, Columbia River and inriver sport anglers. When large runs have been forecast, inriver bag and boundary limits have been liberalized to increase sport harvest.

In the Toutle River, management goals are to return production and harvest to levels present prior to the eruption of Mount St. Helens.

Harvest management within the subbasin consists of regulation through the Washington Department of Fisheries' sport harvest restrictions. The Cowlitz River daily limit is six salmon of lo-inch minimum size of which three may exceed 24 inches. The Toutle and Coweeman rivers are closed to spring chinook harvest. Enforcement consists of Washington Fisheries and Washington Wildlife personnel checking anglers for harvest regulation compliance.

Specific Considerations

Spring chinook in the Cowlitz Subbasin are managed as a hatchery stock. Little habitat is presently available in the Cowlitz River while the Toutle River watershed historically produced few spring chinook.

Sport anglers prize Cowlitz spring chinook as a premier sport and food fish while returns of 17,300 adults to the Cowlitz Salmon Hatchery attract intense sport harvest interest. The Washington Fisheries harvest management goal is to allow enough fish back to the hatchery to meet hatchery spawning needs, provide reasonable sport fishing opportunity, and meet obligations as set forth in the United States vs. Oreqon agreement. Harvest rate in the subbasin averaged 32 percent. Harvest management regulations are not typically directed at meeting the mitigation return goal to the hatchery of 17,300 adults. Population fluctuations, in conjunction with static harvest regulations, can result in substantial shortfalls in some years with respect to the mitigation goal, despite consistent releases of spring chinook juveniles from the hatchery.

Adult harvest and juvenile survival in the lower Cowlitz may be improved with turbidity reduction from construction of the sediment retention structure on the North Fork Toutle. With limited habitat, the major production constraint in the Cowlitz River is hatchery production; the Cowlitz Salmon Hatchery currently exceeds design capacity. Hatchery smolt-to-adult survival averaged 2.74 percent for 1980 through 1983 brood years.

Toutle River habitat carrying capacity was estimated at 788,400 smolts. The sediment retention structure should help habitat recovery, although the dam will flood out some stream sections. Adults moving upstream of the dam are trapped and hauled while efficiency of juvenile downstream passage is untested.

As for missing information, reasons for the recent decline in return rates of hatchery spring chinook need to be determined.

Objectives

Stock: Cowlitz River Spring Chinook

Utilization Objective: 10,000 fish for sport harvest. The utilization objective has priority within the subbasin.

Biological Objective: Maintain biological stock characteristics such as size, timing, and age structure.

Returns to the Cowlitz River for 1975 through 1987 averaged 29,699 fish, although only 16,987 fish for 1985 through 1987. After calibration, the System Planning Model was adjusted to reflect the recent program increase in Cowlitz Hatchery smolt production (an increase of about 450,000 smolts). The System Planning Model indicated subbasin returns would total 48,651 fish at existing harvest rates. Because this increase exceeds the objectives, no alternative strategies are offered for the Cowlitz River.

Stock: Toutle River Spring Chinook

Utilization Objective: 500 fish for sport harvest. The utilization objective has priority within the subbasin.

Biological Objective: Maintain biological stock characteristics such as size, timing, and age structure of spring chinook within the subbasin.

This objective would represent a subbasin return of 1,697 fish and a total production of 2,976 fish. Toutle River returns were currently estimated at 164 fish.

Alternative Strategies

Strategies for spring chinook have specific themes to try to meet objectives with natural production followed by less natural methods as necessary. Actions identified under each strategy are closely related to the theme. Strategy 1 has a natural production theme seeking to improve the productivity of the existing natural stock. Strategy 2 is a "benign" supplementation strategy, emphasizing actions to develop a single supplemented run with yet higher productivity. Strategy 3 relies on a traditional hatchery program to meet objectives. Only those actions necessary for the success of a hatchery program would be included in Strategy 3.

Modeling results for each strategy are presented in Table 38 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 38. 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 39.

STRATEGY 1: Natural Production. This strategy seeks to achieve the objectives by eliminating sources of direct mortality to natural fish, answering management questions and reducing risks of genetic modification of natural stocks.

This strategy provides for prudent stewardship of existing habitat and water quality in the historic distribution range through various existing laws and agreements. Streams in the **subbasin** need to be inventoried for summer temperature profiles: those exceeding temperature sensitivity criteria should be classified as such through the Department of Natural Resources so future impacts will be minimized. Riparian zones should be managed to provide a continuous recruitment of large organic debris into the **subbasin** system.

Hypothesis: Existing habitat, if properly managed, should provide a number of smolts toward the objectives.

Assumptions: This strategy assumes relative egg-to-smolt survival could be improved by 10 percent with aggressive habitat protection.

Numeric Fish Increases: This strategy would increase **subbasin** returns by 296 fish at existing harvest rates while total production increase would be six fish at MSY.

ACTIONS: 1

1. Maintain at least current level of stream habitat quality and quantity. Seek improved water quality via reduction of sedimentation. Investigate to determine if sources of significant smolt mortality exist within the subbasin.

STRATEGY 2: Supplementation. This strategy seeks to achieve the objectives by supplementing natural production with an appropriate existing hatchery stock or natural stock. **Any** actions identified in Strategy 1 necessary for the success of the supplementation program are also required.

Hypothesis: Fingerling plants would utilize existing habitat to capacity in an area with a capacity of 788,355 smolts.

Assumptions: Fingerling plants are assumed to have an initial survival rate of 50 percent.

Numeric Fish Increases: The System Planning Model indicates an additional 1,777 fish would return to the subbasin at existing harvest rates and total production would be increased by 602 fish at MSY. This strategy would meet objectives.

ACTIONS: 1, 2

1. -

2. Seed the Toutle River watershed with 1.5 million spring chinook fingerlings.

STRATEGY 3: Hatchery Production. This strategy seeks to achieve the objectives solely through traditional hatchery production. Only those actions necessary for maintenance of the hatchery program are included.

Hypothesis: Increased smolt production would increase adults produced.

Assumptions: This strategy assumes increased hatchery smolt production would result in commensurate adults produced. This strategy also assumes a suitable water source and pond site can be located on the Toutle River.

Numeric Fish Increases: Subbasin returns would increase by 5,146 fish at existing harvest rates while total production increases would be 9,007 fish at MSY. This strategy would meet objectives.

ACTIONS: 3

3. Construct a rearing facility on the Toutle River to rear 100,000 smolts.

STRATEGY 4: Natural Habitat Expansion. This strategy seeks to achieve objectives by expanding accessible natural spawning and rearing habitat, and freshwater fishing areas.

This strategy restores spring chinook runs to the upper Cowlitz Basin by installing adult and juvenile collection and hauling facilities to pass fish around the dams. The Northwest Power Planning Council's smolt capacity model indicated about 1.6 million smolts could be produced above Mayfield.

Hypothesis: Increased habitat will provide additional natural production.

Assumptions: This strategy assumes that spring chinook will reestablish themselves in the newly available habitat. Problems concerning, disease, hatchery and natural stock separation, and harvest management need to be resolved. Also assumed is that dam passage will be achieved with a minimum of mortality and delay as a result of handling.

ACTIONS: 1, 4

1. -

4. Resolve technical and financial problems that currently prevent dam passage. Restore spring chinook runs starting with hatchery supplementation, and then develop self-sustaining runs.

Recommended Strategy

Strategy 3, hatchery enhancement, is the recommended strategy for the Cowlitz Subbasin. Spring chinook in the subbasin are managed as a hatchery stock so hatchery enhancement is appropriate. Since this stock is highly desired by anglers and inbasin harvest is relatively good, management for a hatchery stock with allowable high harvest rates is desirable. This strategy would also meet the objectives. Construction of spring chinook rearing facilities on the Toutle River would restore culture efforts under way when the volcanic eruption destroyed them in 1980. The general public is anticipated to support those efforts. The SMART analysis (Appendix B) also supports Strategy 3.

Table 38. System Planning Model results for spring chinook in the Cowlitz Subbasin. Baseline value is for pre-mainstem implementation, all other values are post-implementation.

Utilization Objective:
Provide a sport harvest of 10,000 fish in the Cowlitz River and 500 fish in the Toutle River.

Biological Objective:
Maintain biological characteristics of the Cowlitz 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	500 -N	39,582	49,978	37,649	0(1.00)
All Nat	503 -N	39,844	50,308	37,899	580(1.01)
1	503 -N	39,844	50,308	37,899	580(1.01)
2	16,137 -N	27,433	50,428	37,989	789(1.01)
3*	551 -N	43,658	55,124	41,526	9,023(1.10)
4	N/M				

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

[1] Strategy descriptions:

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

1. Aggressive Habitat Protection. Pre Mainstem Implementation.
2. Strategy 1 plus 1,500,000 fingerlings.
3. Strategy 2 plus 100,000 hatchery smolts.
4. Strategy 1 plus resolving technical and financial problems that currently prevent dam passage

[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 39. Estimated costs of alternative strategies for Cowlitz spring chinook. Cost estimates represent new or additional costs to the 1987 Columbia River Basin Fish and Wildlife Program; they do not represent projects funded under other program, 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				
Capita	0	690,000	230,000	0
O&M/yra	0	75,000	25,000	0
Other Costs				
Capi	0	0	0	0
O&M/tal[3] [4]	30,000	0	0	30,000
Total Costs				
Capital	0	690,000	230,000	0
O&M/yr	30,000	75,000	25,000	30,000

• Recommended strategy.

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

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

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

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

COHO SALMON

Fisheries Resource

Natural Production

History and Status

Coho were historically abundant in the subbasin; the Washington Department of Fisheries (1951) estimated that coho escapement was about 32,500 fish. In the Cowlitz River, an average of 24,579 coho were counted past Mayfield Dam in 1961 through 1966 (Thompson and Rothfus 1969). Two spawning peaks were observed, which were classified as early-run and late-run fish. Distribution was throughout the watershed, although the Department of Fisheries (1951) felt the Coweeman was underescaped due to the presence of splash dams blocking areas of production. Recently, distribution has been primarily confined below Mayfield, although some coho have been trucked above Mayfield into the Tilton and upper Cowlitz rivers in most years. The Cowlitz Salmon Hatchery was completed in 1967 to maintain the coho run at a mitigation level of 25,500 adults to the hatchery rack.

Presently, most coho in the Cowlitz River are of hatchery origin. Devore (1987) accounted for the 1982 brood hatchery release and concluded natural production was minor. Of 4,635 naturally spawning fish in 1985, an estimated 91 percent were thought to have originated from hatchery smolt releases. Hatchery fingerling releases could account for additional natural fish.

Toutle River coho were also historically abundant and were probably present throughout the watershed. Run size of natural fish for 1972 through 1979 was estimated at 1,743 fish, based on rack returns (15,108) representing 78 percent of the total and 9 percent being of natural origin, as on the Cowlitz River. Toutle River coho were an early-returning stock with most fish returning from August through October. Hopley and Hager (1981) found harvest of both early Cowlitz and Toutle coho stocks contributed more south of the Columbia River as compared to late Cowlitz coho, which contributed more north of the Columbia. The early component of Cowlitz coho is somewhat more southerly distributed in the ocean than the late Cowlitz component, but generally not as far south as the Toutle stock. Late Cowlitz stock returned to the Columbia River after chinook salmon, so their harvest in the gill net fishery was not affected by chinook conservation closures. The stocks became known as Toutle ("S" for south-turning) and Cowlitz ("N" for north-turning). Although the

Cowlitz Hatchery maintains a wide range of adult return timing, all are considered "N" stock fish.

