Columbia Basin System Planning

SALMON and STEELHEAD PRODUCTION PLAN

DESCHUTES RIVER SUBBASIN

September 1, 1990

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Columbia Basin System **Planning**

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The System Planning Group also wants to acknowledge Duane Anderson of the Northwest Power Planning Council's staff for his assistance and expertise in computer modeling. Eric Lowrance and Leroy Sanchez from the Bonneville Power Administration also deserve recognition for developing the useful salmon and steelhead distribution maps, which appear in many of the subbasin plans.

Last, but not least, the System Planning Group recognizes the members of the System Planning Oversight Committee and the Columbia Basin Fish and Wildlife Authority's Liaison Group for their guidance and assistance over the past several months.

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 drainagesin 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.

This plan was developed by the Oregon Department of Fish and Wildlife (ODFW) and the Confederated Tribes of the Warm Springs Reservation of Oregon with the help of three committees. The Public Advisory Committee, representing non-treaty user groups and other interested members of the public, helped identify a range of objectives and actions for managing the fishery resources in the lower Deschutes River Subbasin. The Technical Advisory Committee, composed'of representatives of state and federal fishery agencies, tribes, land and water management agencies, and utilities, developed specific fishery and other technical information and described and assessed potential actions for managing the fisheries. The Fish Management Committee, composed of representatives of the ODFW and the Warm Springs Tribes, selected a preferred range of objectives and actions.

Members of the Public Advisory Committee and their affiliations are:

Jim Bailey, public
Sergeant Lindsay Ball, Oregon State Police
Cal Cole, Oregon Trout
Spencer Ehrman, Deschutes Club
Mike McLucas, City of Maupin
Lynn Sawyer, Deschutes River Public Outfitters
Mike Wirth, Sherars Bridge Sport Fishing Association
Dallas Worth, The Dalles Rod and Gun Club.

Members of the Technical Committee and their affiliations are:

Brian Cates, U.S. Fish and Wildlife Service
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Harv Forsgren, U.S. Forest Service
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Steve Morris, National Marine Fisheries Service
Jim Newton, Oregon Department of Fish and Wildlife
Larry Rasmussen, U.S. Fish and Wildlife Service
Don Ratliff, Portland General Electric Company
Sheldon Rich, Northern Wasco County Public Utility District
Rob Tracey, U.S. Soil Conservation Service

Members of the Fish Management Committee are Mark Fritsch, representing the Warm Springs Tribes: and Jim Newton and Brian Jonasson, representing the Oregon Department of Fish and Wildlife.

This plan encompasses the flowing waters of the Deschutes River Subbasin below Pelton Reregulating Dam at RM 100. A fishery management plan for the subbasin above Pelton Reregulating Dam will be developed at a later date.

PART I. DESCRIPTION OF SUBBASIN

Location and General Environment

The Deschutes River flows northerly through central Oregon and enters the Columbia River 205 miles from the Pacific Ocean. The basin covers approximately 10,500 square miles, making it the second largest watershed in Oregon.

This plan encompasses the lower Deschutes-River and its tributaries below the Pelton-Round Butte hydroelectric project located at RM 100 (Fig. 1). The lower basin covers approximately 2,700 square miles and has 760 miles of perennial streams and 1,440 miles of intermittent streams. Major tributaries include White and Warm Springs rivers and Shitike Creek on the westside and-Buck Hollow, Bakeoven, and Trout creeks on the eastside.

The Cascade Range forms the western boundary of the basin. The southern boundary of the lower Deschutes Basin follows the Tenino Bench on the Warm Springs Indian Reservation and continues east to the Ochoco Mountains. The plateau between the Deschutes and John Day basins forms the eastern boundary while the Columbia River forms the northern boundary.

The lower Deschutes River flows through a narrow canyon 700 feet to 2,000 feet deep. The elevation of the river drops from 1,393 feet at Pelton Reregulating Dam to 160 feet at the mouth. The average gradient is 0.233 percent. Two major drops in the lower Deschutes River are Sherars Falls at RM 44 with a vertical drop of 15 feet and Whitehorse Rapids at RM 75 with a drop of 35 feet in one mile.

