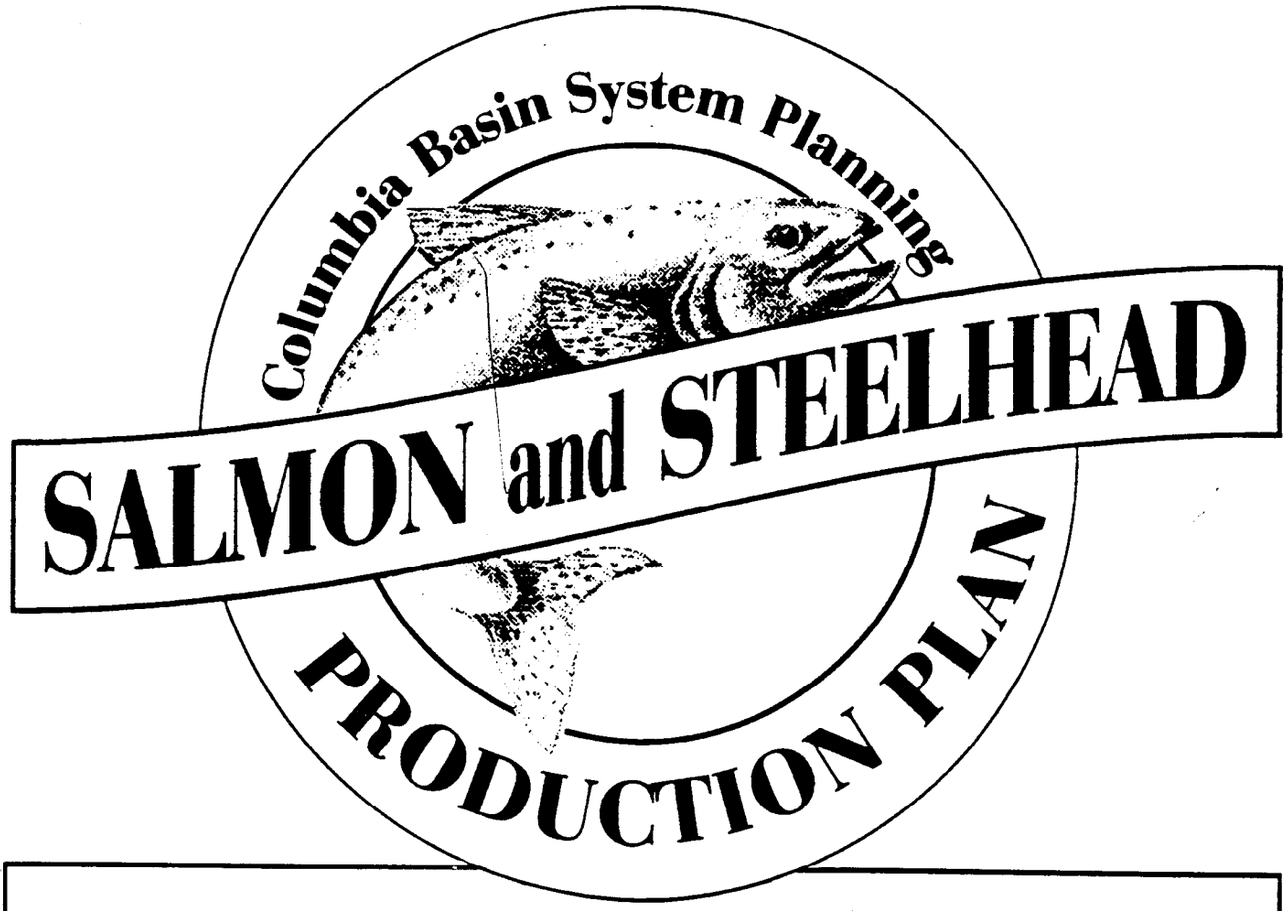

ENTIAT RIVER SUBBASIN

September 1, 1990

ENTIAT RIVER SUBBASIN
Salmon and Steelhead Production Plan

September 1, 1990

Lead Agency: Washington Department of Fisheries
115 General Administration Building
Olympia, Washington 98504

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

Confederated Tribes of the
Colville Indian Reservation
P.O. Box 150
Nespelem, Washington 99155

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

Columbia Basin System Planning

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Columbia Basin Fish and Wildlife Authority

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INTRODUCTION

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

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

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

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

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

Most of the stock-specific information obtained for this report was developed for the Preliminary Information Report (July 8, 1988). Other sources that were particularly helpful and were frequently referred to throughout the course of writing this draft are identified.

As a point of clarification, strategies identified in this plan pertain to the terminal area only (Entiat River). These strategies were analyzed in combination with both current and proposed passage improvements for the mainstem Columbia River dams.

Fish production is obviously part of an intricate web of biological and physical processes. Each strand affects the others in the same way. Without a holistic approach toward resource management, resource improvement is but a remote wish. A major step toward protection and enhancement must involve cooperation among the various resource agencies, the public and private sectors and also individuals. This includes educating one another with regard to present and future needs. Without this interdisciplinary approach, goals and objectives will not be realized.

PART I. DESCRIPTION OF SUBBASIN

Location and General Environment

The Entiat River Basin is located in north central Washington, within Chelan County. Originating in a glaciated basin near the crest of the Cascade Mountains, the Entiat River flows southeasterly joining the Columbia River at River Mile (RM) 483.7 near the town of Entiat, approximately 20 miles upstream of Wenatchee. The drainage covers about 419 square miles and ranges in elevation from over 9,000 feet in the Entiat River headwaters to about 700 feet at the confluence with the Columbia River (Table 1). The drainage is bounded on the northeast by the Chelan Mountains and on the southwest by the Entiat Mountains (Hydrology Subcommittee 1964).

Two major tributaries drain into the Entiat River, the North Fork Entiat, which joins the Entiat River at RM 33, and the Mad River, which flows into the Entiat at RM 10.5. Approximately 84 percent of the watershed is contained within the Wenatchee National Forest. Ninety percent of the Mad River watershed and all of the North Fork Entiat watershed lies within the Wenatchee National Forest. Federally designated wilderness areas cover approximately 14,000 acres of the Entiat watershed.

Geologic uplift, glaciation and volcanic activity have all combined to create a complex geologic structure. The Entiat River Basin is primarily composed of metamorphic schist and gneiss, intrusive granodiorite and quartz diorite. A 25-mile long valley glacier dominated the Entiat Basin during the Pleistocene Epoch. This glacier extended from Mount Maude to Potato Creek, about five miles upstream of Ardenvoir. Valley configuration above the moraine is U-shaped, while downstream of the moraine, the main valley and tributaries are a typical stream-incised V-shape. Much of the watershed is covered by volcanic ash and pumice that originated from Glacier Peak. Generally, the soils are highly erosive, especially on steep slopes and after disturbance.

A variety of climatic conditions in the subbasin has resulted in a diversity of ecotypes, ranging from the Hudsonian Zone at the headwaters with annual precipitation of 70 inches to arid grasslands at the mouth that receive less than 10 inches of precipitation. The majority of precipitation falls as snow, although rain is not uncommon between October and March. Summer months are generally dry, but summer thunderstorms accompanied by intense rain are common.

Riparian vegetation and floodplain development is also variable. Floodplain development in the upper reaches of the system varies from areas of a confined channel to broad

depositional zones with a meandering braided stream. The riparian area on national forest land is generally timbered except where the overstory has been removed by fire. Riparian areas along the lower reaches of the Entiat River have been modified to accommodate dwellings and agricultural development.

Destruction of vegetation, both man-caused and natural, with associated erosion and sedimentation has had significant effects on the streams in the basin. Man's influence on vegetation structure has primarily occurred through agricultural development, grazing, and timber harvest. Catastrophic wildfires have had a great impact on the watershed. Much of the Mad River gorge was burned in the 1880s. Other fires in the Entiat Basin also burned in the early 1900s. Between August 23 and September 7, 1970, 58,000 acres, 22 percent of the Entiat watershed, burned. In 1976 the Crum Canyon Fire blackened 3,000 acres of the watershed. The 1970 and 1976 fires were followed by major flood events that transported large amounts of sediment into the Entiat channel (USDA 1979). The most recent fire occurred in August 1988, when 52,000 acres of the lower Entiat watershed burned.

Table 1. Description of Entiat River watershed.

Subwatershed	Stream Length (miles)	Drainage Area (sq. mi.)	Elev. at Mouth (feet)	RM Confluence
Entiat	47.8	416*	707	
Mad River	24.6	94		10.6
NF Entiat		28		34.0

*Total square miles of Entiat including tributaries (Hydrology Subcommittee 1964).

Water Resources

Prior to the fires of the 1970s, the mean annual runoff of the 419 square miles of Entiat watershed averaged 367,379 acre-feet (1951 through 1958). After 1970, the runoff has increased to 528,275 mean acre-feet. This is a 44 percent mean annual increase in total water yield. Increased erosion and stream channel instability has significantly increased in many areas,

particularly along the mainstem Entiat between the junctions of the North Fork and Mad River.

Flow measurements at the town of Entiat exhibit average low flows at 201 cfs (Table 2). High flows average 1,657 cfs for the same time period, ranging from 310 cubic feet per second (cfs) to 2,870 cfs. Runoff patterns are similar to the Wenatchee River, but tend to show more extreme fluctuations due to the instability of the watershed.

Land Use

The Entiat River system has large areas of intermingled ownership lands (Table 3). In many areas, particularly forested regions, the land lies in a checkerboard ownership pattern, alternating between private and federal ownership. Much of this intermingled private lands are managed for timber production by large corporate landowners. Almost all of the private land falls within the roaded portions of the forest with minor amounts within wilderness or unroaded areas.

Besides the U.S. Forest Service, which manages the largest percentage of land within these drainages, the Bureau of Land Management and the Washington Department of Wildlife manage substantial tracts of land. In addition, there are many existing designations for mineral entry, power sites, reclamation administration and recreation. The Bonneville Power Administration has several major energy transmission corridors that are managed under memorandums of understanding with the U.S. Forest Service.

Table 2. Streamflow averages (in cfs) in the Entiat River at Entiat, 1972-1987 (WDE).

YEAR	LOW	HIGH
1975	164	1,140
1976	222	2,310
1977	58	310
1978	116	3,340
1979	21	1,450
1980	70	1,750
1981	100	2,000
1982	145	2,050
1983	106	2,850
1984	78	2,070
1985	60	754
1986	737	758
1987	735	754
AVERAGES	201	1,657

Table 3. Land ownership in the Entiat River Basin.

Ownership	Approx. Acres*	%
State		
Common School, Indemnity and Escheat	9,000	3.4
Dept. of Wildlife	1,000	.4
Federal		
National Forest	208,000	79.1
Wilderness	14,000	5.3
Private		
Private Ownership	31,000	11.8
TOTAL AFFECTED DRAINAGE	263,000	100

*Acres are approximations derived from the U.S. Department of Natural Resources Quadrangle maps of Washington State Public Lands 1:100 000 Scale Series (Planimetric).

PART II. HABITAT PROTECTION NEEDS

History and Status of Habitat

Watershed Description

The Entiat River Basin is composed primarily of metamorphic schist and gneiss, intrusive granodiorite and quartz diorite. Most of the area is covered by volcanic ash and pumice that erupted from Glacier Peak at intervals within the last 12,000 years. In some places these pyroclastic deposits are deep enough to cover underlying bedrock. Alpine glacial outwash and fluvial deposits form the valley floor.

Basin elevation goes from 700 feet at the river's confluence with the Columbia River to the basin's highest elevation, 9,249-foot Mount Fernow. The watershed is approximately 42 miles in length and varies between five miles and 14 miles wide with a relatively narrow valley floor. Soils vary in depth and are weathered from parent granitic bedrock and pyroclastic deposits. Erosion hazard varies widely with slope, location in the watershed, vegetative cover and local soil type.