Coho returns to the Toutle River are presently rebuilding after the 1980 volcanic eruption. Seeding the watershed with hatchery fingerlings began in 1983 and continues to date. Run size of natural coho in the watershed is largely unknown, but likely small.

Little is known of historic or present status of Coweeman coho. Run size was roughly estimated at 300 hatchery fish and 200 natural fish.

Life History and Population Characteristics

Life history and population characteristics of naturally produced coho in the subbasin are not available after 1967. However, data is presumed similar to hatchery fish and is presented in that section.

The Northwest Power Planning Council's model estimated smolt production capacity of 123,123 fish for the Cowlitz River, 142,234 in the Toutle, and 37,797 in the Coweeman; 303,154 fish overall.

Above Mayfield on the Cowlitz River, the Northwest Power Planning Council's model estimated 131,318 smolts could be produced in the Tilton River and Winston Creek, while 155,018 could be produced above Cowlitz Falls, 286,336 fish total. Data on streams was acquired through Meekin (1962), Birtchet (1963), Rothfus and Thompson (1969), Easterbrooks (1980) and U.S. Forest Service personnel. Some pre-dam habitat is no longer available due to inundation from the pools behind the dams. Easterbrooks (1980) estimated maximum coho production above Cowlitz Falls at 2,696,800 smolts. However, reintroducing anadromous fish is not a preferred option because of the problems listed in Part I of this document. If and when these problems are substantially resolved, reintroduction of coho can become a realistic option. Anadromous passage is not likely in the near future.

In recent years, some smolts were produced by trucking hatchery adults and juveniles above Mayfield into the Tilton River and Mayfield Lake. For 1983 through 1988 an average of 1,929 adults, mostly males, were planted into the Tilton whereupon they tended to drop downstream out of the Tilton (Stober 1986). An average of 341,600 juveniles were also planted directly into Mayfield Lake to provide a sport fishery. Juveniles in the lake could emigrate downstream through a migrant facility at the dam into the lower river. Juvenile plants were terminated after 1985 when low survival rates of marked fish were observed; an average of 0.34 percent and 0.14 percent of Mayfield

Lake and Tilton River planted fish were sport caught, respectively, while an average of 2.60 percent and 2.03 percent of lake and river planted fish passed through the migrant trap (Tipping 1988). Smolts counted at the dam have been relatively small (Table 40). Some juveniles have been observed through 1989 at the Mayfield trap and probably originated from adults in the Tilton River and juveniles in Riffe Reservoir.

Table 40. Coho smolts through the Mayfield migrant trap (Tipping, unpubl. data).

Year	Number of smolts	Year	Number of smolts
1978	10,717	1984	no data
1979	2,771	1985	15,545
1980	2,124	1986	17,150
1981	15,349	1987	2,521
1982	5,707	1988	1,614
1983	570	1989	145

Supplementation History

Hatchery coho have been planted in the subbasin since at least 1915 when the Tilton River Hatchery operated downstream of Morton until 1921. A salmon hatchery also operated in the upper Cowlitz near the mouth of the Clear Fork until 1949 when it was abandoned for rearing due to low water temperatures. Plants since 1967, after the Cowlitz Salmon Hatchery began operation, have been extensive (Appendix D). The Cowlitz Salmon Hatchery plants about 4.8 million yearling smolts annually while over 1 million smolts were planted into the Toutle from the Toutle Hatchery prior to the eruption. In addition, 1984 through 1987 releases of fry and fingerlings averaged 2,310,400 fish in Cowlitz tributaries, 309,500 in the Cowlitz mainstem, 755,900 in the Toutle watershed, and 252,700 fish in the Coweeman watershed. Cowlitz Hatchery smolt plants for the 1981 through 1983 brood years averaged 3.65 percent smolt-to-adult survival (A. Appleby, WDF, pers. commun.). Releases of 1974 (Seidel and Mathews 1977) and 1979 Toutle Hatchery coho smolts were 4.11 percent and 4.32 percent, respectively. Performance of fry and fingerling releases is unknown in the Cowlitz and Coweeman while spring-to-fall survival in three nearly barren post-eruption Toutle tributaries averaged 20.2 percent (Bisson et al. 1988). Purpose of releases was to supplement natural production.

Fish Production Constraints

Subbasin production constraints for coho are listed in Table 9, although inadequate escapement may impact production in some streams. Sedimentation and temperature problems, commonly associated with logging, were frequently mentioned. Production from the Tilton River and Mayfield Lake may be limited by squawfish predation (Tipping 1988).

Hatchery Production

The previously described Cowlitz Salmon Hatchery is the primary producer of coho in the Cowlitz River. Objectives of the program were to maintain a hatchery return of 25,500 adults (about 41,803 jacks and adults) while providing for commercial and sport fisheries. Mitigation goal of all species at the hatchery is 51,100 adult salmon (8,300 fall chinook, 17,300 spring chinook, and 25,500 coho). Original hatchery design called for 5 million coho smolts totaling 231,820 pounds. Recent production averaged 4.8 million coho smolts weighing 282,000 pounds plus about 2.5 million fingerlings weighing about 5,000 pounds. Prior to 1986, about 600,000 and 2.3 million fingerlings at about 100 to 200 fish per pound were planted from the hatchery into Mayfield and Riffe lakes, respectively. Since 1986, coho plants into Mayfield have been terminated and Riffe plants have been reduced to 1.2 million fish. Production at the hatchery amounts to about 600,000 pounds compared to design capacity of 494,800 pounds.

Brood stock source is the Cowlitz River via hatchery rack returns. Managers select fish by arrival time to the hatchery: 10 percent of eggs are selected from mid-September to mid-October returning adults, 80 percent from mid-October through November arriving adults, and 10 percent from adults arriving after November. For 1989, 20 percent, 70 percent and 10 percent of eggs were taken from the early, middle, and late group, respectively. Males and females are spawned at a l-l ratio. Ovarian fluid is tested for IHN virus. No IHN positive coho have been isolated at Cowlitz.

In the Cowlitz River, adult run size in 1984 and 1985 was estimated at 34,023 and 24,946 fish, respectively (Devore 1987). With hatchery fish comprising 91 percent (Devore, 1987), the hatchery run size was 30,621 and 22,701 fish for 1984 and 1985, respectively. Jacks made up an additional 5,088 fish in 1984 and 18,218 fish in 1985. Hatchery rack returns comprised 78 percent of total returns, sport catch 12.3 percent and natural spawning 9.7 percent. Returns to the hatchery for 1977 through 1987 averaged 15,851 jacks and 24,758 adults (Table. 41), which would expand to 52,063 fish to the river when divided by the percent of the run returning to the rack (0.78). With an average rack return of 24,800 adults, about 5,200 females are sold or transferred upstream to the Tilton River.

Table 41. Returns of coho to the Cowlitz Salmon Hatchery.

Year	Jack	Adult	Year	Jack	Adult
1977	18,041	22,419	1983	10,111	24,493
1978	16,834	18,392	1984	24,710	26,149
1979	15,843	13,912	1985	15,296	18,610
1980	16,488	25,736	1986	9,103	54,685
1981	12,183	26,701	1987	19,178	18,716
1982	16,577	22,528			
			AVE	15,851	24,758

Adult time of return ranges from August through January (Table 42). Spawning time is November through January and fry emergence occurs from January through April. Yearling fish are reared through the following March and released in April through June. Some fish are released as fingerlings in the first June after hatching. Fecundity of coho spawned from 1982 through 1987 averaged 2,578 eggs per female (n=34,623). Production goal in 1988 was 4.7 million yearlings and 2.5 million fingerlings.

Table 42. Freshwater life history of Cowlitz Subbasin coho. The developmental stage timing represents basinwide averages, local conditions may cause some variability.

Developmental Stages	Time of year	Peak occurrence
Adult immigration	September-January	October-November
Adult holding	September-January	October-November
Spawning	October-February	October-December
Egg/alevin incubation	October-March	October-February
Emergence	January-April	February-March
Rearing	Jan-May (17 mos.)	Feb-May (16 mos.)
Juvenile emigration	April-June	April-May

Saltwater age composition of hatchery coho in 1977 through 1986 was based on hatchery rack returns; 38 percent of hatchery returns were l-year ocean jacks, 40.2 percent %-year ocean males, and 21.8 percent 2-year ocean females. Few coho exceed two summers in the ocean: of 170 marked groups, only 4.7 percent had any fish return with a third summer in salt water. Adult male-female ratio averaged 1.84-to-1. Mean length of adult returns from Cowlitz N stock for 1968 through 1971 releases was 66.3 cm (Hager and Hopley 1981) and declined to 58.8 cm for 1982 through 1984 releases. Mean length of jacks in 1982 through 1984 was 36.4 cm. Mean length and weight of Cowlitz N stock in the Columbia River net fishery was 64.9 cm and 7.8 pounds in 1971, and 68.1 cm and 9.1 pounds in 1972 (Hager and Hopley 1981).

Hatchery egg-to-fry survival was 95.1 percent for 1982 through 1986. Fry-to-smolt survival was 89.5 percent resulting in an egg-to-smolt survival of 85.1 percent. Smolt-to-adult survival of marked production fish for 1981 through 1983 brood years ranged from 1.67 percent to 7.14 percent and averaged 3.65 percent (A. Appleby, WDF, pers. commun.).

The major constraint presently at the Cowlitz Salmon Hatchery is facility size. Within the hatchery, low temperature disease (Cvtoohasa psychrophilia) has been rated the most severe pathogen, followed by bacterial hemorrhagic septicemia and enteric redmouth (Yersinia ruckeri). Actions that could improve production include facility enlargement including the addition of large release ponds, improved fry starting containers, disease control, and improving outplanting facilities.

Toutle River

On the Toutle River, the previously described Toutle Hatchery was destroyed in the 1980 eruption of Mount St. Helens. Deer Springs rearing pond was later destroyed by failure of a Corps of Engineers flood control structure in the winter of 1981-1982. Production in 1975 through 1980 averaged 1,260,000 yearling smolts. For 1975 through 1979, fecundity averaged 2,632 eggs per female. Egg-to-fry survival averaged 90.6 percent for the 1978 and 1979 broods. Fry-to-smolt survival for the 1978 brood averaged 86.2 percent, resulting in a egg-to-smolt survival of 78.1 percent. Rack counts indicated jacks only comprised 4.6 percent of returns for 1972 through 1979 (King 1987) and females were estimated to comprise 45.5 percent of adults (from Kalama Hatchery S stock data). Smolt-to-adult survival of fish released in April and May 1974 at 18 to 21 fish per pound averaged 4.11 percent (Seidel and Mathews 1977). For the 1979 release, smolt-to-adult survival averaged 4.32 percent. Mean length of the 1967 (Hager and Hopley 1981) and 1972 (Seidel and Mathews 1977) brood averaged 68.9 cm. The 1972 brood averaged 67.9 cm and 8.31 pounds at the hatchery. For 1972 through 1979, hatchery returns averaged 14,406 adults and 702 jacks, a total of 15,108 fish (King 1987). If 78 percent of the total returned to the rack as on the Cowlitz, then total run size was 19,369 fish. Assuming 9 percent were of natural origin as on the Cowlitz (Devore 1987), hatchery run size was 17,626 fish.