The Deschutes Basin lies in the southern portion of the Columbia Basin physiographic province (Franklin and Dyrness 1973). Major geologic formations in the subbasin include the Dalles, John Day, and Clarno formations and the Columbia River Basalts group. Loess, volcanic ash, and pumice have been laid down during recent geologic times. Much of the original deposits of loess and ash have been removed from the uplands and redeposited along streams. The soils are primarily silt loam, but also include clay loams, stony loams, cobbly loams, and clay. Erosion potentials due to water or wind range from slight (less than 2.5 tons/acre/year) to severe (5 to 15 tons/acre/year) (BLM 1985).

The climate in the basin is primarily semiarid. The average annual precipitation ranges from as high as 100 inches in the Cascade Mountains, 20 inches in the Ochoco Mountains, to between 9 inches and 14 inches in the Deschutes Valley and the eastern plateaus. Approximately 25 percent of the annual precipitation falls between May 1 and September 30.

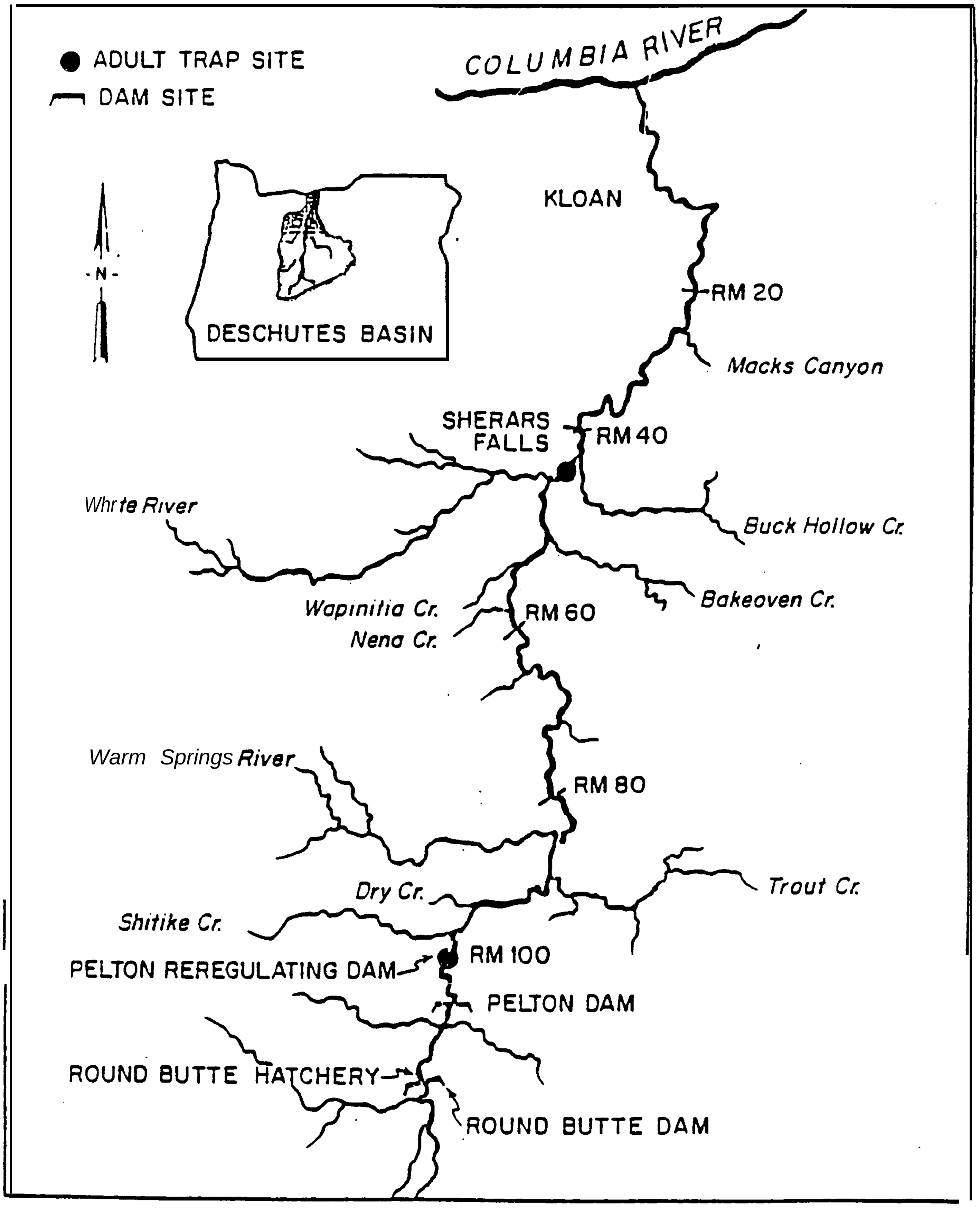


Figure 1. Lower Deschutes River Subbasin.