Basin climate varies from that typical of an arid grassland at the river mouth to moist alpine conditions in the headwaters. Annual precipitation ranges from 90 inches in the headwaters to less than 10 inches near the mouth. Thunderstorms in the summer occasionally produce flash flooding at the mouths of narrow tributary canyons.

Approximately 84 percent of the basin is in federal ownership, with the U.S. Forest Service by far the largest owner. Another 13 percent is privately held while the remainder is in state ownership. Approximately 87 percent of the watershed is timber production. Cattle grazing is common throughout the forested areas of the watershed. Orchard and pastures have been developed along the valley floor adjacent to the river. Even though these land uses constitute less than 1 percent of the basinwide land use, they occupy important riparian habitat and significant stream alterations have been made to protect these properties. Recreational homes dot the riverbanks in the upper watershed and have locally contributed to degradation of the riparian and stream habitat.

Upland habitat was severely damaged in 1970 when approximately 22 percent of the basin burned. More recently in the summer of 1988, approximately 50,000 acres of the lower basin burned in the Dinkleman Ridge fire. The U.S. Forest Service has pursued an aggressive revegetation program following fire events with only limited success. The state of the upland watershed,

coupled with several severe storms, have resulted in massive delivery of sediment to the Entiat River.

Aquatic Habitat Description

The Washington Department of Ecology's ambient monitoring program samples one site on the Entiat River, which is located near the town of Entiat (ST. 46A070). Samples have been taken on a monthly basis since July 1959.

Average monthly temperatures, as recorded since 1980 through 1988, ranged from mid-30s Fahrenheit up to about 60 F (Fig. 1). A high temperature of 70.8 degrees was recorded August 1986. Like the Wenatchee River, high temperatures occur during periods of low flows. However, low flows are generally attributed more to natural runoff conditions rather than water withdrawal. The fires of the 1970s continue to influence runoff, resulting in spiked flows and perhaps decreasing flows below their normal lows as compared to the pre-1970s.

Dissolved oxygen concentrations fall within acceptable range for salmonids and is usually above 10.0 parts per million (ppm). The lowest recorded dissolved oxygen concentration is 8.7 ppm, which occurred during August.

Alkalinity, pH, and ionic concentrations fall within normal ranges. No fish tissue or sediment sampling is conducted within the waters of the Entiat.

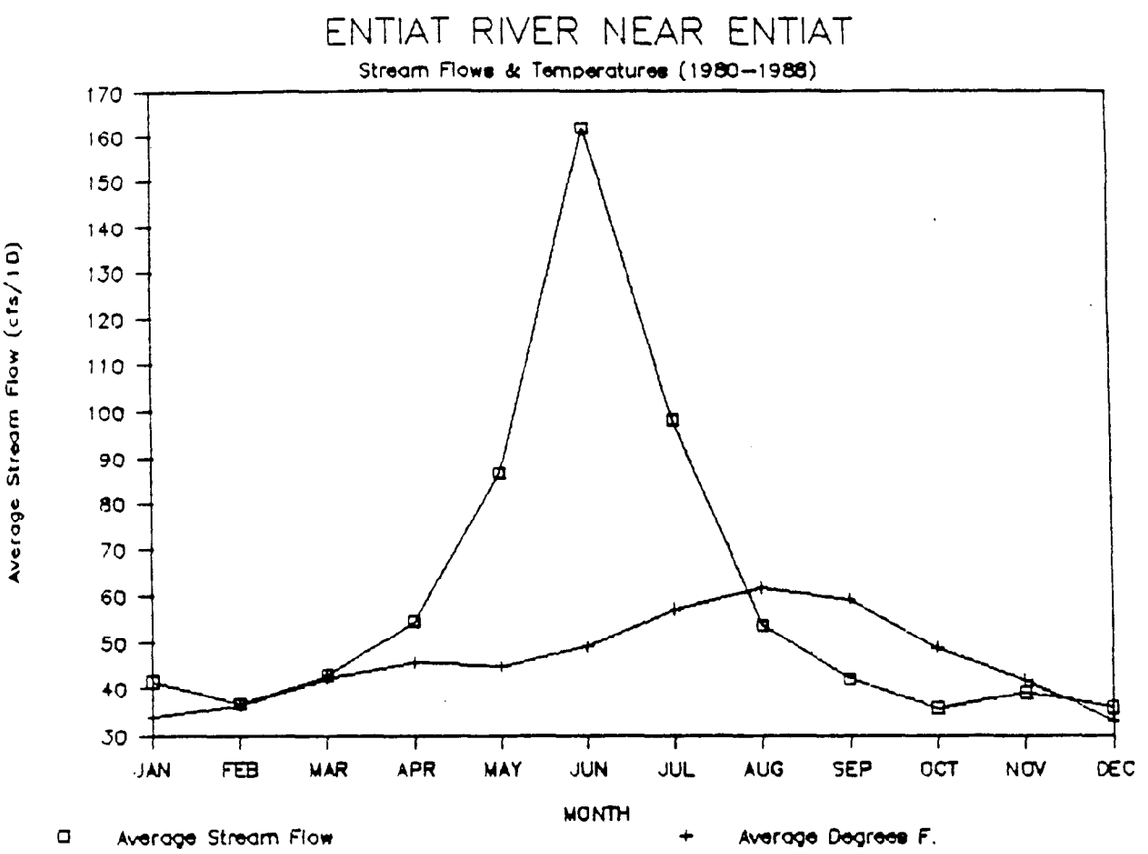
Habitat Factors Limiting Fish Production

Waters in the Entiat River are naturally cool, especially in their forested upper reaches. These cool temperatures coupled with relatively low nutrient characteristics and severe flushing flows combine to limit biological productivity.

The relatively high gradient of valley wall tributaries limit anadromous fish production. This natural constraint is typical of tributaries of glaciated mainstems. Gradient begins to limit anadromous fish production in the Entiat River beginning at approximately RM 27.

Within the Entiat River Basin, riverine habitat structure has been modified by severe flooding and sedimentation, associated with loss of watershed vegetative cover. Remedial channel modifications taken in response to these storm events has permanently altered habitat in some reaches. In addition, debris removal work eliminated organic materials from the channel that likely would have provided fish habitat.

Figure 1


ENTIAT RIVER NEAR ENTIAT
Stream Flows & Temperatures (1980–1988)
Average Stream Flow (cfs/10)
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
MONTH
Average Stream Flow
Average Degrees F.

The Entiat River is typical of streams on the east slopes of the Cascade Mountains that experience high flows in the spring and early summer during snowmelt, then very low flows during late summer and early fall. Rearing habitat for juvenile salmonids may be limited during both the high and low flow stages. Newly emerged chinook fry rear in areas of low velocity, principally along shoreline margins and in backwater areas. In a pristine stream, high flows during the freshet create backwaters and flood shoreline vegetation to make low velocity rearing habitat. However, on the lower Entiat, the development of orchards and other agricultural areas along the shorelines have often included shoreline armoring and fill. These agricultural practices, along with highways and other developments, have reduced the amount of low velocity rearing habitat in these rivers during high flow periods.

Low flows during the late summer and early fall may be a major limiting factor on the production of yearling chinook and steelhead. Low flows naturally result in a reduction of total rearing area, which limits the potential production of fish. Due to the large difference between the annual high flow and low flow (low flows are often one-thirtieth of the spring flow), the river channel at low flow offers very little cover for rearing fish. Undercut banks and shoreline vegetation may be many yards away from the water's edge, and in the low gradient areas, the river bottom is often composed of imbedded cobble that offers little usable habitat for juvenile salmonids.

The normal low flows of late summer are exacerbated in the Entiat River due to the reliance of the agricultural community on surface water diversions for irrigation. The Entiat River does not at this time have any instream flow restrictions to irrigation withdrawals.

The dominant impact limiting anadromous fish production are the Columbia River dams. Although not an inbasin feature, they remain as major obstacles on the "habitat path" for basin fish and mortality at these projects substantially overshadows inbasin habitat limitations.

Constraints and Opportunities for Protection

Legal Considerations

There is an existing patchwork of sometimes overlapping regulation designed to limit impacts to the public's stream and shoreline resources in the state of Washington. This body of rules is generally poorly understood by the public. Environmental laws that set standards, regulate, or restrict actions, which could impact stream and shoreline resources are listed below, along with the responsible agency.

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

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

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

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

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

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

7) Instream Resources and Water Allocation Program, Dept. of Ecology

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

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

10) Flood Control Management RCW 86.26, Dept. of Ecology and local governments

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

Since the adoption of the 1917 Water Code, the state of Washington has allocated water based on the Prior Appropriations Doctrine. In many cases, the amount of water allocated has resulted in many over-appropriations and the reduction in corresponding anadromous fish runs. Instream flow protection started with Chapter 75.20 RCW (1949), with Department of Fisheries and Department of Wildlife recommendations for low flow conditions and stream closures to further appropriations of water. Since 1969, beginning with passage of the Minimum Water Flows and Levels Law (RCW 90.22), the state law has acknowledged a greater need to protect instream flows for fisheries and other instream values through developing basinwide flow protection programs. In addition, the 1917 Water Code provided that water permits would not be granted that could prove "detrimental to the public welfare." (RCW 90.03.290).

Both the Minimum Water Flows and Levels Law and the Water Resources Act of 1971 (RCW 90.54) direct the Department of Ecology to set minimum or base flows that protect and preserve fish and other instream resources. Because minimum or base flow

regulations do not affect existing water rights, reductions in anadromous fish runs in overappropriated streams will continue to be a problem. The Water Resources Act specifically lists fish and wildlife maintenance and enhancement as a beneficial use. It further directs the Department of Ecology (DOE) to enhance the quality of the natural environment where possible.

The state statutes, however, do not define the extent of instream resource protection, leaving to the Department of Ecology the task of determining adequate protection levels for instream flows. This has caused increasing controversy in recent years and resulted in an attempt by the DOE to define the level of flow that was to be provided for fish in the state's streams. The Department of Ecology's 1987 effort to set a standard of "optimum" flows for fish was challenged by out-of-stream water users via the Washington Legislature in 1988. The 1988 Legislature put a moratorium (which has now been lifted) on the DOE's recommended standard and established a Joint Legislative Committee on Water Resources Policy to address Washington's water future. To date, the committee has yet to define the level of protection that will be afforded fish resources.

Lacking any legislative direction on instream flow protection levels, water continues to be allocated from state streams under past practices. All water right applications are reviewed by the Department of Fisheries (WDF) and the Department of Wildlife (WDW), under RCW 75.20, prior to issuance by the Department of Ecology. The Ecology Department considers WDW and WDF comments before making a decision regarding the issuance of a permit for withdrawal. Wildlife and Fisheries Department comments are recommendations only, and can be accepted or ignored by the Ecology Department. DOE practice is to issue water permits if water, above that recommended to be retained instream, is available for allocation. Virtually all domestic use requests are approved as are many non-domestic requests. The impacts of specific withdrawals on fish resources is often unclear, however, the cumulative impact of the new withdrawals is less instream water and negative impacts on fish populations.

The majority of Washington's streams do not have minimum flows established. Yet the Department of Ecology continues to issue permits for diversion and water withdrawal. It is unlikely that the current system will change until the Joint Legislative Committee on Water Resources Policy defines state policy in this area. The committee's decision could have a major impact on the future of the state's fisheries resources.

The fisheries agencies have requested that for most streams, instream flows be protected at levels that would maintain existing fish production, including the full range of variations that occurs naturally due to environmental conditions. For some streams, like the Yakima River, the fisheries agencies request

flows to levels that would achieve potential production. This potential production would be determined by analyzing what could reasonably and practically be expected to return to the stream in the future.