The present salmon culture facility on the Toutle is the previously described Beaver Slough in which yearling smolt production was 155,250 fish in 1986, 333,350 in 1987 and 306,900 in 1988. Anticipated facilities include expanding Beaver Slough to produce about 800,000 coho yearlings and constructing a rack on the Green River to collect brood stock. Additionally, the Toutle Hatchery could be reconstructed, depending on funding. Numbers of fish to be produced would also depend on funding. Program objectives would be to contribute to sport and commercial fisheries.

Coweeman River

No facility exists on the Coweeman River.

Harvest

Subbasin harvest averaged 2,550 adult coho for 1977 through 1979 and was distributed as 61.5 percent Cowlitz, 38.4 percent Toutle and 0.1 percent Coweeman. For 1977 through 1979, harvest in the Toutle River averaged 1,061 fish for a 5.5 percent harvest rate. A commercial gill net fishery occurred in the lower Cowlitz in 1980 and 1981; catch was 6,618 and 2,764 coho for those years, respectively. The Toutle and Coweeman have been closed to adult harvest since 1981. Subbasin harvest for 1982 through 1986 averaged 2,202 adults and 2,634 jacks. Harvest rate within the Cowlitz for 1984 and 1985 averaged 12.3 percent.

The System Planning Model estimated 73.1 percent of total production was harvested in the ocean and Columbia River.

In the Cowlitz River, dam mitigation goals are based on an escapement of 25,500 adult fish to the Cowlitz Hatchery, equivalent to about 53,600 jacks and adults to the river. Harvest management goals are to harvest all fish in excess of hatchery spawning needs. Fish in excess of hatchery needs are usually sold. Tacoma City Light has tentatively expressed a desire to reevaluate the mitigation package to seek a measurement of mitigation not based solely on adult returns to the hatchery. When large runs have been forecast, inriver bag limits have been liberalized to increase sport harvest.

In the Toutle River, management goals are to return pre-eruption production, which is dependant on funding of facilities.

Management procedures within the subbasin consist of regulation through the Washington Fisheries' sport harvest restrictions. On the Cowlitz River, the daily limit is six salmon of lo-inch minimum size of which two may exceed 20 inches. The Toutle River is currently closed to salmon angling to protect escapement. The Coweeman is open to sport angling for coho less than 20 inches from September 1 to December 31 downstream from the mouth of Mulholland Creek: daily bag limit is six. Enforcement activities consist of Washington Fisheries and Washington Wildlife personnel checking for compliance with harvest restrictions.

Specific Considerations

Coho in the subbasin are managed as a hatchery stock. Relatively few hatchery fish are needed for hatchery escapement and because of high harvest rates outside of the subbasin, natural fish may be underescaped. However, natural spawning by some of the large numbers of hatchery fish may offset underescapement of natural fish.

Two stocks of coho exist in the subbasin -- 1) Toutle (S) stock, early returning (August-October), generally harvested in the ocean off of Oregon and to a lesser extent, Washington and California: and 2) Cowlitz (N) stock, generally late returning (September-November), harvested off the coasts of Washington and Oregon. The Cowlitz Hatchery maintains a wide range of return times although all are considered Type-N fish. N stock has dominated Cowlitz Hatchery production because catch distribution favors Washington fishermen.

In the Cowlitz River, smolt-to-adult survival (catch plus escapement) averaged 3.65 percent for N stock coho. Smolts released to adult hatchery returns averaged 0.57 percent for 1981 through 1986 releases. Cowlitz N coho have decreased in size from 66 cm to 59 cm, possibly a reflection of selective harvest in gill net fisheries. Within the Cowlitz River, coho were distributed as 12.3 percent sport harvest, 78 percent hatchery return, and 9.7 percent natural spawning. Of natural spawners, an average of 91 percent originated from hatchery releases while additional natural fish could have originated from fry plants. Harvest of most Cowlitz coho is sought outside of the subbasin because of the low harvest rate of inriver anglers.

In the Cowlitz River and its tributaries (excluding the Toutle and Coweeman), the Northwest Power Planning Council's model estimated carrying capacity at 123,123 smolts. In 1984 through 1987, an average of 2,619,900 fry and fingerlings were released in the Cowlitz River watershed while potential egg deposition of naturally spawning fish (x=3,451 from Devore 1987) was over 3 million eggs. Due to limited habitat for natural production, hatchery production may be the major production constraint.

Production of coho in the Toutle River is presently rebuilding and much depends on future funding. Natural production capacity was estimated at 142,234 smolts. Present production of natural fish is depressed due to high harvest rates outside the subbasin and habitat degradation from the volcano. Habitat should improve over time and the sediment retention structure may help. Adults are trapped and hauled above the sediment retention structure. However, the dam could impede downstream movement and survival of juveniles.

Prior to 1980, smolt-to-adult survival averaged 4.2 percent for Toutle Hatchery S coho. Toutle coho were noted to be large fish, averaging 68 cm and much desired by anglers. Because of anticipated high harvest rates on this stock, natural production capacity may be comprised of naturally spawning hatchery fish or hatchery fingerling plants.

Natural production capacity in the Coweeman River was estimated to be 37,797 smolts. Because of high harvest rates outside the subbasin, the Coweeman River may be underescaped.

Critical Data Gaps

Complete spawning surveys in the Toutle and Coweeman rivers are needed to generate natural spawning escapement. Origin of spawners also needs to be determined so hatchery run size can be estimated for the subbasin.

Objectives

Stock: Cowlitz River Coho

Utilization Objective: 5,000 fish for sport harvest and support of out of basin harvests. The utilization objective has priority within the subbasin.

Biological Objective: Maintain biological stock characteristics such as size, timing, and age structure.

Coho have met this objective and consequently, no alternative strategies are offered for the Cowlitz River. The System Planning Model indicated with existing harvest rates, smolt capacity, and carcass sales of excess hatchery fish, production of natural fish in the Cowlitz River would peak at 726 fish. Consequently, the Toutle and Coweeman rivers were modeled separately as a S stock, but Cowlitz stock was added in for the total production estimates.

Stock: Toutle River Coho

Utilization Objective: 2,200 fish sport harvest and support of out-of-basin harvests. The utilization objective has priority within the subbasin.

Biological Objective: Maintain biological stock characteristics such as size, timing, and age structure of Type S coho.

This objective would reestablish Toutle River production at pre-eruption levels.

Stock: Coweeman River Coho

Utilization Objective: Support out-of-basin harvests. The utilization objective has priority within the subbasin.

Biological Objective: Maintain biological stock characteristics such as size, timing, and age structure of Type S coho.

The Toutle and Coweeman rivers were calibrated at pre-eruption hatchery production and then reduced to reflect present conditions.

Alternative Strategies

Strategies for coho have specific themes to meet objectives with natural production followed by less natural methods as necessary. Actions identified under each strategy are closely related to the theme. Strategies 1 and 2 have natural production themes seeking to improve the productivity of the existing natural stock. Strategy 3 is a "benign" supplementation strategy, emphasizing actions to develop a single supplemented run with yet higher productivity. Strategy 4 employs all the actions to improve stock productivity, but also includes any opportunities to increase stock size by providing passage into inaccessible habitat or releasing fry into such areas to make use of additional natural rearing potential. Strategy 5 relies on a traditional hatchery program to meet objectives. Only those actions necessary for the success of a hatchery program would be included in Strategy 5.

Modeling results for each strategy are presented in Tables 43 and 44 as fish produced at "maximum sustainable yield" (MSY). The sustainable yield of a fish population refers to that portion of the population that exceeds the number of fish required to spawn and maintain the population over time. Sustainable yield can be "maximized," termed MSY, for each stock at a specific harvest level. The MSY is estimated using a formula (Beverton-Holt function) that analyzes a broad range of harvest rates. Subbasin planners have used MSY as a tool to standardize results so that decision makers can compare stocks and strategies.

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

The amount of buffer appropriate for each stock is a management question not addressed in the subbasin plans. For this reason, the utilization objective, which usually refers to harvest, may not be directly comparable to the MSY shown in Tables 43 and 44. 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 45.

STRATEGY 1: Natural Production, Level 1. This strategy seeks to achieve the objectives by eliminating sources of direct mortality to natural fish, answering management questions and reducing risks of genetic modification of natural stocks.

This strategy provides for prudent stewardship of existing habitat and water quality in the historic distribution range through various existing laws and agreements. Streams in the **subbasin** need to be inventoried for summer temperature profiles: those exceeding temperature sensitivity criteria should be classified as such through the Department of Natural Resources so future impacts will be minimized. Riparian zones should be managed to provide a continuous recruitment of large organic debris into the **subbasin** system. **Fishways** should be maintained.

Hypothesis: Existing habitat, if properly managed, should provide a number of smolts towards objectives.

Assumptions: This strategy was modeled with the assumption that egg-to-smolt survival could be increased by a relative 10 percent.

Numeric Fish Increases: The System Planning Model indicated this strategy would increase **subbasin** returns by 52 fish at current harvest rates. Total production would increase by 206 fish at MSY.

ACTIONS: 1

1. Maintain at least current level of stream habitat quality and quantity. Seek improved water quality via reduction of sedimentation. Conduct research to determine if significant sources of within **subbasin** smolt mortality exist.

STRATEGY 2: Natural Production, Level 2. This strategy seeks to achieve the objectives by the same means as Strategy 1, but also includes actions to enhance productivity of habitat already available to the stock in question.

Hypothesis: Increased overwintering habitat would result in increased smolt production, which would increase adults.

Assumptions: This strategy assumes production would be 0.226 smolts per square meter and that natural smolt capacity would be increased by 13,600 smolts.

Numeric Fish Increases: The System Planning Model indicated this strategy would add 137 fish to the subbasin at current harvest rates. Total production would increase by 594 fish at MSY.

ACTIONS: 1, 2

1. -

2. Construct off-channel rearing areas (40 to 1,500 square meters) in the Toutle and Coweeman rivers.

STRATEGY 3: Supplementation. This strategy seeks to achieve the objectives by supplementing natural production with an appropriate existing hatchery stock or natural stock. Any actions identified in Strategies 1 and 2 necessary for the success of the supplementation program are also required.

Hypothesis: By supplementing natural production with fingerlings, full natural production smolt capacity may be met. Increasing the number of hatchery smolts planted would increase the number of adults produced.

Assumptions: The fingerling plants, research and annual stock assessments were not modeled, but were assumed they would ensure carrying capacity. The increased hatchery smolt production would be assumed to result in commensurate adult returns.

Numeric Fish Increases: The System Planning Model indicated Strategy 3 would increase subbasin returns by 12,462 fish at current harvest rates. Total production increase would be 50,741 fish at MSY. This strategy would meet the objectives.

ACTIONS: l-5

1. -
2. -

3. Seed with fry and fingerlings as needed. Conduct research to determine optimum planting density of coho fingerlings. Bilby and Bisson (1987) suggested that excessive coho fingerling plants resulted in a decline in net coho smolt production. Fraser (1969) indicated that high density coho plantings resulted in decreased biomass of steelhead and coho in streams. Along with the research, annual stock assessment needs to be conducted to determine fingerling needs.

4. Expand Toutle River hatchery production by 700,000 smolts (eggs would be taken within the basin). This action would reestablish the former Toutle/Green hatchery facility, which was destroyed as a result of the eruption.