In those streams that have already been overappropriated, establishment of instream flows may limit losses of fish resources to that which has already occurred. In many of these streams, restoration of instream flows is requisite for increasing or reestablishing fish runs.

In support of the continuing investments by the Northwest Power Planning Council's Columbia River Basin Fish and Wildlife Program, the following recommendations are made relative to instream flows and fisheries resources:

1) No new out-of-stream appropriations of any kind should be issued unless appropriate instream flow levels are established for the stream to be impacted either through comment on the water right application or through the adoption of an instream flow regulation.

2) There should not be any exceptions to the minimum flow levels, including domestic use.

3) Minimum flows should be impacted only if concurrence is obtained from the state and federal fish resource agencies and tribes and adequate mitigation is provided.

4) Minimum instream flow levels should be adequate to protect existing and potential (where appropriate) fish production.

5) State law should be changed so that saved, purchased or donated water can be dedicated to instream flows.

Institutional Considerations

In many cases, important factors affecting the quantity and quality of aquatic habitat are outside the direct regulatory authority of the fisheries management agencies. Agency cooperation is critical to the protection of aquatic resources.

A good example of how agency cooperation strengthens a regulatory program is the procedure the Department of Natural Resources uses to review forest practice applications. These new rules and agreements, commonly referred to as Timber/Fish/Wildlife (TFW), encourage interdisciplinary review of individual forest practice applications. Another example is the attempt to coordinate permits for streambank stabilization through the memorandum of understanding signed by the Washington departments of Fisheries, Wildlife, and Ecology, and the conservation districts and the U.S. Soil Conservation Service.

Better interagency communication of goals and objectives within watersheds and then cooperative administration and enforcement of rules could improve habitat protection.

All agencies have different management mandates and objectives. Some, such as the Department of Fisheries, have specific management objectives. Others, such as the Department of Wildlife, have more complex management responsibilities (some of WDW programs depend on voluntary cooperation of those they must also regulate). In general, all the fisheries management agencies subscribe to some statement of "no net loss" of existing habitat as a management goal. Even though this goal is difficult to attain, it is an appropriate policy, one that subbasin planning supports and the only one that will protect the production potential of entire river systems for the long term.

In spite of the best efforts of numerous state and federal agencies and the imposition of regulatory programs, much of which the public deems onerous and excessive, there is a gradual loss of aquatic habitat. This cumulative loss is occasioned by the routine development of natural resources and dedication of shoreline and water resources to uses other than natural. These incremental impacts have resulted in reduced anadromous fish production in Columbia River subbasins. Subbasin planning must address the problem of cumulative habitat loss if the goals of the Northwest Power Planning Act are to be achieved.

Critical Data Gaps

Developing strategies that will accomplish specific production objectives requires a detailed knowledge of the aquatic system and the biology and behavior of the fish. Parts of both data bases exist, but significant gaps remain. Since spawning habitat does not appear to be limiting for any species of anadromous fish in these subbasins, research should concentrate on rearing habitat utilization, passage limitation, and entrainment within diversion due to inadequate screening.

To improve resiliency of a natural stock through habitat manipulation, an action must rely on an understanding of micro-habitat utilization over the freshwater residence period. Some of this information for chinook has been collected (Hillman et al. 1986), but it is likely that much more must be known.

The role of the mainstem Columbia River reservoirs in chinook production is poorly understood. For summer chinook this is an especially important topic and one that needs to be understood if these stocks are to be enhanced efficiently.

Agricultural development that alters natural conditions, has and continues to impose a variety of shoreline treatments in these subbasins. For habitat management purposes, it is

important to know how these treatments effect habitat productivity.

Additional species interactions information would be helpful in assessing the effects of enhancing an anadromous stock within the same range.

Neither the Wenatchee or the Entiat rivers have had complete IFIM (instream flow incremental methodology) studies to determine appropriate flows to provide habitat for anadromous fishes. Some of the micro-habitat utilization data collected by Hillman et al. (1986) should be especially useful in this analysis.

Habitat Protection Objectives and Strategies

Objectives

The habitat protection objectives for the Wenatchee, Entiat and upper Columbia rivers are stated below. These objectives pertain primarily to the protection of existing habitat, but to a lesser degree, address habitat improvement generally. Specific habitat improvement projects will appear in individual species sections.

1. Maintain existing habitat.

2. Maintain water quality.

3. Maintain existing surface water quantity and where possible, establish flows more conducive for fish habitat.

4. Increase security for existing habitat.

5. Increase usage of existing underutilized habitat.

6. Enhance production potential of existing habitat.

7. Increase quality of habitat through selected, cost-effective enhancement programs.

8. Eliminate fish entrainment in diversions.

Strategies

Strategies for securing the preceding kinds of habitat objectives generally are outside the direct influence of the Northwest Power Planning Council. As such their implementation must, to a large degree, remain the responsibility of the fisheries agencies and Indian tribes. The Northwest Power

Planning Council has already taken action to limit the proliferation of hydroelectric impacts by developing the "protected areas" program, which identifies stream reaches where hydroelectric development would be inappropriate. Unless these general habitat objectives can be realized basinwide, the subbasin plans and the interim goal of doubling fish production from the Columbia River will ultimately be jeopardized by the cumulative loss of habitat. The agencies and Indian tribes must take an aggressive, proactive and cooperative approach to habitat protection. Community and local government support must be cultivated for their work.

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

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

2) Provide funds for long-term habitat monitoring activities in support of fish and wildlife program production strategies.

2) Funding additional habitat management positions within the agencies and tribes.

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

4) Purchasing riparian property adjacent to critical habitat.

5) Testifying at state legislative hearings when habitat protection laws are threatened as has been the case in Washington for the past four years.

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

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

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

This is an area that does not lend itself to neatly engineered strategies. As a result there is a danger that this portion of subbasin planning will be given less consideration than it should receive during the implementation phase. The

struggle to prevent cumulative loss of habitat is ultimately one of public policy and administration of carefully crafted state and federal statute.

The agencies and Indian tribes could bolster their habitat protection programs by initiating a cooperative review of regional programs. Such a review would identify specific common goals, specify cooperative action to achieve those goals, monitor and periodically modify actions in pursuit of those goals.

State and federal habitat protection efforts could be enhanced by better interagency communication of goals and objectives. A well coordinated approach to the imposition of different existing regulatory programs is needed because no one statute is broad enough in scope to succeed alone. Anything the Northwest Power Planning Council can do to encourage a cooperative approach to habitat protection will be important. Any plan should attempt to identify general strategies and participants responsible for implementing proposed actions.

PART III. CONSTRAINTS AND OPPORTUNITIES FOR ESTABLISHING PRODUCTION OBJECTIVES

Institutional Considerations

There are a number of federal, state, and local agencies and organizations that are involved and/or related in some way to anadromous fish production within these subbasins. The names of these agencies are listed below.

Federal Land and Water Managers

- Department of Agriculture
  - U.S. Forest Service
  - Soil Conservation Service
- Department of the Interior
  - U.S. Geological Service
  - U.S. Fish and Wildlife Service, including Leavenworth National Fish Hatchery and Entiat National Fish Hatchery
- Federal Energy Regulatory Commission
- U.S. Army Corps of Engineers

Tribes

- Yakima Indian Nation
- Confederated Tribes of the Colville Reservation
- Umatilla Tribe (intervenor in mid-Columbia proceedings)

State Land and Water Managers

- Washington Department of Fisheries
- Washington Department of Wildlife
- Washington Department of Natural Resources
- Washington Department of Ecology
- Oregon Department of Fish and Wildlife (intervenor)

County Land and Water Managers

- Chelan County Public Utility District
- Douglas County PUD
- Grant County PUD

Since the construction of the mainstem Columbia dams, the public utility districts and fishery agencies have undertaken been various mitigation efforts. Some of these are described in Part IV of this document. Recently, the Rock Island and Wells settlement agreements have been renegotiated. The Rock Island Agreement was signed April 1987, establishing Chelan's obligations with respect to development, installation, and

operation of juvenile downstream migrant bypass facilities, juvenile fish passage through spill, hatchery compensation for fish losses, and fish ladder operation (FERC 1987). With regard to fish production, information will be brought out in more detail in Part IV. At the time of this writing, negotiations were still under way for Wells Dam mitigation.

Legal Considerations

Indian Treaties

With the conclusion of the Yakima Indian Treaty (1855) and the subsequent Executive Order of July 2, 1872, most of the original native Americans who inhabited regions that are presently Chelan, Kittitas, Yakima, Okanogan, and Douglas counties were resettled onto the Yakima and Colville reservations. As guaranteed by the Yakima Treaty of 1855, the Yakima Nation reserved the right to continue to hunt and fish outside of the established reservation without interference from states or the federal government, absent express acts of Congress. The majority of the Wenatchee Basin was encompassed within lands ceded by the Yakima Indian Nation to the U.S. government.

The area of the Columbia River north from Priest Rapids Dam and extending to the Canadian border, including the tributaries, is part of the original territory of numerous Indian tribes. Those tribes include, but are not limited to, the Chelan, Wenatchee, Entiat, Columbia (Moses band), Yakima, Palouse, Okanogan and Nespelem tribes. This entire area was used extensively by Indian people for hunting and fishing as well as being an integral part of their cultural and religious way of life. It is still a significant resource area and includes many places considered sacred by Indian people today. The use of this area by Indian people is not questioned. There is however a dispute between existing Indian nations as to the nature and extent of rights within the subbasin.

Among those tribes who signed the Treaty at Walla Walla and reserved the rights to fish off-reservation were the Yakima, Chelan, Wenatchee, Entiat and Columbia tribes. The Confederated Tribes and Bands of the Yakima Indian Nation and its members, as the legal successors in interest to those tribes, reserved those rights for itself and its members. Today members of those tribes reside on and off reservation.

As a result of the treaty right to fish, tribes that were party to the treaties retain substantial governmental authority over the activities that affect hunting and fishing. Thus, treaty tribes have a right to co-manage and to participate equally in fishery management decisions affecting the Columbia

River including its tributaries. Such co-management responsibilities include harvest management, habitat development or modification, fish culture and enhancement projects, as well as habitat utilization and restoration.

Colville Tribe

The Colville Indian Reservation occupies territory that includes the Columbia River from Chief Joseph Dam to the confluence of the Columbia and Okanogan rivers, and the Okanogan River north to the Colville Reservation boundary.

Those portions of the Columbia and Okanogan rivers within the Colville Reservation as well as that portion of the Okanogan River north of the Colville Reservation are within the jurisdiction of the Colville Tribes. Tribal law applies to the exercise of fishing activities on those waters.

Yakima Indian Nation

As is noted above, the subbasin area is virtually all within the lands ceded by the Confederated Tribes and Bands of the Yakima Indian Nation to the United States in the Yakima Treaty of 1855. The Yakima Indian Nation formed the Confederation of the Tribes and Bands occupying and using this region. Since before treaty times and even more substantially at present, the Yakima Indian Nation has exercised management authority over its fisheries and fishermen from Bonneville Dam to the headwaters of the areas in this subbasin. The Yakima Nation, pursuant to the Treaty of 1855, retained this authority as a confederation and on behalf of the tribes who were joined into the Yakima Confederation under the Treaty of 1855.

Federal Acts

The Wild and Scenic Rivers Act, PL 90-542, does not include the Wenatchee or the Entiat rivers. However, as part of the forest planning process, they are being considered for inclusion (Table 4). Portions of the Chiwawa, White, Wenatchee, Entiat, and Mad rivers are currently on the list for inclusion. Upper reaches of some of these watersheds are located within existing designated wilderness and already fall under protection of wilderness area management. But there are segments outside wilderness regions that have been determined eligible and are presently being considered for inclusion (U.S. Forest Service 1986).

Table 4. Rivers in the Entiat watershed being considered for inclusion into the national Wild and Scenic Rivers System.

RIVER	SEGMENT	CLASSIFICATION	LENGTH/-MILE
N.F. Entiat	All	Wild	9.2
Entiat	Above Cottonwood Campground	Wild	3.5
Entiat	Below Cottonwood Campground to Forest boundary	Recreational	13.7
Mad	Above Pine Flat Campground	Wild	24.0

Wilderness areas occupy large portions of the Entiat watershed. The establishment of wilderness areas was designated by Congress with the Wilderness Act of 1964, which, at that time, included Glacier Peak Wilderness Area. In 1976, Alpine Lakes region was added. Since then, the Washington State Wilderness Act of 1984 has added 62,712 acres to Glacier Peak Wilderness and established the Henry M. Jackson Wilderness Area. Present acreage includes: Glacier Peak - 576,865 acres; Henry M. Jackson - 103,591 acres; and Alpine Lakes - 393,360 acres. Total area that falls within the Entiat drainage is 14,000 acres, or 5 percent of watershed.

State Laws

All of the following laws potentially affect fish production.

- Hydraulic Code, RCW 75.20
- State Environmental Policy Act, RCW 43.21C
- Water Quality Certification
- Forest Practices
- Shoreline Management Act - local decisions reviewed by Department of Ecology
- Water Resource Program, Implementing Water Rights
- Department of Natural Resources Land Lease Agreements

PART IV. ANADROMOUS FISH PRODUCTION PLANS

Within the region identified in this subbasin plan, there are four species of anadromous salmonids present -- chinook (Oncorhynchus tshawytscha), coho (Oncorhynchus kisutch), sockeye (Oncorhynchus nerka) and steelhead (Oncorhynchus mykiss). Among these, various stocks have been identified that have specific management implications, which will be addressed within the following subsections.

The Entiat River is managed for spring chinook and steelhead. Summer chinook, sockeye and coho are also present in the Entiat system, but at low levels. Consequently, these three stocks will not be tested in detail.

Habitat quality has been significantly reduced from historic levels as a result of fires occurring in 1970, 1976 and 1988. With the burning of considerable amounts of vegetation, coupled with high intensity rain and flooding, erosion of slopes and deposition of materials within the river resulted in heavy losses of spawning and rearing habitat. The river, however, is undergoing a natural rehabilitative process, particularly within the upper reaches, which were completely inundated with silt and sand in 1972.

The stream gradient on the Entiat steepens at about RM 27, with the Box Canyon Cascades located at RM 29.1. This reach may act as a partial barrier to upstream migration, depending upon flows and species. A complete barrier exists at RM 33.8, preventing passage into the upper Entiat, including the North Fork. Habitat between RM 27 and RM 33.8 is questionable for chinook.

Like the Leavenworth National Fish Hatchery, the Entiat National Fish Hatchery was built for mitigation purposes. Presently, it rears both spring chinook and steelhead for release into the Entiat system. Coho production was discontinued in the late 1960s because of the inability to reestablish the run.

The Entiat facility is presently operating at capacity with no potential for increases in yearling production. There may be limited potential for increased fingerling productivity using the adult holding pond. This pond is programmed for improvement, hopefully reducing pre-spawning mortality.

In terms of identifying objectives, general considerations focus on United States vs. Oregon negotiations and the need to use this planning process as a means to fulfill the implementation of that decision. At the core of the United States vs. Oregon agreement is the objective "to rebuild weak

runs to 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 wild 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.

The plan established a mechanism that gives a priority to developing tributary fishing opportunities as run sizes exceed spawning escapement objectives. In the interim, mainstem fisheries are limited to specific harvest levels, as a function of spring chinook run to Bonneville Dam and to Lower Granite Dam on the Snake River. Non-Indian sport fisheries will be limited to the 1983 through 1985 average, in no cases exceeding 5 percent (combined sport and commercial) of the total inriver run size of upriver spring chinook adults.

Consistent with United States vs. Oregon is the need to maintain a flexible and dynamic plan 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 resolve disagreements over fishing regulations and collection and interpretation of management data.

As an extension of these objectives, any subbasin plan should:

1. Protect stocks within the upper basin areas by minimizing dam passage mortality.

2. Achieve a balance with the stock of any given type, such as spring, summer and fall chinook.

3. Work toward harvest stability within the subbasins.

4. Provide equitable opportunity to each user group.

5. Maintain habitat and improve where possible.

6. Manage for consistent achievement of escapement allowances.

7. Optimize production and maximize long-term net benefits.

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

SPRING CHINOOK SALMON

Fisheries Resource

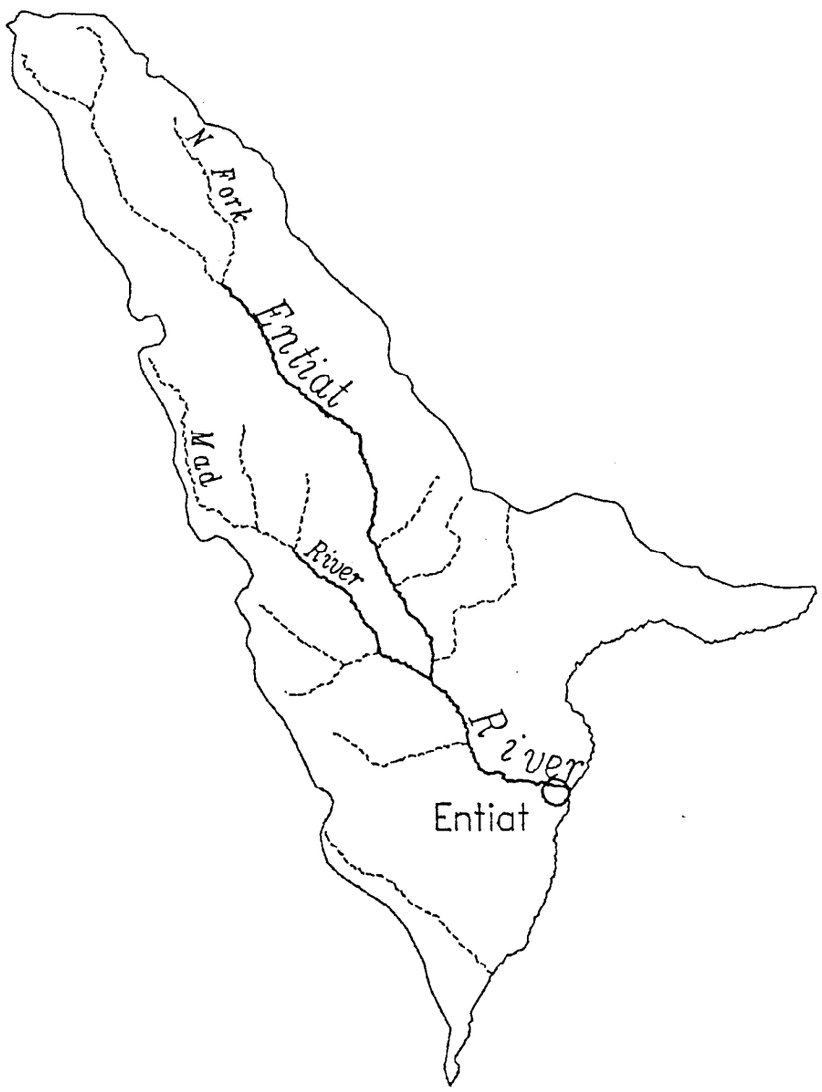
Natural Production

Entiat spring chinook are managed on a natural stock basis. Run sizes entering the Entiat River are estimated on the basis of interdam counts. Spawning ground surveys are also conducted, but they are not considered as reliable as dam counts. During 1977 through 1985, run size ranged from about 760 fish in 1983 to 4,400 fish in 1978 (Table 5). Releases of hatchery-origin spring chinook occur at the Entiat National Fish Hatchery, with annual releases of about 0.6 million to 1 million fish in recent years. There has been no directed fishery in the terminal area on spring chinook with the exception of a sport fishery in 1986, which took less than 100 estimated fish.

Freshwater life history of Entiat spring chinook is similar to what was described for the Wenatchee (Table 6). Poor spawning and rearing habitat exists in the Mad River up to Tillicum Creek, whereupon habitat is upgraded to "fair" up to Young Creek. A series of water falls at RM 29.1 forms a natural barrier. Another passage problem exists at Roundy Diversion Dam at RM 16.5. Natural stock spring chinook must pass this low, wooden diversion structure. Under certain conditions, this dam causes delay and possible injuries. Recently, the regional habitat manager has required the owner to improve passage in conjunction with dam maintenance. However, improvements involved moving rock from downstream to raise the tailwater and reduce the height that fish must jump. A more permanent solution is needed.

Some fair spawning and rearing habitat occurs sporadically up the Entiat from Mud Creek to Potato Creek; from Stormy Creek to Tommy Creek; and from Lake Creek to the North Fork of the Entiat River. Fair rearing habitat occurs from the mouth of the Entiat up through these spawning and rearing areas. Smolt carrying capacity is estimated at 176,000 smolts, based on the Smolt Density Model.

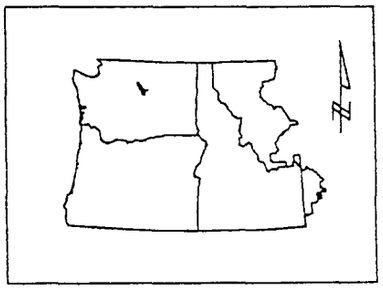
ENTIAT SUBBASIN



SPRING CHINOOK DISTRIBUTION*

——————— PRESENT/POTENTIAL

---------- ABSENT



GIS GEOGRAPHIC INFORMATION SYSTEM

BONNEVILLE POWER ADMINISTRATION

* Due to the limitations of scale, all streams which support anadromous fish are not shown on this map.

Table 5. Subbasin adult harvest and spawning escapement for Entiat spring chinook.

SPAWNING ESCAPEMENT	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
HATCHERY										
ENTIAT				305	247	242	660	753	793	959
NATURAL/WILD	2132	3844	1300	637	1834	517	629	899	3671	N/A
TOTAL ESCAPEMENT	2132	3844	1300	942	2081	759	1289	1652	4464	N/A
SUBBASIN HARVEST										
RECREATIONAL HARVEST										100
TRIBAL										
SUBTOTAL	0	0	0	0	0	0	0	0	0	100
TOTAL IN-RIVER RUNSIZE	2132	3844	1300	942	2081	759	1289	1652	4464	N/A

Table 6. Freshwater life history of spring chinook.

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

Sex ratio of the natural run averages 58.6 percent female. Hatchery spring chinook have shown much higher (and variable) sex ratios (83 percent in 1984, and 61 percent in 1985). Three quarters of the returning chinook are ocean age-2 fish and the rest, ocean age-3 fish. Fecundity is estimated at 4,400 eggs per female. Average size of fish collected during 1978 through 1986 was 34 inches for males and 29.7 for females. Using the Data Standardization Report's egg-to-smolt survival rate regression, the average for 1977 through 1985 was 7.37 percent. The survival rate ranged from 11.91 percent for peak years like 1978, to 3 percent in poor years like 1982. The record year of 1978, according to this method, would have produced 297,341 smolts (1.7 times the estimated carrying capacity). It is therefore likely that the egg-to-smolt survival or fecundity estimates are high.

The major constraint on the Entiat River is productivity, with instream cover and adequate flows also problems. Since the Entiat is in a semiarid farm region, irrigation diversions and improper culvert installation have adverse effects on spring chinook production. Upstream migration within the Entiat occurs in spring, with spawning taking place primarily within the headwaters during late summer. The fry emerge in early spring and emigrate to the lower reaches of the primary tributaries, and the mainstem Entiat River, where they rear until emigrating during late spring and early summer. These constraints, and the temporal distribution of the stock, must be considered in habitat maintenance and improvements, supplementation, and other such programs.