5. Construct rearing facilities on the Coweeman River to produce 100,000 smolts (eggs would be taken within the basin).

STRATEGY 4: Supplementation and Habitat Base Increase. This strategy seeks to achieve the objectives by all the measures to increase productivity contained in Strategies 1, 2, and 3, but also increases stock size by providing passage into inaccessible areas or release of fry into such areas.

Hypothesis: Access to new habitat would result increase smolt capacity.

Assumptions: This strategy would assume full seeding of habitat would occur and that 2,821 additional smolts would be added to existing capacity.

Numeric Fish Increases: The System Planning Model indicates this strategy would add 12,480 fish to the subbasin at current harvest rates, an increase of 18 fish above Strategy 3. Total production increase for Strategy 4 would be 50,743 fish at MSY.

ACTIONS: l-6

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

6. Expand historic distribution through laddering of falls on Green River or planting fry above those barriers, which would add five miles of habitat.

STRATEGY 5: Hatchery Production. This strategy seeks to achieve the objectives solely through traditional hatchery production. Only those actions necessary for maintenance of the hatchery program are included.

Hypothesis: Increased smolt production would result in increased production of adults.

Assumptions: This strategy assumes increased smolt production would result in commensurate numbers of adults. It also assumes water and space are available for facilities.

Numeric Fish Increases: The System Planning Model indicated **subbasin** returns would be increased by 11,283 fish at existing harvest rates. Total production increase would be 50,644 fish at MSY. This strategy would meet objectives.

ACTIONS: 4, 5 (see above)

STRATEGY 6: Natural Habitat Expansion. This strategy seeks to achieve objectives by expanding accessible natural spawning and rearing habitat, and freshwater fishing areas.

This strategy restores coho runs to the upper Cowlitz Basin by installing adult and juvenile trap and haul facilities to pass fish around the dams. The Northwest Power Planning Council's smolt capacity model indicated about 300,000 smolts could be produced above Mayfield.

Hypothesis: Increased habitat will provide additional natural production.

Assumptions: This strategy assumes that coho will reestablish themselves in the newly available habitat. Problems concerning hatchery and natural stock separation and harvest management need to be resolved. Also assumed is that dam passage will be achieved with a minimum of mortality and delay as a result of handling.

Actions: 1, 7

1. -

7. Resolve technical and financial problems that currently prevent dam passage. Restore Type S coho runs starting with hatchery supplementation, and then develop **self-**sustaining runs.

Recommended **Strategy**

Strategy 3, aggressive habitat protection, off-channel rearing construction, seeding habitat with fingerlings along with research and assessment, expanding Toutle rearing facilities and constructing Coweeman facilities is the recommended strategy. Because of the high ocean and Columbia River harvest rates on lower Columbia River stocks of coho, many natural populations may be underescaped. This strategy allows for aggressive habitat protection while seeding underutilized areas using prudent proven planting levels of fingerlings. It also calls for expansion of Toutle rearing facilities up to pre-eruption levels which is desired by much of the public.

Table 43. System Planning Model results for early-run coho in the Cowlitz Subbasin. Baseline value is for pre-mainstem implementation, all other values are post-implementation.

Utilization Objective:
2,200 sport harvest in the Toutle and support out of basin harvest from the Coueeman.

Biological Objective:
Maintain biological characteristics of Type-S coho.

Strategy[1]	Maximum[2] Sustainable Yield (MSY)	Total[3] Spawning Return	Total' Return to Subbasin	out of[5] Subbasin Harvest	Contribution[6] To Council's Goal (Index)
Baseline	605 -N	48,138	54,091	151,239	0(1.00)
All Nat	532 -N	47,431	53,234	148,309	- 3,788(0.98)
1	606 -N	48,182	54,141	151,411	222(1.00)
2	542 -N	48,324	54,235	151,733	637(1.00)
3*	666 -N	59,359	66,621	194,082	55,371(1.27)
4	666 -N	59,377	66,641	194,151	55,461(1.27)
5	654 -N	58,241	65,365	189,789	49,824(1.24)
6	N/M				

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

[1] Strategy descriptions:

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

1. Aggressive habitat protection. Pre Mainstem Irrplementation.
2. Strategy 1 plus 40 off-channel rearing areas. Pre Mainstem Implementation.
3. Strategy 2 plus 800,000 hatchery smolts. Pre Mainstem Implementation.
4. Strategy 3 plus ladder Green River Falls. Pre Mainstem Implementation.
5. Baseline plus 800,000 hatchery smolts. Pre Mainstem Irrplementation.
6. Strategy 1 plus resolving technical and financial problems that currently prevent dam passage.

[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 44. System Planning Model results for late coho in the Cowlitz Subbasin. Baseline value is for pre-mainstem implementation, all other values are post-implementation.

Utilization Objective: 5,000 sport harvest in the Cowlitz River.

Biological Objective: Maintain biological characteristics of Type N stock.

Strategy[1]	Maximum[2] Sustainable Yield (MSY)	Total[3] Spawning Return	Total[4] Return to Subbasin	out of[5] Subbasin Harvest	Contribution' To Council's Goal (Index)
Baseline	478 -N	42,541	47,745	129,539	0(1.00)

(see Table 43 for footnotes)

Table 45. Estimated costs of alternative strategies for Cowlitz 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	6
Hatchery Costs						
Capital[1]	0	0	1,314,220	0	1,314,220	
O&M/yr[2]	0	0	142,850	0	142,850	
Other Costs						
Capital[3]	0	600,000	650,000	1,150,000	0	0
O&M/yr[4]	30,000	40,000	50,000	60,000	0	30,000
Total Costs						
Capital	0	600,000	1,964,220	1,150,000	1,314,220	0
O&M/yr	30,000	40,000	192,850	60,000	142,850	30,000

* 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

Winter Steelhead

The objective calls for a sport harvest in the Cowlitz River of 15,400 fish, a harvest in the Toutle of 250 fish, and **a** harvest of 700 hatchery fish in the Coweeman. Only Coweeman hatchery stock objectives are not currently being met. The recommended strategy, Strategy 3, is to increase the smolts into the Coweeman by 25,000 smolts and to construct a rearing pond to increase smolt quality.

Summer Steelhead

The objective is to provide a sport harvest in the Cowlitz and Toutle rivers of 15,000 and 3,000 hatchery fish, respectively. The recommended strategy, Strategy 2, is to add 60,000 hatchery smolts to the Toutle River and 550,000 hatchery smolts to the Cowlitz.

Sea-Run Cutthroat Trout

The objective is to provide a sport harvest of 10,000 hatchery fish in the Cowlitz River and 900 hatchery fish in the Coweeman. The recommended strategy, Strategy 2, is to add 105,000 hatchery smolts to the Cowlitz and 15,000 hatchery smolts and a rearing pond to the Coweeman.

Fall Chinook

The objective is to provide a sport harvest in the Cowlitz and Toutle rivers of 2,000 and 1,800 fish, respectively, while providing out-of-basin harvests for those two rivers plus the Coweeman River. The recommended strategy, Strategy 3, is to expand the Beaver Slough facility on the Toutle by 600,000 fingerlings and add a rearing facility on the Coweeman capable of producing 1 million fingerlings.

Spring Chinook

The objective is to provide a sport harvest in the Cowlitz and Toutle rivers of 10,000 fish and 500 fish, respectively. The recommended strategy, Strategy 3, is to add 100,000 hatchery smolts to the Toutle River.

Coho

The objective is to provide a within basin sport harvest of 5,000 and 2,200 in the Cowlitz and Toutle rivers, respectively while also providing for out-of-subbasin harvest from the Cowlitz, Toutle and Coweeman rivers. The recommended strategy, Strategy 3, is to seed the watershed with fingerlings as needed, conduct research to determine optimum planting levels, expand the Toutle facility by 700,000 smolts, and add a rearing facility on the Coweeman to rear 100,000 smolts.

Implementation

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

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

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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: Cowlitz Stock: Winter steelhead Strategy: 1

Criteria	Rating	Confidence	Weight	Utility	Discount Utility
1 EXT OBJ	8	0.9	20	160	144
2 CHG MSY	5	0.6	20	100	60
3 GEN IMP	7	0.6.	20	140	84
4 TECH FEAS	9	0.9	20	180	162
5 PUB SUPT	6	0.6	20	120	72
TOTAL VALUE				700	
DISCOUNT VALUE					522
CONFIDENCE VALUE					0.75

Subbasin: Cowlitz 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	0.6	20	80	48
3 GEN IMP	7	0.6	20	140	84
4 TECH FEAS	8	0.9	20	160	144
5 PUB SUPT	6	0.9	20	120	108
TOTAL VALUE				600	
DISCOUNT VALUE					474
CONFIDENCE VALUE					0.79

Subbasin: Cowlitz Stock: Winter steelhead Strategy: 3

Criteria	Rating	Confidence	Weight	Utility	Discount Utility
1 EXT OBJ	8	0.9	20	160	144
2 CHG MSY	5	0.6	20	100	60
3 GEN IMP	7	0.6	20	140	100
4 TECH FEAS	8	0.9	20	160	144
5 PUB SUPT	9	0.9	20	180	162
TOTAL VALUE				740	
DISCOUNT VALUE					610
CONFIDENCE VALUE					0.83

Subbasin: Cowlitz Stock: Summer steelhead Strategy: 1

Criteria	Rating	Confidence	Weight	Utility	Discount Utility
1 EXT OBJ	4	0.6	20	80	48
2 CHG MSY	2	0.6	20	40	24
3 GEN IMP	7	0.6	20	140	84
4 TECH FEAS	2	0.9	20	40	36
5 PUB SUPT	7	0.6.	20	140	84
TOTAL VALUE				440	
DISCOUNT VALUE					276
CONFIDENCE VALUE					0.63

Subbasin: Cowlitz Stock: Summer steelhead Strategy: 2

Criteria	Rating	Confidence	Weight	Utility	Discount Utility
1 EXT OBJ	8	0.6	20	160	96
2 CHG MSY	8	0.6	20	160	96
3 GEN IMP	3	0.9	20	60	54
4 TECH FEAS	8	0.9	20	160	144
5 PUB SUPT	9	0.9	20	180	162
TOTAL VALUE				720	
DISCOUNT VALUE					552
CONFIDENCE VALUE					0.77

Subbasin: Cowlitz Stock: Fall chinook Strategy: 1

Criteria	Ratinq	Confidence	Weisht	Utility	Discount Utility
1 EXT OBJ	5	0.6	20	100	60
2 CHG MSY	5	0.6	20	100	60
3 GEN IMP	3	0.9	20	60	54
4 TECH FEAS	5	0.6	20	100	60
5 PUB SUPT	5	0.6.	20	100	60
TOTAL VALUE				460	
DISCOUNT VALUE					294
CONFIDENCE VALUE					0.64

Subbasin: Cowlitz Stock: Fall chinook Strategy: 2

Criteria	Ratinq	Confidence	Weiaht	Utility	Discount Utility
1 EXT OBJ	6	0.6	20	120	72
2 CHG MSY	6	0.6	20	120	72
3 GEN IMP	3	0.9	20	60	54
4 TECH FEAS	7	0.9	20	140	126
5 PUB SUPT	7	0.6	20	140	84
TOTAL VALUE				580	
DISCOUNT VALUE					408
CONFIDENCE VALUE					0.70