Transplants of fish from sources outside the mid-Columbia have been made (Table 7). There is a distinct possibility that wild stocks have been supplemented by gene flow from hatchery stocks of Carson National Fish Hatchery origin. It should also be noted that the original brood stock for the Entiat hatchery was a mixed bag of whatever came over Rock Island Dam, and then supplemented with stock from the Little White Salmon Hatchery, Carson Hatchery, and Icicle River.

Hatchery Production

The egg-take goal for Entiat spring chinook releases is currently 1.3 million eggs, with a planting goal of 800,000 smolts. Actual release patterns have ranged from about 0.6 million to 1 million fish. Egg sources have included Carson National Fish Hatchery, Little White Salmon National Fish Hatchery, Cowlitz, Icicle, and Entiat stocks (Table 7).

Table 7. Releases of hatchery spring chinook in the Entiat subbasin

RELEASE YEAR	HATCHERY	NUMBER RELEASE /1	RELEASE LOCATION	ADULT BROOD COLLECTION SITE
1974	ENTIAT	436000 S	ENTIAT RIVER	COWLITZ RIVER
1975	ENTIAT	631200 S	ENTIAT RIVER	CARSON NFH
	ENTIAT	400000 S	ENTIAT RIVER	LITTLE WHITE NFH
	ENTIAT	268400 S	ENTIAT RIVER	CARSON NFH
1976	ENTIAT	257000 S	ENTIAT RIVER	CARSON NFH
	ENTIAT	165000 S	ENTIAT RIVER	LITTLE WHITE NFH
1977	ENTIAT	459000 S	ENTIAT RIVER	CARSON NFH
1978	ENTIAT	61900 S	ENTIAT RIVER	CARSON NFH
	ENTIAT	596200 S	ENTIAT RIVER	LITTLE WHITE NFH
1979	ENTIAT	247900 S	ENTIAT RIVER	CARSON NFH
	ENTIAT	326800 S	ENTIAT RIVER	LITTLE WHITE NFH
	ENTIAT	48600 S	ENTIAT RIVER	ICICLE CREEK
1980	ENTIAT	481300 S	ENTIAT RIVER	ENTIAT RIVER
	ENTIAT	380600 S	ENTIAT RIVER	CARSON NFH
	ENTIAT	136000 S	ENTIAT RIVER	ICICLE CREEK
1981	ENTIAT	136200 S	ENTIAT RIVER	CARSON NFH
	ENTIAT	621800 S	ENTIAT RIVER	LITTLE WHITE NFH
	ENTIAT	197900 S	ENTIAT RIVER	ENTIAT RIVER
1982	ENTIAT	386400 S	ENTIAT RIVER	ENTIAT RIVER
	ENTIAT	259000 S	ENTIAT RIVER	CARSON NFH
1983	ENTIAT	894000 S	ENTIAT RIVER	ENTIAT RIVER

1/ S in this column designates smolt releases.

Adult hatchery returns to the Entiat River from 1980 to 1986 have ranged from 242 adults to 959 adults (Table 5). Age structure is based on length-frequency information from 1984 and 1985 samples. In both years, 76 percent of the adults returned as ocean age-2 fish, 24 percent as ocean age-3 fish. Based on the same information, 83 percent and 61 percent for 1984 and 1985 respectively, were females. Eggs per female is based on the standard value of 4,400.

Egg-to-smolt survival is approximately 70 percent (56 percent to 84 percent). Based on returns and releases for the past decade, the smolt-to-adult survival rate is approximately 0.07 percent. No supplementation program or hatchery program is scheduled for the basin. Chelan County PUD operates Rocky Reach Dam below the Entiat River confluence, and may be party to such developments.

Specific Considerations

- The Entiat River is located above eight mainstem Columbia River dams.
- Entiat spring chinook are currently managed on a natural stock basis.
- Run sizes during 1977 through 1985 have ranged from 760 fish to 4,464 fish, including hatchery returns. Average run size is about 2,000 fish.
- Hatchery-origin spring chinook have originated from a variety of sources including Carson National Fish Hatchery, Little White Salmon National Fish Hatchery, and Leavenworth National Fish Hatchery.
- Direct fisheries occur infrequently on adult Entiat spring chinook. Above the Highway 97 bridge, salmon fishing is currently closed. Below the highway, jacks can be taken. Poaching has been a problem in the past, especially in 1985 when an estimated 450 adult fish to 500 adult fish were illegally taken.
- Fires during 1970, 1972, and 1988 have degraded habitat quality and quantity in the Entiat.
- Carrying capacity of the system has not been clearly defined.
- The current hatchery facility is presently operating at capacity with no potential increases in yearling production.

Objectives

Biological Objective

Maintain management on a natural stock basis, determine natural spawning potential and identify MSY.

This does not preclude the use of a hatchery stock to provide some level of terminal harvest, but it may be difficult to selectively harvest hatchery stock without impacting the natural component. To resolve this, it may be recommended that hatchery brood be composed of Entiat natural stock and harvest be designed accordingly.

Utilization Objectives

Level 1: Achieve returns to terminal area at levels that will allow a directed harvest of spring chinook that could support catch levels from 200 fish to 500 fish annually. Fisheries should be directed on hatchery origin fish, but with allowance of incidental harvest of natural stock of up to 20 percent of total catch.

Level 2: Achieve returns to terminal area at levels that will allow directed harvest of spring chinook, supporting catches from 500 fish to 1,000 fish annually. Returns from natural spawners would be expected to contribute up to 50 percent to the tributary catch at this level.

Alternative Strategies

There are three strategies proposed for Entiat spring chinook. The first focuses on reduction of natural mortality while the second attempts to provide increase in a natural habitat base. The third uses hatchery supplementation to increase production.

Modeling results for each strategy are presented in Table 8 as fish produced at "maximum sustainable yield" (MSY). The sustainable yield of a fish population refers to that portion of the population that exceeds the number of fish required to spawn and maintain the population over time. Sustainable yield can be "maximized," termed MSY, for each stock at a specific harvest level. The MSY is estimated using a formula (Beverton-Holt function) that analyzes a broad range of harvest rates. Subbasin planners have used MSY as a tool to standardize results so that decision makers can compare stocks and strategies.

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

The amount of buffer appropriate for each stock is a management question not addressed in the subbasin plans. For this reason, the utilization objective, which usually refers to harvest, may not be directly comparable to the MSY shown in Table 8. At a minimum, a strategy should produce an estimated MSY equal to or greater than the utilization objective. A MSY substantially larger than the subbasin utilization objective may be needed to meet subbasin biological objectives.

Critical assumptions focus primarily on the modeling exercises and the belief that conditions are accurately reflected. Like all of the models in this report, estimated changes first involved identification of maximum survival rates, which in most cases were generic values. Constraints, as identified within the tributary, diminished this value to some level due to such things as unscreened diversions or low flows. This value of decrease was based on best judgement or simply given an subjective value for calibration purposes and/or to provide some opportunity for increase.

From these base levels, identified actions increased these values. The actual result of a particular action is unknown, therefore increases are subjective. With this in mind, care must be taken to look at the results not in terms of absolute values but in relative values, and may merely illustrate where the sensitivities lay.

Estimated costs of the alternative strategies below are summarized in Table 8a.

STRATEGY 1: Natural Production, Level 1.

This strategy involves reducing smolt-to-smolt mortality by improving diversion screens. Since the extent of improvements in terms of increased survival rates is unknown, the value 0.8 was subjectively increased to 0.9 (Action 1). Similarly, Action 2 increased pre-spawning survival by 9 percent, changing the 0.72 rate to 0.79.

ACTIONS: 1, 2

1. Identify diversions with screening problems and replace or repair structures.

   Planners estimate costs to be approximately $75,000 in capital and $15,000 in annual operation and maintenance costs (Appendix C).

2. Decrease poaching activities through educational programs and placement of signs at Forest Service and primitive campgrounds along the river where poaching and harassment occurs. Increase enforcement during May through August.

STRATEGY 2: Natural Production, Level 2.

This strategy reflects potential increased habitat base as indicated in Actions 3 and 4. Passage at Box Canyon would provide an additional 4.7 miles of habitat. Using the density of 435.5 smolts per mile, as calculated from the stretch immediately downstream, production would increase by 2,046 smolts. For the spawning channel, given that there is little information about this site, a general assumption was made that it would provide additional spawning for 25 pairs of adults, or 23,100 additional smolts, assuming no density dependent factors.

ACTIONS: 1-4

1. -
2. -

3. Provide passage at Box Canyon RM 29.1, which would allow extended habitat utilization up to RM 33.8. In addition, maintain Roundy Diversion Dam at RM 16.5 to allow passage of spring chinook.

   Planners estimate costs to be approximately $1.5 million in capital and $20,000 in annual O&M costs.

4. Reactivate a spawning channel in the upper region of the Entiat that was built in the late 1960s.

   Estimated costs come to $300,000 in capital and $30,000 in annual O&M costs.

STRATEGY 3: Supplementation.

This strategy attempts to use a supplementation program similar to the ones identified for the Methow and Wenatchee rivers, in that local brood stock would be collected, reared in a remote site, then released via an acclimation pond. Actions 1 and 2 will also be implemented in conjugation with this strategy.

ACTIONS: 1, 2, 5

1. -
2. -

5. Introduce a supplementation program with an initial capacity of 200,000 fingerling spring chinook. Local brood stock will be used. Incubation and rearing would take place at the East Bank Hatchery. Releases would be made using an acclimation facility established in area of brood stock collection. (See Appendix C for estimated costs.)

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

Utilization Objective:

Level 1: Achieve returns to terminal area at levels that will allow a directed harvest of 200 to 500 fish annually. Fisheries should be directed on hatchery origin fish, but with allowance of incidental harvest of natural stock of up to 20% of catch. Level 2: Achieve returns to terminal area at levels that will allow directed harvest of 500 to 1000 fish annually. Returns from natural spawners would be expected to contribute up to 50% to the tributary catch at this level.

Biological Objective:

Maintain management on a natural stock basis, determine natural spawning potential and identify MSY. This does not preclude the used of a hatchery stock to provide some level of terminal harvest, but it may be difficult to selectively harvest hatchery stock without impacting the natural component. To resolve this, it may be recommended that hatchery brood be composed of Entiat natural stock and harvest be designed accordingly.

Strategy[1]	Maximum[2] Sustainable Yield (MSY)	Total[3] Spawning Return	Total[4] Return to Subbasin	Out of[5] Subbasin Harvest	Contribution[6] To Council's Goal (Index)
Baseline	1,279 -C	1,585	3,481	992	0(1.00)
All Nat	2,968 -C	2,857	6,936	1,977	7,518(1.99)
1	3,111 -C	2,821	6,682	1,905	6,967(1.92)
2	3,256 -C	3,231	7,347	2,095	8,414(2.11)
3*	NM				

*Recommended strategy.
NM - 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. Identify water diversions with screening problems and replace or repair. Decrease poaching activities through educational programs, placement of signs where problems exists, and increased enforcement activities. Post Mainstem Implementation.
2. Strategy 1 actions plus provide passage at Box Canyon, improve passage at Round Diversion dam, and reactivate spawning channel. Post Mainstem Implementation.
3. Supplement with an initial 200,000 fingerling spring chinook.

[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 8a. Estimated costs of alternative strategies for Entiat spring chinook. Cost estimates represent new or additional costs to the 1987 Columbia River Basin Fish and Wildlife Program; they do not represent projects funded under other programs, such as the Lower Snake River Compensation Plan or a public utility district settlement agreement. (For itemized costs, see Appendix C.)

	Proposed Strategies		
	1	2	3*
Hatchery Costs			
Capital[1]	0	0	46,000
O&M/yr[2]	0	0	5,000
Other Costs			
Capital[3]	150,000	1,950,000	150,000
O&M/yr[4]	15,000	65,000	15,000
Total Costs			
Capital	150,000	1,950,000	196,000
O&M/yr	15,000	65,000	20,000

* Recommended strategy.

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

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

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

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

The following non-modeled actions are monitoring and evaluation procedures that managers are implementing or would implement in concert with the actions discussed above.

A) Investigate Brennigan Creek (RM 2.9) to determine if riparian restoration and slope stabilization work could reduce bedload inputs into river. Coarse sand enters the mainstem at Brennigan, completely blanketing spawning habitat and filling holding pools downstream for a significant length.

B) Minimize pre-spawning mortality of hatchery spring chinook by improving the adult holding pond.

C) Accurately identify juvenile releases from Entiat Hatchery.

D) Utilize the adult holding pond for rearing of fingerlings.

E) Improve health of released juveniles by 1) providing regular IHN screening and egg sterilization program, 2) using medicated feed to control bacterial kidney disease (BKD), 3) optimizing loading rates and pond flows.

Recommended Strategy

The recommended strategy for Entiat spring chinook is Strategy 3, natural production improvements and supplementation. The strategy involves directly addressing current smolt survival problems through the installation of additional diversion screening within the drainage. It also enacts a level of supplementation that would provide additional benefits to the terminal area and give an opportunity for evaluation.

The recommendations are generally consistent with the results of the SMART analysis (Appendix B). Strategy 3 scored the highest in terms of both the direct utility value, which reflects the absolute rankings assigned to the criteria, and the discounted utility value, which incorporates a general assessment of the relative uncertainty in the rankings.

SUMMER STEELHEAD

Fisheries Resources

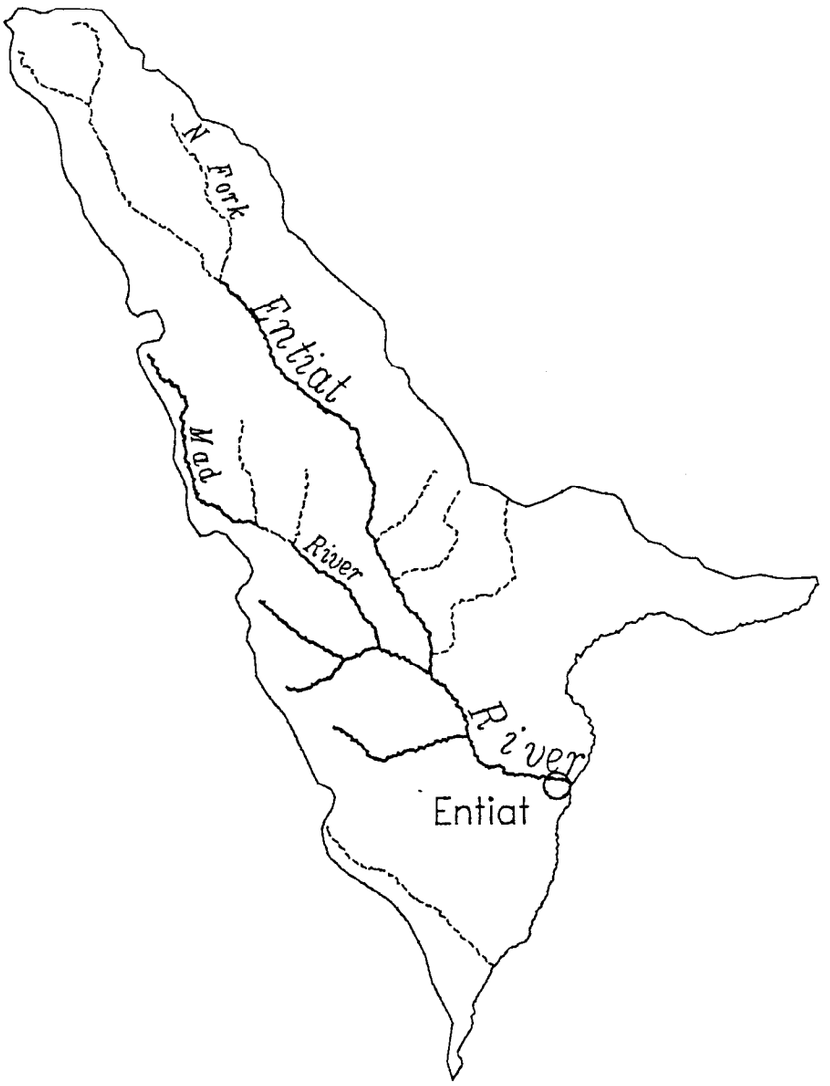
Natural Production

The Entiat River historically had a moderate population of natural steelhead that was probably distributed throughout the watershed. Like the other upper subbasins, the natural stock is thought to have declined dramatically from historical numbers, although the extent of decline is unknown. Between 1939 and 1943, as part of the Grand Coulee Fish Maintenance Project, upper Columbia River steelhead were trapped at Rock Island Dam and released into the Methow, Entiat and Wenatchee rivers. Thus, Entiat steelhead were mixed with other upper Columbia River stocks. Historical annual counts at Rock Island Dam, representing the Methow, Okanogan, Wenatchee, and Entiat rivers and the upper Columbia, averaged 2,780 fish for the 1930s, 2,605 fish for the 1940s, and 3,722 fish for the 1950s. There is some historical documentation that steelhead once spawned in the Mad River, a tributary of the Entiat, but no major runs have been noted in recent years. Presently, about 140 natural fish are thought to return to the subbasin. Subbasin diversions, low flows and improper screening impact steelhead production and juvenile survival. Fires within the Entiat watershed have also impacted the quality and quantity of spawning and rearing habitat.

The Northwest Power Planning Council's habitat carrying capacity model indicated 51,037 smolts could be produced within the subbasin. The Washington Department of Wildlife gradient area flow model (GAFM) indicated an estimated smolt capacity of 32,273 fish. Current spawning escapement goal of natural fish is 1,471 fish.

Due to lack of data on natural steelhead within the Entiat Subbasin, population characteristics were derived from Wells Hatchery steelhead brood stock data. Generally, Entiat steelhead enter the lower Columbia between May and September with fish arriving at Wells Pool in early July. Fish enter the Entiat in mid-July and peak between mid-September and October. Spawning begins in March and continues through May. Fry emerge that summer and juveniles rear for two to three years prior to spring ocean emigration. Mean smolt age is thought to be about 2.63 years (L. Brown, WDW, pers. commun. and Chelan PUD).

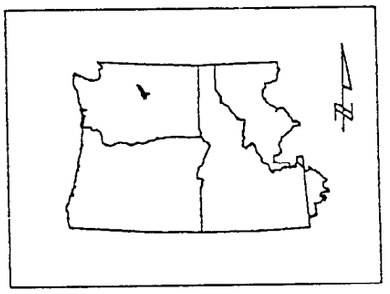
ENTIAT SUBBASIN



SUMMER STEELHEAD DISTRIBUTION*

———— PRESENT/POTENTIAL

---------- ABSENT



GIS GEOGRAPHIC INFORMATION SYSTEM

BONNEVILLE POWER ADMINISTRATION

* Due to the limitations of scale, all streams which support anadromous fish are not shown on this map.

Returning adults averaged 40.7 percent 1-salt fish and 58.1 percent 2-salt fish (Table 9). Female-male sex ratios for 1-salt and 2-salt fish were 1-to-0.66 and 1-to-0.22, respectively (Table 10). For adults (natural and hatchery) at Wells for 1983 through 1987, 1-salt fish averaged 24.1 inches and 5.7 pounds, and 2-salt fish averaged 29.1 inches and 10.2 pounds (Table 11). Average fecundity of 23.9-inch 1-salt and 28.6-inch 2-salt females was 5,082 and 6,368 eggs per female, respectively.

Run size of natural fish was estimated at 134 fish by subtracting the 1983-1985 mean harvest (159 fish) from the 1986-1988 mean harvest (92 fish) and assuming a 50 percent harvest rate.

Table 9. Adult age structure of Wells Dam summer steelhead (includes freshwater ages) (Williams 1988).

	Age (year)									
	1.1	1.2	2.1	2.2	2.3	3.1	3.2	4.1	4.2	7.1
Natural %	-	-	23.0	35.1	1.4	12.2	18.9	4.1	4.1	1.4
Hatchery %	42.3	47.6	2.7	5.8	0.2	0.5	0.5	0.2		-

Table 10. Sex ratio (F:M) of Wells Dam summer steelhead (Williams 1988).

Origin	1-Salt	n	2-Salt	n	Total	n
Natural	1:0.66	30	1:0.22	43	1:0.38	73
Hatchery	1:1.13	1422	1:0.33	1384	1:0.64	2806

Table 11. Length and weight and sex of Wells steelhead (Williams 1988).

Ocean Age	Male		Female	
	Length(in)	Weight (lbs)	Length(in)	Weight (lbs)
1-Salt	24.3	5.9	23.9	5.5
2-Salt	29.5	10.4	28.6	9.9

Hatchery Production

In 1963, the Washington Department of Wildlife and Chelan County Public Utility District No. 1 entered into a 50-year agreement to mitigate fish losses incurred from Rocky Reach Dam. This agreement required Chelan County to construct a hatchery and fund an annual production of 195,000 steelhead smolts, of which approximately 40,000 are allocated to the Entiat River (the other 155,000 are allocated to the Wenatchee River). Subbasin hatchery releases averaged 40,625 fish for 1977 through 1989 (Table 12) with no additional production anticipated.

Brood stock collected at Wells Dam are from fish returning in August through November with most captured in September. Brood stock was previously collected at Priest Rapids Dam until the early 1980s. Wells stock adults migrate over Bonneville Dam from May through September, pass Priest Rapids Dam from early June through mid-October, and first arrive at Wells Dam in mid-July. Adults are collected at random in a fish trap on the right bank fishway and include natural and hatchery fish. Spawning begins in early January, peaks by early February and is completed by early March. Approximately 650 fish are required for brood stock.

On average, Wells adults are comprised of 45.7 percent 1-salt fish and 53.9 percent 2-salt fish, but vary considerably (Williams 1988). Female-male sex ratios were 1-to-1.13 and 1-to-0.33, for 1-salt and 2-salt fish, respectively. Adults (natural and hatchery) for 1983 through 1987 averaged 24.1 inches and 5.7 pounds for 1-salt fish and 29.1 inches and 10.2 pounds for 2-salt fish. Average fecundity of 1- and 2-salt females was 5,082 and 6,368 eggs per female, respectively.

Table 12. Subbasin releases of hatchery steelhead smolts.

Year	Smolts	Year	Smolts
1977	45,011	1983	48,328
1978	33,264	1984	47,021
1979	41,640	1985	44,280
1980	16,780	1986	46,185
1981	35,536	1987	46,520
1982	41,254	1988	43,960
		1989	38,350
Average			40,625

Harvest

An average of 87 steelhead were caught in the subbasin between 1977 and 1988 (Table 13). "Wild" fish release regulations for the subbasin were implemented in 1986. Harvest prior to 1986 averaged 89 fish while post 1986 harvest averaged 92 fish. Harvest rate within the subbasin is assumed to have been 50 percent on both stocks prior to the 1986 regulations.

Regulations within the subbasin restrict harvest to the area of the mouth of the Entiat River to Burns Creek from June 1 through March 31. Only hatchery steelhead can be retained, with a limit of two fish. Bait is prohibited between June 1 and November 30 to protect juvenile steelhead from hooking mortality. A 12-inch minimum size limit is also in effect to protect juvenile fish.

Table 13. Sport harvest of Entiat summer steelhead.