Subbasin: Cowlitz Stock: Fall chinook Strategy: 3

Criteria	Ratinq	Confidence	Weisht	Utility	Discount Utility
1 EXT OBJ	6	0.6	20	120	72
2 CHG MSY	6	0.6	20	120	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				620	
DISCOUNT VALUE					486
CONFIDENCE VALUE					0.78

Subbasin: Cowlitz Stock: Spring chinook Strategy: 1

Criteria	Rating	Confidence	Weight	Utility	Discount Utility
1 EXT OBJ	5	0.6	20	100	60
2 CHG MSY	4	0.6	20	80'	48
3 GEN IMP	2	0.9	20	40	36
4 TECH FEAS	5	0.6	20	100	60
5 PUB SUPT	5	0.6	20	100	60
TOTAL VALUE				420	
DISCOUNT VALUE					264
CONFIDENCE VALUE					0.63

Subbasin: Cowlitz Stock: Spring chinook Strategy: 2

Criteria	Rating	Confidence	Weight	Utility	Discount Utility
1 EXT OBJ	5	0.6	20	100	60
2 CHG MSY	5	0.6	20	100	60
3 GEN IMP	2	0.9	20	40	36
4 TECH FEAS	7	0.9	20	140	126
5 PUB SUPT	6	0.6	20	120	72
TOTAL VALUE				500	
DISCOUNT VALUE					354
CONFIDENCE VALUE					0.71

Subbasin: Cowlitz Stock: Spring chinook Strategy: 3

Criteria	Rating	Confidence	Weight	Utility	Discount Utility
1 EXT OBJ	6	0.6	20	120	72
2 CHG MSY	6	0.6	20	120	72
3 GEN IMP	2	0.9	20	40	36
4 TECH FEAS	8	0.9	20	160	96
5 PUB SUPT	8	0.9	20	160	144
TOTAL VALUE				600	
DISCOUNT VALUE					420
CONFIDENCE VALUE					0.70

Subbasin: Cowlitz   Stock: Coho   Strategy: 1

Criteria	Rating	Confidence	Weight	Utility	Discount Utility
1 EXT OBJ	5	0.6	20	100	60
2 CHG MSY	4	0.6	20	80	48
3 GEN IMP	3	0.9	20	60	54
4 TECH FEAS	5	0.6	20	100	60
5 PUB SUPT	5	0.6.	20	100	60
TOTAL VALUE				440	
DISCOUNT VALUE					282
CONFIDENCE VALUE					0.64

Subbasin: Cowlitz   Stock: Coho   Strategy: 2

Criteria	Rating	Confidence	Weight	Utility	Discount Utility
1 EXT OBJ	5	0.6	20	100	60
2 CHG MSY	5	0.6	20	100	60
3 GEN IMP	3	0.9	20	60	54
4 TECH FEAS	6	0.6	20	120	72
5 PUB SUPT	3	0.6	20	60	36
TOTAL VALUE				440	
DISCOUNT VALUE					282
CONFIDENCE VALUE					0.64

Subbasin: Cowlitz   Stock: Coho   Strategy: 3

Criteria	Rating	Confidence	Weight	Utility	Discount Utility
1 EXT OBJ	6	0.6	20	120	72
2 CHG MSY	6	0.6	20	120	72
3 GEN IMP	3	0.9	20	60	54
4 TECH FEAS	8	0.6	20	160	96
5 PUB SUPT	7	0.6	20	140	84
TOTAL VALUE				600	
DISCOUNT VALUE					378
CONFIDENCE VALUE					0.63

Subbasin: Cowlitz Stock: Coho Strategy: 4

Criteria	Rating	Confidence	Weight	Utility	Discount Utility
1 EXT OBJ	6	0.6	20	120	72
2 CHG MSY	5	0.6	20	100	60
3 GEN IMP	3	0.9	20	60	54
4 TECH FEAS	6	0.9	20	120	108
5 PUB SUPT	6	0.9.	20	120	108
TOTAL VALUE				520	
DISCOUNT VALUE					402
CONFIDENCE VALUE					0.77

Subbasin: Cowlitz Stock: Coho Strategy: 5

Criteria	Rating	Confidence	Weight	Utility	Discount Utility
1 EXT OBJ	6	0.6	20	120	72
2 CHG MSY	6	0.6	20	120	72
3 GEN IMP	3	0.9	20	60	54
4 TECH FEAS	8	0.6	20	160	84
5 PUB SUPT	7	0.6	20	140	96
TOTAL VALUE				600	
DISCOUNT VALUE					378
CONFIDENCE VALUE					0.63

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 changesin hydroelectric system operations, are not addressed.

ESTIMATED COSTS FOR ALTERNATIVE STRATEGIES

Subbasin: Coulitz River
Stock: Winter Steelhead

Action	Cost Categories*	Proposed Strategies 1	2	3**
Habitat Enhancement	Capital:			
	O&M/yr:			
	Life:			
Screening	Capital:			
	O&M/yr:			
	Life:			
Barrier Removal	Capital:			
	O&M/yr:			
	Life:			
Acclimation Pond	Capital:		250,000	250,000
	O&M/yr:		5,000	5,000
	Life:		50	50
Hatchery Production	Capital:	115,000		115,000
	O&M/yr:	12,500		12,500
	Life:	50		50
TOTAL COSTS	Capital:	115,000	250,000	365,000
	O&M/yr:	12,500	5,000	17,500
	Years:	50	50	50
Water Acquisition		N	N	N
Fish to stock	Number/yr:	25,000		25,000
	Size:	S, 5/lb.		S, 5/lb.
	Years:	50		50

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

** Recommended strategy.

ESTIMATED COSTS FOR ALTERNATIVE STRATEGIES

Subbasin: Cowlitz River
Stock: Summer Steelhead

Action	cost Categories*	Proposed Strategies 1	2**
Habitat Enhancement	Capital:		
	O&M/yr:		
	Life:		
Screening	Capital:		
	O&M/yr:		
	Life:		
Barrier Removal	Capital:	100,000,000	
	O&M/yr:	2,000,000	
	Life:	50	
Misc. Projects	Capital:		
	O&M/yr:		
	Life:		
Hatchery Production	Capital:		2,806,000
	O&M/yr:		305,000
	Life:		50
TOTAL COSTS	Capital:	100,000,000	2,806,000
	O&M/yr:	2,000,000	305,000
	Years:	50	50
Uater Acquisition		N	N
Fish to stock	Number/yr:		610,000
	Size:		S, 5/lb.
	Years:		50

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

** Recommended strategy.

ESTIMATED COSTS FOR ALTERNATIVE STRATEGIES

Subbasin: Cowlitz River
Stock: Fall Chinook

Action	Cost Categories*	Proposed Strategies 1	2	3**	4
Habitat Enhancement	Capital:	0			0
	O&M/yr:	30,000			30,000
	Life:	50			50
Screening	Capital:				
	O&M/yr:				
	Life:				
Barrier Removal	Capital:				
	O&M/yr:				
	Life:				
Misc. Projects	Capital:				
	O&M/yr:				
	Life:				
Hatchery Production	Capital:		713,000	368,000	
	O&M/yr:		21,250	40,000	
	Life:		50	50	
TOTAL COSTS	Capital:	0	713,000	368,000	0
	O&M/yr:	30,000	21,250	40,000	30,000
	Years:	50	50	50	50
Uater Acquisition		N	N	N	N
Fish to Stock	Number/yr:		1 ,000,000	1,600,000	
	Size:		F, 400/lb.	J, 100/lb.	
	Years:		600,000	50	
			J, 100/lb.		
			50		

* Life expectancy of the project is defined in years. Uater 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 = jwenile, fingerling, parr, subsmolt; S = smolt; A = adult.

** Recommended strategy.

ESTIMATED COSTS FOR ALTERNATIVE STRATEGIES

Subbasin: Cowlitz River
Stock: Spring Chinook

		Prooosed Strategies			
Action	cost Categories*	1	2	3**	4
	Capital:	0			0
Habitat	O&M/yr:	30,000			30,000
Enhancement	Life:	50			50
	Capital:				
	O&M/yr:				
Screening	Life:				
	Capital:				
Barrier	O&M/yr:				
Removal	Life:				
	Capital:				
Misc.	O&M/yr:				
Projects	Life:				
	Capital:		690,000	230,000	
Hatchery	O&M/yr:		75,000	25,000	
Production	Life:		50	50	
	Capital:	0	690,000	230,000	0
TOTAL	O&M/yr:	30,000	75,000	25,000	30,000
COSTS	Years:	50	50	50	50
Uater Acquisition		N	N	N	N
	Number/yr:		1,500,000	100,000	
Fish to	Sire:		J, 50/lb.	S, 10/lb.	
Stock	Years:		50	50	

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

** Recommended strategy.

ESTIMATED COSTS FOR ALTERNATIVE STRATEGIES

Subbasin: Cowlitz River
Stock: Coho

Action	Cost Categories*	Proposed Strategies 1	2	3**	4	5	6
	Capital:	0	0	0	0		0
Habitat	O&M/yr:	30,000	30,000	30,000	30,000		30,000
Enhancement	Life:	50	50	50	50		50
	Capital:				500,000		
Barrier	O&M/yr:				10,000		
Removal	Life:				50		
Research	Capital:			50,000	50,000		
and	O&M/yr:			50,000	50,000		
Assessment	Life:			10	10		
Off-channel	Capital:		300,000	300,000	300,000		
Rearing	O&M/yr:		10,000	10,000	10,000		
Areas	Life:		25	25	25		
	Capital:			1,314,220		1,314,220	
Hatchery	O&M/yr:			142,850		142,850	
Production	Life:			50		50	
	Capital:	0	600,000	1,964,220	1,150,000	1,314,220	0
TOTAL	O&M/yr:	30,000	40,000	192,850	60,000	142,850	30,000
COSTS	Years:	50	50	50	50	50	50
Water Acquisition		N	N	N	N	N	N
	Number/yr:			800,000		800,000	
Fish to	Size:			S, 14/lb.		S, 14/lb.	
Stock	Years:			50		50	

* Life expectancy of the project is defined in years. Uater 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.

APPENDIX D
HATCHERY RELEASES

Table **D1.** Cowlitz **Subbasin** hatchery winter steelhead plants, Cowlitz River watershed.