Year	Sport catch	Year	Sport catch
1977	24	1983	174
1978	8	1984	120
1979	64	1985	183
1980	43	1986*	118
1981	88	1987*	44
1982	69	1988*	114
Average			87

* Wild fish release regulations

Specific Considerations

The goal of steelhead management in the subbasin is to rebuild the natural run to meet spawning escapement goals. To protect the genetic integrity of natural fish, harvest is targeted on hatchery fish. Natural steelhead are managed for maximum sustained population and escapement at that level is the minimum acceptable escapement. Minimum spawning escapement requirements have been set with the best available information and is presently 1,471 adults.

The largest natural fish production limitation has been inadequate escapement reaching the subbasin as a result of smolt mortalities at dams and adult overharvest downstream of the subbasin. Natural fish destined for the Entiat are subjected to non-selective mixed-stock fisheries in the Columbia River. Because large hatchery programs are present, which need relatively little escapement, non-selective harvest can overharvest smaller natural populations that need a relatively large amount of escapement. As hatchery programs in other basins expand, the jeopardy of overharvest by non-selective fisheries in the Columbia increases. Returns of natural fish are estimated to be about 140 fish; unless out-of-basin harvest rates or techniques are altered, this run will be terminated. Selective harvest of hatchery fish at dams would allow natural fish to escape.

The subbasin is located above eight Columbia River dams and smolts and adults are subjected to mortalities at each dam and impoundment. Washington Department of Wildlife policy emphasizes natural fish. The genetic consequences of the current dependency on hatchery fish may be severe. Subsequent "wild fish release" regulations are expected to increase subbasin spawning escapement of natural fish although returns will probably be inadequate unless downstream conditions are changed.

To bypass the mortalities suffered by juveniles at the dams, the possibility of a pipeline from Rocky Reach Dam to below Bonneville should be explored. Fish collected at each dam and each mainstem hatchery could be placed in the pipeline. Considerable expense is attached to improvements suggested by the subbasin plans, perhaps some money should be spent to examine the feasibility of a pipeline that might avoid the major limiting factor within the upper subbasins.

Habitat improvements within the subbasin are of relatively minor importance compared to out-of-basin fish mortalities. However, some opportunities exist and are addressed as strategies in a following section.

Objectives

Stock: Entiat Natural Summer Steelhead

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

Biological objective: Maintain the biological characteristics of the natural stock. The biological objective has priority within the subbasin. A minimum spawning escapement of 1,471 fish is needed. This population is managed for maximum sustained population.

Stock: Entiat Hatchery Summer Steelhead

Utilization objective: 3,000 fish for sport and tribal harvest. The utilization objective has priority within the subbasin for this stock.

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

Alternative Strategies

Strategies for summer steelhead in this report have specific themes. Means to obtain the objectives are first attempted using natural methods followed by less natural techniques and finally, hatchery production. Actions identified under each strategy are closely related to the theme. 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 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 4. After mainstem improvements are made, the System Planning Model indicates subbasin returns will increase by about 62 percent.

Modeling results for each strategy are presented in Table 14 as fish produced at "maximum sustainable yield" (MSY). The sustainable yield of a fish population refers to that portion of the population that exceeds the number of fish required to spawn and maintain the population over time. Sustainable yield can be "maximized," termed MSY, for each stock at a specific harvest level. The MSY is estimated using a formula (Beverton-Holt function) that analyzes a broad range of harvest rates. Subbasin planners have used MSY as a tool to standardize results so that decision makers can compare stocks and strategies.

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

The amount of buffer appropriate for each stock is a management question not addressed in the subbasin plans. For this reason, the utilization objective, which usually refers to harvest, may not be directly comparable to the MSY shown in Table 14. At a minimum, a strategy should produce an estimated MSY equal to or greater than the utilization objective. A MSY substantially larger than the subbasin utilization objective may be needed to meet subbasin biological objectives.

Estimated costs of the alternative strategies below are summarized in Table 14a.

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. Water withdrawals should be reduced as possible. Riparian zones should be managed to provide a continuous recruitment of large organic debris. Stream typing should be reviewed and streams should be upgraded as needed.

Hypothesis: Existing habitat, if managed properly, should provide near capacity numbers of natural smolts if adequately seeded. Location of diversions on smaller tributaries is unknown and some diversions remain unscreened. If natural smolts from the subbasin were enumerated, carrying capacity and spawner-recruit data would greatly assist management.

Assumptions: Action 1 assumes egg-to-smolt survival will be increased by a relative 10 percent. Action 2 assumes smolt to smolt survival will be increased from an estimated 85 percent to 95 percent for natural fish.

Numeric Fish Increases: The System Planning Model indicated an additional 28 fish would return to the subbasin with this strategy under current conditions. MSY after mainstem improvements would increase by 88 fish.

ACTIONS: 1, 2

1. Maintain at least current level of stream habitat quality and quantity. Seek improved water quality via reduction of sedimentation. Inventory and map habitat.

2. Inventory and evaluate all irrigation diversion structures. Install new or improved fish screening systems at substandard diversions.

Cost Estimates: Estimated one FTE year to inventory diversion screening needs and inventory and map habitat ($40,000). New screen and refurbishing costs for existing structures (includes implementation and operation and maintenance costs) for the first 25 years is estimated at $200,000 ($500,000 for 50 years).

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 such as improving tributary streamflows.

Hypothesis: By breaking up the extensive riffle habitat currently found in the subbasin and creating pools and instream structures, egg-to-smolt survival will increase, particularly benefitting age-2 and age-3 juveniles.

Assumptions: This strategy assumes egg-to-smolt survival will increase by a relative 50 percent with adequate structure emplacement.

Numeric Fish Increases: The System Planning Model indicated this strategy would add 115 natural fish to the subbasin under current conditions. MSY after mainstem improvements would increase by 168 fish.

ACTIONS: 1-3

1. -
2. -

3. Place instream structures to create pool-riffle habitat.

Cost Estimates: Costs to install 300 instream structures is estimated at $5,000 each to total $1.5 million. Operation and maintenance is estimated to be $50,000 per year.

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 using natural stock for hatchery releases, relative fitness should be improved and chances of genetic degradation of natural fish will be decreased. Also, the relative fitness of hatchery progeny should be increased.

Assumptions: This strategy assumes the natural stock can be increased enough to allow removal of enough fish for brood stock purposes. Action 4 assumes relative smolt survival of hatchery fish will increase from 0.67 to 0.71. Viability of naturally spawning hatchery-hatchery and hatchery-natural crosses will increase by a relative 10 percent.

Numeric Fish Increases: The System Planning Model indicated this strategy would add 142 fish to the subbasin under current conditions. MSY after mainstem improvements would increase 192 fish.

ACTIONS: 1-4

1. -
2. -
3. -

4. Use captured natural brood stock for existing hatchery programs.

Cost Estimates: Capital costs are estimated at $20,000 with O&M at $10,000 per year.

STRATEGY 4: Hatchery Production. This strategy seeks to achieve the objectives solely through traditional hatchery production. Only those actions necessary for maintenance of the hatchery program are included.

Hypothesis: Increasing hatchery plants will increase adult returns.

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

Numeric Fish Increases: This strategy would add 2,169 fish to the subbasin under current conditions. MSY after mainstem improvements would increase by 2,424 fish.

ACTIONS: 5

5. Increase hatchery smolt plants by 400,000 fish (see Appendix C for cost estimates).

STRATEGY 5: Combination of Actions. This strategy seeks to achieve the objectives by combining the above actions.

Hypothesis and Assumptions: See above strategies.

Numeric Fish Increases: This strategy would add 2,433 fish to the subbasin under current conditions. MSY after mainstem improvements would increase by 2,705 fish.

ACTIONS: 1-5 (see above)

Cost Estimates: This strategy sums the above costs.

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

Utilization Objective:
Zero natural and 3,000 hatchery fish for sport and tribal harvest.

Biological Objective:
Maintain the biological characteristics of the natural stock. Minimum spawning escapement goal is 1,471 natural fish.

Strategy[1]	Maximum[2] Sustainable Yield (MSY)	Total[3] Spawning Return	Total[4] Return to Subbasin	Out of[5] Subbasin Harvest	Contribution[6] To Council's Goal (Index)
Baseline	100 -N	135	251	62	0(1.00)
All Nat	268 -N	347	653	161	866(2.61)
1	188 -N	328	552	136	649(2.20)
2	268 -N	347	653	161	866(2.61)
3	292 -N	362	694	171	955(2.77)
4	2,254 -N	1,469	3,886	958	7,824(15.52)
5*	2,805 -N	1,301	4,250	1,048	8,606(16.97)

*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. Aggressive habitat protection, upgrade diversions, etc. Post Mainstem Implementation.
2. Strategy 1 plus add instream structures. Post Mainstem Implementation.
3. Strategy 2 plus use natural fish for hatchery brood stock. Post Mainstem Implementation.
4. Baseline plus 400,000 hatchery smolts. Post Mainstem Implementation.
5. Strategy 3 plus strategy 4. Post Mainstem Implementation.

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

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

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

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

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

Table 14a. Estimated costs of alternative strategies for Entiat summer steelhead. Cost estimates represent new or additional costs to the 1987 Columbia River Basin Fish and Wildlife Program; they do not represent projects funded under other programs, such as the Lower Snake River Compensation Plan or a public utility district settlement agreement. (For itemized costs, see Appendix C.)

	Proposed Strategies				
	1	2	3	4	5*
Hatchery Costs					
Capital[1]	0	0	0	1,840,000	1,840,000
O&M/yr[2]	0	0	0	200,000	200,000
Other Costs					
Capital[3]	500,000	2,000,000	2,020,000	0	2,020,000
O&M/yr[4]	800	50,800	60,800	0	60,800
Total Costs					
Capital	500,000	2,000,000	2,020,000	1,840,000	3,860,000
O&M/yr	800	50,800	60,800	200,000	260,800

* 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.

Recommended Strategy

The recommended strategy is Strategy 5. This strategy seeks to inventory, repair and aggressively guard habitat while using natural fish for hatchery brood stock and increasing hatchery smolt plants. The subbasin emphasis is on natural fish although increased hatchery returns are expected from an improved hatchery stock. Habitat needs aggressive protection to compensate for smolt and adult losses at Columbia River dams and overharvest downstream of the subbasin. Use of natural brood stock for hatchery supplementation should reduce genetic impacts on natural fish. This strategy was also supported by the SMART analysis (Appendix B). The natural stock in this subbasin is so depressed it will probably be destroyed unless alternate out-of-basin harvest techniques are used in Columbia River pools.

FALL CHINOOK SALMON

As evidenced by dam counts (Table 15), a small but persistent run of fall chinook has always returned to the upper Columbia River. Little quantitative information exists on these fish except the dam counts. Timing has also cast some doubt on the classification of these fish, some observers feeling that a number of summer chinook might have been included. Spawning locations, except for an area near the mouths of the Wenatchee and Chelan rivers, went unnoticed until recently.

Table 15. Adult fall chinook (upriver brights) interdam counts, upper mainstem, 1977-1987[a].

Year	Priest Rapids & Wanapum Pools	Rock Island Pool[b]	Rocky Reach Pool[b]	Wells Pool[c]
1977	2,684	401	-176	1,151
1978	3,414	566	-49	856
1979	3,730	593	-535	1,070
1980	4,695	545	314	477
1981	3,019	202	786	438
1982	6,945	1,019	17	786
1983	6,630	566	499	593
1984	5,851	422	745	903
1985	7,037	1,922	1,091	1,083
1986	11,486	4,232	5,559	753
1987	20,776	5,676	9,210	2,822

[a] Tribal catch subtracted from PR-RI interdam count, 1986 and 1987. However, salmon punch-card statistics are not pool-specific and therefore could not be used to estimate sport catch. Escapements of fall chinook to tributary subbasin, if any, were not accounted for in this table.