Release Date	Number Released	Release Location	Hatchery	Stock
1977	5,462(s)	Cowlitz	Swofford RP	Cowlitz R.
1977	31,698(s)	Cowlitz	Beaver Ck	Cowlitz R.
1977	**1,027,363(s+f)(1)**	Cowlitz	Cowlitz	Cowlitz R.
1977	21,222(s)	Lacamas Ck	Cowlitz	Cowlitz R.
1978	**815,900(s+f)(2)**	Cowlitz	Cowlitz	Cowlitz R.
1978	26,406(s)	Cowlitz	Beaver Ck	Cowlitz R.
1978	20,398(s)	Lacamas Ck	Cowlitz	Cowlitz R.
1978	20,270(s)	Olequa Ck	Cowlitz	Cowlitz R.
1979	10,080(f)	Cowlitz	Cowlitz	Cowlitz R.
1979	49,651(s)	Cowlitz	Swofford RP	Cowlitz R.
1979	**526,998(s+f)**	Cowlitz	Cowlitz	Cowlitz R.
1979	19,424(s)	Olequa Ck	Cowlitz	Cowlitz R.
1979	22,260(s)	Lacamas Ck	Cowlitz	Cowlitz R.
1979	83,940(f)	Salmon Ck	Cowlitz	Cowlitz R.
1980	29,370(s)	Cowlitz	Swofford RP	Cowlitz R.
1980	**510,651(s+f)**	**Cowlitz/Columbia**	Cowlitz	Cowlitz R.
1980	20,451(s)	Olequa Ck	Cowlitz	Cowlitz R.
1980	**8,301(f)**	Lacamas Ck	Cowlitz	Cowlitz R.
1981	**4,350(f)**	Olequa Ck	Cowlitz	Cowlitz R.
1981	29,263(s)	Cowlitz	Beaver Ck	Cowlitz R.
1981	34,864(s)	Cowlitz	Swofford RP	Cowlitz R.
1981	**678,506(s+f)**	Cowlitz	Cowlitz	Cowlitz R.
1982	323,801(s)	Cowlitz	Cowlitz	Cowlitz R.
1982	**178,582(f)**	Cowlitz	Cowlitz	Cowlitz R.
1983	510,156(s)	Cowlitz	Cowlitz	Cowlitz R.
1983	270,513(f)	Cowlitz	Cowlitz	Cowlitz R.
1984	649,223(s)	Cowlitz	Cowlitz	Cowlitz R.
1984	**116,575(f)**	Cowlitz	Cowlitz	Cowlitz R.
1985	698,249(s)	Cowlitz	Cowlitz	Cowlitz R.
1985	196,535(f)	Cowlitz	Cowlitz	Cowlitz R.
1986	531,018(s)	Cowlitz	Cowlitz	Cowlitz R.
1986	86,448(f)	Cowlitz	Cowlitz	Cowlitz R.
1987	810,185(s)	Cowlitz	Cowlitz	Cowlitz R.
1987	182,377(f)	Cowlitz	Cowlitz	Cowlitz R.
1988	533,409(s)	Cowlitz	Cowlitz	Cowlitz R.
1988	103,080(f)	Cowlitz	Cowlitz	Cowlitz R.

(1) 25,336 marked RVAD to look at adult return time.
(2) 26,000 marked ADCWT to look at adult return time.

Table D2. Cowlitz Subbasin hatchery winter steelhead plants, Toutle River watershed.

Release Date	Number Released	Release Location	Hatchery	Stock
1977	50,000(s)	Alder Ck	Alder Ck Pnd	Cowlitz R.
1977	34,464(s)	Toutle R.	Beaver Ck	Cowlitz R.
1977	61,061(s)	Toutle R.	Cowlitz	Cowlitz R.
1978	50,000(s)	Alder Ck	Alder Ck Pnd	Cowlitz R.
1978	21,123(s)	Toutle R.	Beaver Ck	Cowlitz R.
1978	63,671(s)	Toutle R.	Cowlitz	Cowlitz R.
1979	55,500(s)	Alder Ck	Alder Ck Pnd	Cowlitz R.
1979	30,752(s)	Toutle R.	Beaver Ck	Cowlitz R.
1979	65,751(s)	Toutle R.	Cowlitz	Cowlitz R.
1980	49,104(s)	Alder Ck	Alder Ck Pnd	Cowlitz R.
1980	20,758(s)	Toutle R.	Beaver Ck	Cowlitz R.
1980	27,436(s)	N. Fk Toutle	Cowlitz	Cowlitz R.
1980	19,480(s)	S. Fk Toutle	Beaver Ck	Cowlitz R.
1981	32,844(f)	S. Fk Toutle	Klineline Net	Kalama R.
1981	31,168(s)	Toutle R.	Cowlitz	Cowlitz R.
1981	7,350(f)	S. Fk Toutle	Vancouver	S. Toutle R.
1982	23,325(f)	S. Fk Toutle	S. Toutle Pnd	Chambers Ck
1983	7,290(s)	Green R.	Beaver Ck	Chambers Ck
1985	6,345(s)	N. Fk Toutle	Alder Ck Pnd	Elochoman R.

Table D3. Cowlitz Subbasin hatchery winter steelhead plants, Coweeman River watershed.

Release Date	Number Released	Release Location	Hatchery	Stock
1977	40,435(s)	Coweeman R.	Beaver Ck	Cowlitz
1978	40,028(s)	Coweeman R.	Beaver Ck	Cowlitz
1979	54,586(s)	Coweeman R.	Beaver Ck	Cowlitz
1980	41,534(s)	Coweeman R.	Beaver Ck	Cowlitz
1981	57,560(s)	Coweeman R.	Beaver Ck	Cowlitz
1982	45,855(s)	Coweeman R.	Beaver Ck	Bogachiel/ Chambers Ck
1983	33,486(s)	Coweeman R.	Beaver Ck	Chambers Ck
1984	40,225(s)	Coweeman R.	Beaver Ck	Elochoman
1985	18,262(s)	Coweeman R.	Coweeman net	Elochoman
1985	18,905(s)	Coweeman R.	Beaver Ck	Elochoman
1985	7,050(s)	Coweeman R.	Alder Ck Pnd	Elochoman
1986	54,550(s)	Coweeman R.	Beaver Ck	Elochoman
1986	8,927(s)	Coweeman R.	Coweeman Pnd	Elochoman
1987	46,220(s)	Coweeman R.	Beaver Ck	Elochoman
1987	8,640(s)	Coweeman R.	Coweeman Pnd	Elochoman
1988	10,105(s)	Coweeman R.	Coweeman Pnd	Elochoman
1988	27,000(s)	Coweeman R.	Beaver Ck	Elochoman

* Adult brood collection site same as stock.

Table D4. Cowlitz Subbasin hatchery summer steelhead plants, Cowlitz River watershed.

Release Date	Number Released	Release Location	Hatchery	Stock
1977	298,257(s+f)	Cowlitz	Cowlitz	Skamania(l)
1978	245,963 (s+f)	Cowlitz	Cowlitz	Skamania(l)
1979	168,168(s+f)	Cowlitz	Cowlitz	Skamania(l)
1980	10,912(f)	Lacamas Ck	Cowlitz	Skamania(l)
1980	22,255(s)	Cowlitz	Cowlitz	Skamania(l)
1980	86,824(s+f)	Columbia R.	Cowlitz	Skamania(l)
1980	85,143(s+f)	Cowlitz	Cowlitz	Skamania(l)
1981	203,674(s+f)	Cowlitz	Cowlitz	Skamania(l)
1982	25 336(f)	Cowlitz	Cowlitz	Skamania(l)
1982	31,131(s)	Cowlitz	Cowlitz	Skamania(l)
1983	56,922(s)	Cowlitz	Cowlitz	Skamania(l)
1983	32,534(f)	Cowlitz	Cowlitz	Skamania(l)
1984	122,983(s)	Cowlitz	Cowlitz	Skamania(l)
1984	81,988(f)	Cowlitz	Cowlitz	Skamania(l)
1985	144,116(s)	Cowlitz	Cowlitz	Skamania(l)
1985	42,810(f)	Cowlitz	Cowlitz	Skamania(l)
1986	113,325(s)	Cowlitz	Cowlitz	Skamania(l)
1986	42,466(f)	Cowlitz	Cowlitz	Skamania(l)
1987	56,908(s)	Cowlitz	Cowlitz	Skamania(l)
1987	10,830(f)	Cowlitz	Cowlitz	Skamania(l)
1988	82,153(s)	Cowlitz	Cowlitz	Skamania(l)
1988	51,977(f)	Cowlitz	Cowlitz	Skamania(l)

(1) Adult brood stock collected at Cowlitz Hatchery.

Table D5. Cowlitz Subbasin hatchery summer steelhead plants, Toutle River watershed.

Release Date	Number Released	Release Location	Hatchery	Stock
1977	28,530(s)	Green R.	Skamania	Skamania
1977	83,808(s)	N. Fk Toutle	Skamania	Skamania
1977	28,353(s)	S. Fk Toutle	Skamania	Skamania
1977	32,000(s)	Alder Ck	Alder Ck Pd	Skamania
1978	34,000(s)	Alder Ck	Alder Ck Pd	Skamania
1978	27,068(s)	Green R.	Skamania	Skamania
1978	99,141(s)	N. Fk Toutle	Skamania	Skamania
1978	34,328(s)	S. Fk Toutle	Skamania	Skamania
1979	33,660(s)	Alder Ck	Alder Ck Pd	Skamania
1979	32,421(s)	Green R.	Skamania	Skamania
1979	109,494(s)	N. Fk Toutle	Skamania	Skamania
1979	33,617(s)	S. Fk Toutle	Skamania	Skamania
1980	34,020(s)	Alder Ck	Alder Ck Pd	Skamania
1980	36,686(s)	Green R.	Beaver Ck	Skamania
1980	19,634(s)	Toutle R.	Skamania	Skamania
1980	50,022(s)	N. Fk Toutle	Skamania	Skamania
1980	17,594(s)	N. Fk Toutle	Beaver Ck	Skamania
1980	28,752(s)	S. Fk Toutle	Beaver Ck	Skamania
1981	9,735(s)	S. Fk Toutle	'Beaver Ck	Skamania
1982	16,440(s)	Green R.	Skamania	Skamania
1983	108,605(f)	Green R.	Skamania	Skamania
1983	108,605(f)	S. Fk Toutle	Skamania	Skamania
1984	25,815(s)	Green R.	Skamania	Skamania
1984	20,600(s)	S. Fk Toutle	Skamania	Skamania
1985	17,995(s)	S. Fk Toutle	Skamania	Skamania
1985	22,990(s)	Green R.	Skamania	Skamania
1986	32,010(s)	Green R.	Skamania	Skamania
1986	40,344(s)	S. Fk Toutle	Skamania	Skamania
1987	49,440(s)	Alder Ck	Alder Ck Pd	Skamania
1987	8,550(s)	Green R.	Skamania	Skamania
1987	22,385(s)	S. Fk Toutle	Skamania	Skamania
1988	20,338(s)	Green R.	Skamania	Skamania
1988	30,210(s)	N. Fk Toutle	Skamania	Skamania
1988	19,890(s)	S. Fk Toutle	Skamania	Skamania

* Adult brood collection site same as stock.

Table D6. Cowlitz Subbasin hatchery sea-run cutthroat plants, Cowlitz River watershed.

Release Date	Number Released	Release Location	Hatchery	Stock
1977	299,915(s)	Cowlitz R.	Cowlitz	Cowlitz
1977	10,736(f)	Cowlitz R.	Cowlitz	Cowlitz
1977	5,040(s)	Olequa Ck	Mossyrock	Elochoman
1978	16,410(f)	Cowlitz R.	Cowlitz	Cowlitz
1978	115,368(s)	Cowlitz R.	Cowlitz	Cowlitz
1979	122,248(s)	Cowlitz R.	Cowlitz	Cowlitz
1979	2,000(s)	Olequa Ck	Mossyrock	Elochoman
1980	97,076(s)	Cowlitz R.	Cowlitz	Cowlitz
1980	9,868 (s)	Mill Ck	Cowlitz	Cowlitz
1980	13,599(f)	Olequa Ck	Cowlitz	Cowlitz
1981	25,740(f)	Olequa Ck	Cowlitz	Cowlitz
1981	101,594(s)(1)	Cowlitz R.	Cowlitz	Cowlitz
1981	131,521(f)	Cowlitz R.	Cowlitz	Cowlitz
1982	51,551(s)(2)	Cowlitz R.	Cowlitz	Cowlitz
1982	25,342(f)	Cowlitz R.	Cowlitz	Cowlitz
1983	55,067(s)(3)	Cowlitz R.	Cowlitz	Cowlitz
1983	29,224(f)	Cowlitz R.	Cowlitz	Cowlitz
1984	110,622(s)	Cowlitz R.	Cowlitz	Cowlitz
1984	23,017(f)	Cowlitz R.	Cowlitz	Cowlitz
1985	73,142(s)	Cowlitz R.	Cowlitz	Cowlitz
1985	62,165(f)	Cowlitz R.	Cowlitz	Cowlitz
1986	60,763(s)	Cowlitz R.	Cowlitz	Cowlitz
1986	29,133(f)	Cowlitz R.	Cowlitz	Cowlitz
1987	6,837(s)	Cowlitz R.	Cowlitz	Cowlitz/Elochoman
1987	19,663(f)	Cowlitz R.	Cowlitz	Cowlitz/Elochoman
1988	10,336(s)	Cowlitz R.	Cowlitz	Cowlitz
1988	72,943(f)	Cowlitz R.	Cowlitz	Cowlitz

(1) 20,000 marked LV, 10,020 marked RV, 1,000 marked w/Floy anchor tags; size @ release experiment.
(2) 2,000 marked for size at release experiment.
(3) 1,050 marked for size at release experiment.