[b] 56 adults and 28 jacks were killed at Rocky Reach Dam for tag recovery in 1986 and were subtracted from the count for Rocky Reach Pool.

[c] Used Wells Dam counts.

Upriver bright fall chinook run sizes to the Columbia River have increased dramatically since 1984. These increases have been reflected in sharply higher spawning escapements in the Hanford Reach, the free-flowing stretch of the Columbia between Priest Rapids and McNary dams. Coincident with these

observations and the cessation of trapping for fall chinook at Priest Rapids Dam, scattered concentrations of spawners began to show up in locations like Sand Hollow Creek, a tributary of Wanapum Reservoir, selected locations in Wanapum and Priest Rapids reservoirs, in the tailrace of Wells Dam and the lower end of the Okanogan, Methow, Chelan, Entiat and Wenatchee rivers. These isolated concentrations were either a direct result of increased production in the Hanford Reach ("over runs" that actually originated from the Hanford Reach) or are just indications of improved production conditions for existing populations that may have benefitted from the same conditions that the Hanford Reach has. Either way, it remains to be seen if these production units persist past the current high levels of returns to the Hanford Reach.

The limited information available on these populations comes from spawning ground surveys. In most cases, these surveys are incomplete and probably underestimate numbers of redds. This is especially true of those done in the mainstem, such as the Wells Dam tailrace, where visible spawning locations are gradually obscured in the deeper water where additional redds likely exist (Steve Hays, Chelan County PUD, pers. commun.). Recent fyke net catches taken above Rocky Reach Dam include recently emerged chinook fry, indicating some successful reproduction is occurring above that site. Managers believe these fish assume a rearing strategy similar to the summer chinook fry entering the mainstem from the major tributaries in the spring of the year, like the Wenatchee or Methow.

With the limited information available at this time, it does not seem reasonable to propose production strategies for this stock. However, the status of fall chinook should be evaluated and monitored annually. This will require detailed spawning ground surveys such as those conducted on the Methow and Okanogan rivers. Surveys have identified that there is a spatial and temporal separation between summer and fall chinook spawning in these rivers (Kohn 1987).

Modeling of these fall chinook populations is not considered possible now for two reasons, 1) the paucity of data, and 2) uncertainty about their origin and continued production. If annual monitoring and new studies identify stock parameters and limiting factors that suggest possible production strategies it would be desirable to model them at that time.

PART V. SUMMARY AND IMPLEMENTATION

Objectives and Recommended Strategies

Spring Chinook

Objectives involve a two-level approach for natural stock management. The first attempts to achieve terminal area returns that will allow directed fisheries supporting an annual catch of 200 fish to 500 fish. The second level objective attempts to achieve terminal returns that will support a directed harvest of 500 fish to 1,000 fish annually. Planners identified three strategies to achieve these objectives. Strategy 1 attempts to reduce smolt mortality by improving diversion screens while Strategy 2 focuses on potential habitat base increases through a spawning channel and a barrier removal. Strategy 3 includes the supplementation action to provide initial production of 200,000 smolts. Planners recommend Strategy 3.

Summer Steelhead

Objectives call for a minimum spawning escapement of 1,471 natural summer steelhead and 3,000 hatchery steelhead for sport and tribal harvest. Planners recommend Strategy 5, which seeks to inventory, repair and aggressively guard habitat while using natural fish for hatchery brood stock and increasing hatchery smolt plants.

Fall Chinook

With the limited information available at this time, planners did not propose production strategies for this stock. Planners do, however, recommend that the status of fall chinook be evaluated and monitored annually. This will require detailed spawning ground surveys such as those conducted on the Methow and Okanogan rivers.

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: Entiat

STOCK: Spring chinook

STRATEGY: 1. Natural production, level 1

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1 EXT OBJ	7	0.6	20	140	84
2 CHG MSY	7	0.6	20	140	84
3 GEN IMP	7	0.9	20	140	126
4 TECH FEAS	9	0.9	20	180	162
5 PUB SUPT	7	0.9	20	140	126

TOTAL VALUE 740

DISCOUNT VALUE 582

CONFIDENCE VALUE 0.78648648

SUBBASIN: Entiat

STOCK: Spring chinook

STRATEGY: 2. natural production, level 2

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1 EXT OBJ	7	0.6	20	140	84
2 CHG MSY	7	0.6	20	140	84
3 GEN IMP	9	0.9	20	180	162
4 TECH FEAS	5	0.9	20	100	90
5 PUB SUPT	7	0.9	20	140	126

TOTAL VALUE 700

DISCOUNT VALUE 546

CONFIDENCE VALUE 0.78

Subbasin: Entiat 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	5	0.9	20	100	90
5 PUB SUPT	4	0.6	20	80	48
TOTAL VALUE				440	
DISCOUNT VALUE					294
CONFIDENCE VALUE					0.67

Subbasin: Entiat Stock: Summer steelhead Strategy: 2

Criteria	Rating	Confidence	Weight	Utility	Discount Utility
1 EXT OBJ	5	0.6	20	100	60
2 CHG MSY	3	0.6	20	60	36
3 GEN IMP	7	0.6	20	140	84
4 TECH FEAS	5	0.6	20	100	60
5 PUB SUPT	6	0.6	20	120	72
TOTAL VALUE				520	
DISCOUNT VALUE					312
CONFIDENCE VALUE					0.60

Subbasin: Entiat Stock: Summer steelhead Strategy: 3

Criteria	Rating	Confidence	Weight	Utility	Discount Utility
1 EXT OBJ	6	0.9	20	120	108
2 CHG MSY	5	0.6	20	100	60
3 GEN IMP	8	0.6	20	160	96
4 TECH FEAS	7	0.9	20	140	126
5 PUB SUPT	7	0.9	20	140	126
TOTAL VALUE				660	
DISCOUNT VALUE					516
CONFIDENCE VALUE					0.78

Subbasin: Entiat Stock: Summer steelhead Strategy: 4

Criteria	Rating	Confidence	Weight	Utility	Discount Utility
1 EXT OBJ	8	0.6	20	160	96
2 CHG MSY	6	0.6	20	120	72
3 GEN IMP	5	0.9	20	100	90
4 TECH FEAS	7	0.6	20	140	84
5 PUB SUPT	6	0.6	20	120	72
TOTAL VALUE				640	
DISCOUNT VALUE					414
CONFIDENCE VALUE					0.65

Subbasin: Entiat Stock: Summer steelhead Strategy: 5

Criteria	Rating	Confidence	Weight	Utility	Discount Utility
1 EXT OBJ	8	0.6	20	160	96
2 CHG MSY	6	0.6	20	120	72
3 GEN IMP	7	0.9	20	140	126
4 TECH FEAS	7	0.6	20	140	84
5 PUB SUPT	8	0.6	20	160	96
TOTAL VALUE				720	
DISCOUNT VALUE					474
CONFIDENCE VALUE					0.66

APPENDIX C
SUMMARY OF COST ESTIMATES

The cost estimates provided in the following summary tables represent new or additional costs necessary to implement the alternative strategies. Although many strategies involve projects already planned or being implemented under the Columbia River Basin Fish and Wildlife Program or other programs, such as the Lower Snake River Compensation Plan, the associated costs and hatchery production do not appear in the following tables.

In many cases, the following costs are no more than approximations based on familiarity with general costs of similar projects constructed elsewhere. Although the costs are very general, they can be used to evaluate relative, rather than absolute, costs of alternative strategies within a subbasin.

Particular actions are frequently included in strategies for more than one species or race of anadromous fish. In these cases, the same costs appear in several tables, but would only be incurred once, to the benefit of some, if not all, of the species and races of salmon and steelhead in the subbasin.

Subbasin planners used standardized costs for actions "universal" to the Columbia River system, such as costs for installing instream structures, improving riparian areas, and screening water diversions (see the Preliminary System Analysis Report, March 1989). For other actions, including the removal of instream barriers, subbasin planners developed their own cost estimates in consultation with resident experts.

Planners also standardized costs for all new hatchery production basinwide. To account for the variability in fish stocking sizes, estimates were based upon the cost per pound of fish produced. For consistency, estimated capital costs of constructing a new, modern fish hatchery were based on $23 per pound of fish produced. Estimated operation and maintenance costs per year were based on $2.50 per pound of fish produced.

All actions have a life expectancy, a period of time in which benefits are realized. Because of the variation in life expectancy among actions, total costs were standardized to a 50-year period. Some actions had life expectancies of 50 years or greater and thus costs were added as shown. Other actions (such as instream habitat enhancements) are expected to be long term, but may only have life expectancies of 25 years. Thus the action would have to be repeated (and its cost doubled) to meet the 50-year standard. Still other actions (such as a study or a short-term supplementation program) may have life expectancies of 10 years after which no further action would be taken. In this case, operation and maintenance costs were amortized over 50

years to develop the total O&M per year estimate. Capital costs, being up-front, one-time expenditures, were added directly.

Subbasin planners have estimated all direct costs of alternative strategies except for the purchase of water rights. No cost estimates have been or will be made for actions that involve purchasing water. Indirect costs, such as changes in water flows or changes in hydroelectric system operations, are not addressed.

ESTIMATED COSTS FOR ALTERNATIVE STRATEGIES

Subbasin: Entiat River
Stock: Spring Chinook

Action	Cost Categories*	Proposed Strategies 1	2	3**
Habitat Enhancement	Capital:			
	O&M/yr:			
	Life:			
Screening	Capital:	75,000	75,000	75,000
	O&M/yr:	15,000	15,000	15,000
	Life:	25	25	25
Barrier Removal	Capital:		1,500,000[a]	
	O&M/yr:		20,000	
	Life:		50+	
Misc. Projects	Capital:		300,000[b]	
	O&M/yr:		30,000	
	Life:		15	
Hatchery Production	Capital:			46,000
	O&M/yr:			5,000
	Life:			50
TOTAL COSTS	Capital:	150,000	1,950,000	196,000
	O&M/yr:	15,000	65,000	20,000
	Years:	50	50	50
Water Acquisition		N	Y	N
Fish to Stock	Number/yr:			200,000
	Size:			J, 100/lb.
	Years:			50

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

** Recommended strategy.

[a] Passage at Box Canyon.

[b] Spring (spawning) channel development.

ESTIMATED COSTS FOR ALTERNATIVE STRATEGIES

Subbasin: Entiat River
Stock: Summer Steelhead

Action	Cost Categories*	Proposed Strategies 1	2	3	4	5**
Habitat Enhancement	Capital:		1,500,000	1,500,000		1,500,000
	O&M/yr:		50,000	50,000		50,000
	Life:		50	50		50
Inventory & Mapping	Capital:	0	0	0		0
	O&M/yr:	40,000	40,000	40,000		40,000
	Life:	1	1	1		1
Screening	Capital:	500,000[a]	500,000[a]	500,000[a]		500,000[a]
	O&M/yr:					
	Life:	50	50	50		50
Natural Brood Stock	Capital:			20,000		20,000
	O&M/yr:			10,000		10,000
	Life:			50		50
Hatchery Production	Capital:				1,840,000	1,840,000
	O&M/yr:				200,000	200,000
	Life:				50	50
TOTAL COSTS	Capital:	500,000	2,000,000	2,020,000	1,840,000	3,860,000
	O&M/yr:	800	50,800	60,800	200,000	260,800
	Years:	50	50	50	50	50
Water Acquisition		N	N	N	N	N
Fish to Stock	Number/yr:				400,000	400,000
	Size:				S, 5/lb.	S, 5/lb.
	Years:				50	50

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

** Recommended strategy.

[a] Represents total cost over 50 years. Planners did not specify capital versus O&M costs.