Table D7. Cowlitz Subbasin hatchery sea-run cutthroat plants, Coweeman River watershed.

Release Date	Number Released	Release Location	Hatchery	Stock
1977	18,000(s)	Coweeman R.	Vancouver	Elochoman
1978	15,878(s)	Coweeman R.	Vancouver	Elochoman
1979	12,684(s)	Coweeman R.	Vancouver	Elochoman
1980	9,150(s)	Coweeman R.	Vancouver	Elochoman
1981	18,193(s)	Coweeman R.	Vancouver	Elochoman
1985	7,050(s)	Coweeman R.	Beaver Ck	Elochoman
1985	15,478(f)	Coweeman R.	Beaver Ck	Elochoman
1986	6,700(s)	Coweeman R.	Coweeman Pnd	Elochoman
1987	7,755(s)	Coweeman R.	Beaver Ck	Elochoman
1987	8,850(s)	Coweeman R.	Coweeman Pnd	Elochoman

* Adult brood collection site same as stock.

Table D8. Cowlitz Subbasin fall chinook hatchery fish plants, Cowlitz Hatchery unless otherwise noted.

Stock	Brood Year	Release Date	Number	Release Site	Comments
Cowlitz	1976	1977	3,824,412(f)	Cowlitz	
"	1977	1978	4,126,174(f)	"	
"	"	1978	146,001(f)	"	CWT Production eval
"	1978	1979	4,481,337(f)	"	
"	"	1979	154,648(f)	"	CWT Production eval
"	1979	1979	799,000	"	unfed fry
"	"	1980	7,131(f)	"	
"	"	1980	2,270(f)	"	CWT Production eval
"	"	1981	543,634(y)	"	
"	"	1981	20,719(y)	"	CWT Production eval
"	1980	1981	3,128,708(f)	"	
"	"	1981	153,216(f)	"	CWT Production eval
Kalama	"	1981	1,453,447(f)	"	
"	"	1981	63,312(f)	"	CWT Production eval
Big Creek	"	1981	807,000(f)	"	
Bonneville	"	1981	1,322,141(f)	"	
"	"	1981	57,959(f)	"	CWT Production eval
Cowlitz	1981	1982	7,964,444(f)	"	
"	"	1982	296,258(f)	"	CWT Production eval
"	1982	1983	221,300(f)	"	Grays River Hatchery
"	"	1983	5,384,909(f)	"	
"	"	1983	150,236(f)	"	CWT Columbia R.index
"	"	1983	146,355(f)	"	CWT Release timing
"	1983	1984	7,110,565(f)	"	
"	"	1984	383,635(f)	"	CWT Columbia R.index
"	1984	1985	5,494,628(f)	"	
"	"	1985	189,388(f)	"	CWT Columbia R.index
"	"	1985	194,717(f)	"	CWT Release timing
"	1985	1986	8,347,500(f)	"	
"	"	1986	197,500(f)	"	CWT Columbia R.index
"	1986	1986	3,917,000	"	unfed fry
"	"	1987	8,864,997(f)	"	
"	"	1987	207,003(f)	"	CWT Columbia R.index

Table D9. Cowlitz Subbasin fall chinook hatchery fish plants, Toutle Hatchery unless otherwise noted.

Stock	Brood Year	Release' Date	Number	Release Site	Comments
Toutle	1976	1977	2,942,413(f)	Toutle	
"	"	1977	132,500(f)	"	CWT Production eval
"	1977	1978	1,023,250(f)	"	
"	"	1978	582,856(f)	S. Fk Toutle-Cowlitz Hatchery	
"	"	1978	608,985(f)	N. Fk Toutle-Cowlitz Hatchery	
"	"	1978	2,403,221(f)	Deer Ck -Deer Springs Pond	
"	"	1978	142,797(f)	"	CWT Production eval
"	"	1978	126,522(f)	"	CWT ATPase study
"	1978	1979	275,000(f)	S. Fk Toutle	
"	"	1979	275,000(f)	Outlet Ck	
Kalama	"	1979	947,456(f)	S. Fk Toutle-Cowlitz H.	
Toutle	"	1979	2,901,040(f)	Toutle	
"	"	1979	144,085(f)	"	CWT Production eval
Kalama	1986	1987	456,100(f)	"	
Washougal	"	1987	446,300(f)	"	

Table D10. Cowlitz Subbasin fall chinook hatchery fish plants, Coweeman River.

Stock	Brood Year	Release Date	Number	Release Site	Comments
Washougal	1977	1978	454,230(f)	"	Cowlitz Hatchery
Toutle	1978	1979	1,075,000	"	unfed fry Cowlitz H.

Table D11. Cowlitz Subbasin hatchery spring chinook production, Cowlitz Hatchery unless otherwise noted.

Stock	Brood Year	Release Date	Number	Release Site	Comments
Cowlitz	1975	1977	543,219(y)	Cowlitz R.	
"	"	1977	356,895 (y)	"	CWT Disease study
"	1976	1977	1,572,887(f)	"	
"	"	1977	168,410(f)	"	CWT Disease study
"	"	1978	15,274(y)	"	
"	"	1978	489,365(y)	"	CWT Density study
"	1977	1977	42,500	"	unfed fry
"	"	1978	1,138,917(f)	"	
"	"	1979	635,351(y)	"	
"	1978	1978	1,164,300	"	unfed fry
"	"	1979	991,700(f)	"	
"	"	1980	635,386(y)	"	
"	1979	1979	3,158,000	"	unfed fry
"	"	1980	1,448,190(f)	"	
"	"	1981	742,637(y)	"	
"	1980	1980	5,848,000	"	unfed fry
"	"	1981	1,275,674(f)	"	
"	"	1982	626,889(y)	"	
"	"	1982	95,620(y)	"	CWT Disease study
"	1981	1981	550,000	"	unfed fry
"	"	1982	1,285,484(f)	"	
"	"	1983	422,254(y)	"	
"	"	1983	208,746(y)	"	CWT Adult rtn timing
"	1982	1982	1,101,000	"	unfed fry
"	"	1983	2,239,500(f)	"	
"	"	1984	400,193(y)	"	
"	"	1984	219,207(y)	"	CWT Adult rtn timing
"	1983	1984	2,815,900(f)	"	
"	"	1985	401,005(y)	"	
"	"	1985	202,095(y)	"	CWT Adult rtn timing
"	1984	1985	1,730,000	"	eggs
"	"	1985	3,008,800(f)	"	
"	"	1986	433,953(y)	"	
"	"	1986	231,500(y)	"	CWT Adult rtn timing
"	1985	1986	2,194,400(f)	"	
"	"	1987	495,011(y)	"	
"	"	1987	143,389(y)	"	CWT Columbia R.index
"	1986	1987	2,561,736(f)	"	
"	"	1987	1,864(f)	"	CWT Columbia R.index
"	1987	1987	256,000	"	eggs
"	"	1987	192,000	"	unfed fry

Table D12. Cowlitz Subbasin hatchery spring chinook production, Toutle River watershed.

Stock	Brood Year	Release Date	Number	Release Site	Comments
Cowlitz	1976	1977	418,002(f)	Green R.	Toutle H.
"	1978	1978	1,249,600	"	unfed fry-Cowlitz H.
"	1979	1980	653,949(f)	S.Fk Toutle	Sea Resources
"	1982	1983	309,100(f)	Toutle R.	Cowlitz H.
"	"	1983	209,400(f)	S.Fk Toutle	Cowlitz H.
"	1983	1984	728,474(f)	"	Cowlitz H.
"	"	1984	262,500(f)	N.Fk Toutle	Cowlitz H.

Table D13. Cowlitz Subbasin hatchery coho plants, Cowlitz River plants (Cowlitz Hatchery unless otherwise noted).

Stock	Brood Year	Release Date	Number	Comments
N	1975	1977	3,475,024(y)	
N	1977	1978	495,429(f)	
N	1977	1979	3,567,602(y)	
N	1978	1979	1,318,000	unfed fry
N	1978	1979	653,800(f)	
N	1978	1980	3,832,659(y)	
N	1979	1980	250,000	unfed fry
N	1979	1981	4,848,997(y)	
N	1980	1981	9,079,000	unfed fry
N	1980	1982	4,464,499(y)	
N	1980	1982	311,011(y)	CWT Density study
N	1981	1982	120,000	unfed fry
N	1981	1983	4,569,990(y)	
N	1981	1983	311,009(y)	CWT Density study
N	1982	1983	8,000	unfed fry
N	1982	1983	8,100(f)	
N	1982	1984	4,694,457(y)	
N	1982	1984	308,343(y)	CWT Density study
N	1983	1985	4,137,756(y)	
N	1983	1985	93,582(y)	CWT Genetic resrch
N	1983	1985	46,862(Y)	CWT Coho index
N	1984	1985	272,800(f)	
N	1984	1986	4,730,417(y)	
N	1984	1986	179,377(y)	CWT Genetic resrch
N	1984	1986	255,454(y)	CWT Coho index
N	1985	1986	143,900(f)	
N	1985	1987	12,000(f)	
N	1985	1987	4,513,316(y)	
N	1985	1987	167,664(y)	CWT Jack cross study
N	1985	1987	77,020(y)	CWT Coho index
N	1986	1987	83,000	unfed fry
N	1986	1987	726,200(f)	

Table D14. Cowlitz Subbasin hatchery coho plants, Cowlitz River watershed, miscellaneous streams.

Stock	Brood Year	Release Date	Number	Release Site	Comments
N	1986	1987	11,600(f)	Agren Ck	
N	1985	1986	37,000(f)	Baxter Ck	
N	1986	1987	33,800(f)	"	
N	1983	1984	59,500(f)	Bear Ck	
N	1984	1985	6,200(f)	"	
N	1985	1986	63,000	"	unfed fry
N	1986	1987	37,300(f)	Blue Ck	
N	1984	1985	117,000(f)	Brim Ck	
N	1985	1986	125,900(f)	"	
N	1986	1987	127,500(f)	"	
S	1979	1980	500,000	Campbell Ck	unfed fry w/Ryderwood
N	1980	1981	479,575	"	unfed fry w/Ryderwood
S	1981	1982	204,000	"	unfed fry egg boxes
N	1983	1984	47,600(f)	"	
N	1984	1985	17,100(f)	"	
N	1985	1986	18,200(f)	"	
N	1986	1987	105,800(f)	"	
N	1984	1985	62,700(f)	Cedar Ck	
N	1985	1986	298,600(f)	"	
N	1986	1987	273,600(f)	"	
N	1985	1986	3,000	Coon Ck	unfed fry
N	1985	1986	27,600(f)	"	
N	1983	1984	285,900(f)	Delameter Ck	
N	1984	1985	294,600(f)	"	
N	1985	1986	258,900(f)	"	
N	1986	1987	249,700(f)	"	
N	1986	1987	19,400(f)	Ferrier Ck	
N	1986	1987	31,800(f)	Foster Ck	
N	1985	1986	108,200(f)	Hill Ck	
N	1986	1987	98,400(f)	"	
N	1983	1984	14,000(f)	Jones Ck	
N	1984	1985	13,000(f)	"	
N	1986	1987	12,000(f)	"	
N	1980	1981	700,000	King Ck	unfed fry
N	1983	1984	158,300(f)	"	
N	1984	1985	90,600(f)	"	
N	1985	1986	161,200(f)	"	
N	1986	1987	85,700(f)	"	
N	1983	1984	320(f)	Lacamas Ck	Coop w/Toledo HS
N	1983	1984	242,500(f)	"	
N	1984	1985	323,100(f)	"	
N	1985	1986	355,900(f)	"	

(continued)

Table D14 continued. Cowlitz Subbasin hatchery coho plants, Cowlitz River watershed, miscellaneous streams.

Stock	Brood Year	Release Date	Number	Release Site	Comments
N	1986	1987	481,000(f)	"	
N	1986	1987	77,000(f)	Lechler Ck	
N	1984	1985	3,000(f)	Lenoue Ck	
N	1985	1986	31,200(f)	"	
N	1985	1986	95,700(f)	Little Salmon Ck	
N	1986	1987	58,600(f)	"	
N	1976	1977	192,000	Mill Ck	unfed fry
N	1976	1977	29,532(f)	"	
N	1977	1978	39,300(f)	"	
N	1984	1985	21,400(f)	"	
N	1985	1986	25,000	"	unfed fry
N	1983	1984	95,300(f)	Monahan Ck	
N	1984	1985	16,300(f)	"	
N	1985	1986	52,300(f)	"	
N	1986	1987	19,900(f)	"	
N	1980	1981	1,400,000	Olequa Ck	unfed fry
N	1983	1984	69,800(f)	"	
N	1984	1985	439,300(f)	"	
N	1985	1986	283,500(f)	"	
N	1986	1987	453,300(f)	"	
N	1986	1987	800(f)	"	Coop w/Olequa resids
N	1980	1981	390,000	Ostrander Ck	unfed fry
N	1983	1984	95,300(f)	"	
N	1984	1985	189,900(f)	"	
N	1985	1986	224,500(f)	"	
N	1986	1987	274,200(f)	"	
N	1980	1981	676,800	Salmon Ck	unfed fry
N	1982	1983	102,700(f)	"	
N	1983	1984	238,200(f)	"	
N	1984	1985	371,300(f)	"	
N	1985	1986	367,100(f)	"	
N	1986	1987	312,500(f)	"	
N	1975	1976	1,047,200	Stillwater Ck	unfed fry
N	1977	1978	161,130(f)	"	
N	1978	1979	127,658(f)	"	
N	1983	1984	238,200(f)	"	
N	1984	1985	107,200(f)	"	
N	1985	1986	119,500(f)	"	
N	1986	1987	89,400(f)	"	
N	1985	1986	37,000(f)	Unnamed (9098)	
N	1985	1986	39,100(f)	Whittle Ck	
N	1986	1987	38,300(f)	"	

Table D15. Cowlitz Subbasin hatchery coho plants, Toutle River watershed (Toutle Hatchery unless noted otherwise).

Stock	Brood Year	Release Date	Number	Release Site	Comments
N	1975	1977	342,424(y)	Green R.	
S	1975	1977	882,185(y)	"	
N	1976	1977	29,200(f)	"	
N	1976	1978	362,889(y)	"	
S	1976	1978	898,291(y)	"	
N	1977	1978	150,640(f)	"	
N	1977	1979	96,076(y)	"	
S	1977	1979	854,539(y)	"	
S	1977	1979	238,280(y)	"	CWT Time/size exp.
S	1978	1979	182,400(f)	"	
S	1978	1980	1,059,060(y)	"	
S	1978	1980	78,108(y)	"	CWT Time/size exp.
S	1984	1985	70,000(f)	"	Grays River H.
S	1984	1986	155,250(y)	"	
S	1985	1987	333,350(y)	Green R.	
S	1978	1980	494,000(f)	Alder Ck	
N	1982	1983	167,400(f)	"	Cowlitz H.
N	1983	1984	186,400(f)	"	Cowlitz H.
S	1984	1985	205,100(f)	"	Washougal H.
S	1985	1986	187,200(f)	"	Kalama H.
S	1975	1976	42,900(f)	Bear Ck (NF)	
S	1976	1977	119,980(f)	"	
S	1978	1979	300,000(f)	"	
N	1982	1983	15,200(f)	"	Cowlitz H.
N	1984	1985	55,100(f)	"	Cowlitz H.
N	1982	1983	81,400(f)	Bear Ck (SF)	Cowlitz H.
N	1986	1987	72,700(f)	"	Cowlitz H.
S	1984	1985	35,900(f)	Beaver Ck	Grays R. H.
S	1984	1985	5,100(f)	Clancy Ck	Grays R. H.
S	1976	1977	114,975(f)	Coldwater Ck	
N	1982	1983	124,000(f)	Devils Ck	Cowlitz H.
N	1983	1984	177,500(f)	"	Cowlitz H.
S	1984	1985	83,900(f)	"	Washougal H.
S	1985	1986	981,000(f)	"	Washougal H.
N	1982	1983	137,700(f)	Elk Ck	Cowlitz H.
N	1983	1984	173,900(f)	"	Cowlitz H.
S	1984	1985	156,000(f)	"	Washougal H.
S	1985	1986	153,800(f)	"	Washougal H.
S	$984	1985	5,100(f)	Fly Ck	Grays R. H.
S	1977	1978	22,838	Hemlock Ck	unfed fry
N	1982	1983	31,400(f)	Herrington Ck	Cowlitz H.

(continued)

Table D15 continued. Cowlitz Subbasin hatchery coho plants, Toutle River watershed (Toutle Hatchery unless noted otherwise).

Stock	Brood Year	Release Date	Number	Release Site	Comments
N	1983	1984	14,700(f)	"	Cowlitz H.
S	1984	1985	14,100(f)	"	Grays R. H.
S	1985	1986	15,000(f)	"	Washougal H.
S	1976	1977	115,000(f)	Hoffstadt Ck	
N	1982	1983	15,200(f)	"	Cowlitz H.
N	1983	1984	14,700(f)	"	Cowlitz H.
S	1984	1985	14,100(f)	"	Grays R. H.
S	1985	1986	15,000(f)	"	Washougal H.
S	1984	1985	23,800(f)	Jim Ck	Grays R. H.
N	1982	1983	63,400(f)	Johnson Ck	Cowlitz H.
N	1983	1984	124,200(f)	"	Cowlitz H.
S	1984	1985	148,800(f)	"	Washougal H.
S	1985	1986	110,400(f)	"	Kalama H.
S	1984	1985	33,000(f)	Jordan Ck	Grays R. H.
S	1978	1979	275,000(f)	Outlet Ck	
N	1982	1983	60,000(f)	"	Cowlitz H.
N	1983	1984	43,200(f)	"	Cowlitz H.
S	1984	1985	44,100(f)	"	Washougal H.
S	1985	1986	43,200(f)	"	Kalama H.
N	1986	1987	64,500(f)	Owl Ck	Cowlitz H.
S	1984	1985	51,200(f)	Pullen Ck	Grays R. H.
N	1983	1984	14,700(f)	Schultz Ck	Cowlitz H.
S	1984	1985	14,100(f)	"	Grays R. H.
S	1985	1986	15,000(f)	"	Washougal H.

Table D16. Cowlitz Subbasin hatchery coho plants, Toutle River watershed, miscellaneous streams.

Stock	Brood Year	Release Date	Number	Release Site	Comments
S	1984	1985	120,000(f)	S Fk Toutle	Grays River H.
S	1978	1979	150,000(f)	Spirit Lk	
N	1982	1983	73,200(f)	Studebaker Ck	Cowlitz H.
N	1983	1984	120,300(f)	"	Cowlitz H.
S	1984	1985	46,800(f)	"	Cowlitz H.
S	1985	1986	117,600(f)	"	Kalama H.
N	1982	1983	60,000(f)	Thirteen Ck	Cowlitz H.
N	1983	1984	68,700(f)	"	Cowlitz H.
S	1984	1985	57,300(f)	"	Washougal H.
S	1985	1986	52,200(f)	"	Washougal H.
N	1982	1983	32,400(f)	Unnamed(9070)	Cowlitz H.
N	1983	1984	29,500(f)	"	Cowlitz H.
S	1984	1985	26,000(f)	"	Washougal H.
S	1985	1986	29,800(f)	"	Kalama H.
N	1982	1983	31,400(f)	Unnamed(9071)	Cowlitz H.
N	1983	1984	47,600(f)	"	Cowlitz H.
S	1984	1985	38,000(f)	"	Washougal H.
S	1985	1986	43,800(f)	"	Kalama H.
N	1982	1983	70,000(f)	Unnamed(9075)	Cowlitz H.
S	1984	1985	113,000(f)	"	Grays R. H.
N	1982	1983	52,200(f)	Unnamed(9076)	Cowlitz H.
S	1984	1985	56,500(f)	"	Grays R. H.
S	1984	1985	24,300(f)	Unnamed(9088)	Grays R. H.
N	1982	1983	135,000(f)	Wyant Ck	Cowlitz H.
N	1983	1984	159,900(f)	"	Cowlitz H.
S	1984	1985	154,700(f)	"	Washougal H.
S	1985	1986	125,900(f)	"	Kalama H.

Table D17. Cowlitz Subbasin hatchery coho plants, Coweeman River watershed.

Stock	Brood Year	Release Date	Number	Release Site	Comments
N	1976	1977	210,000(f)	Coweeman R.	Toutle H.
N	1980	1981	200,000(f)	"	Kalama H.
N	1982	1983	399,000(f)	"	Kalama H.
N	1983	1984	48,800(f)	Baird Ck	Cowlitz H.
S	1984	1985	5,100(f)	Disappointment Ck	Grays R. H.
S	1975	1977	49,190(y)	Goble Ck	Toutle H.
N	1977	1978	182,750(f)	"	Kalama H.
N	1982	1983	200,000(f)	"	Kalama H.
N	1983	1984	154,900(f)	"	Cowlitz H.
N	1984	1985	134,100(f)	"	Cowlitz H.
N	1985	1986	205,300(f)	"	Cowlitz H.
N	1986	1987	160,600(f)	"	Cowlitz H.
N	1983	1984	47,600(f)	Mulholland Ck	Cowlitz H.
N	1984	1985	60,000(f)	"	Cowlitz H.
N	1985	1986	59,700(f)	"	Cowlitz H.
N	1986	1987	122,000(f)	"	Cowlitz H.