Major vegetation groups are steppe, shrub-steppe, and juniper savanna in the canyon and plateau areas and coniferous forest in the Cascade and Ochoco mountains. Native vegetation includes bunchgrass, sagebrush, bitterbrush, juniper, and ponderosa pine. Introduction of non-native species such as cheatgrass, Kentucky bluegrass, and medusahead wildrye has altered the native plant communities, as have cultivation, livestock grazing, and other human activities (BOR 1981).

Riparian vegetation along the perennial streams includes perennial grasses, sedges, rushes, emergent aquatic plants, shrubs and deciduous trees, primarily willow and alder. Condition of the riparian vegetation is fair along the mainstem Deschutes River and generally poor along the minor tributaries.

Major upstream barriers to fish migration in the subbasin are-White River Falls and the Pelton-Round Butte hydroelectric project. White River Falls, a series of the three waterfalls approximately two miles upstream from the mouth of White River, has a total drop of 180 feet. Pelton Reregulating Dam, the dam farthest downstream of the three dam hydroelectric project, blocks fish passage at RM 100 on the Deschutes River. Pelton Reregulating Dam was completed in 1958. Downstream fish passage facilities at the hydroelectric project failed and hatchery production began in 1968 to mitigate for lost fish production.

Water Resources

The lower Deschutes River is characterized by its uniform flow. Mean annual discharge at the mouth was about 6,000 cubic feet per second (cfs) from 1965 through 1985. Mean monthly discharge for the Deschutes River near Madras and at the mouth are shown in Tables 1 and 2. Peak flows generally occur during December to March.

Flow in the lower Deschutes River is regulated at RM 100 by Pelton Reregulating Dam. Under terms of the Federal Energy Regulatory Commission operating license for the Pelton-Round Butte hydroelectric project, flows can drop below 3,500 cfs from March through June or below 3,000 cfs during the remainder of the year only if inflow into the reservoirs also falls below these levels. Portland General Electric adopted a guideline to limit changes in river elevation below Pelton Reregulating Dam to no more than 0.1 foot per hour and no more than 0.2 foot per 24 hours during the primary fishing season of May 15 to October 31, or no more than 0.1 foot per hour and no more than 0.4 foot per 24 hours during the remainder of the year.

Principal **eastside** tributaries are Buck Hollow, Bakeoven, and Trout creeks. Drainage area of these tributaries is approximately 690 square miles. These streams are generally characterized as rainfall and spring fed.

Table 1. Mean monthly discharge (cfs) for the Deschutes River at the mouth, USGS Station 14103000, 1965-1985.

Month	Discharge	Month	Discharge
January	7,844	July	4,732
February	7,508	August	4,477
March	7,407	September	4,535
April	6,862	October	4,809
May	6,097	November	5,589
June	5,457	December	6,627

Table 2. Mean monthly discharge (cfs) for the Deschutes River near Madras, USGS Station 14092500, 1965-1985.

Month	Discharge	Month	Discharge
January	5,809	July	4,124
February	5,517	August	4,020
March	5,632	September	4,049
April	5,297	October	4,258
May	4,555	November	4,830
June	4,357	December	5,265

Principal **westside** tributaries are the White and Warm Springs rivers and Shitike Creek. Drainage areas for these tributaries are 417 square miles for White River, 526 square miles for Warm Springs River, and 76 square miles for Shitike Creek. Mean monthly flows for these tributaries are shown in Tables 3, 4 and 5. The **westside** streams are generally characterized as **snowmelt** fed.

Table 3. Mean monthly discharge (cfs) for White River at Tygh Valley, USGS Station 14101500, 1965-1985.

Month	Discharge	Month	Discharge
January	736	July	185
February	715	August	129
March	621	September	121
April	590	October	139
May	655	November	238
June	420	December	490

Table 4. Mean monthly discharge (cfs) for Warm Springs River near Kah-Nee-Ta Hot Springs, USGS Station 14097100, 1973-1985.

Month	Discharge	Month	Discharge
January	656	July	290
February	703	August	263
March	623	September	260
April	547	October	266
May	528	November	330
June	417	December	553

Table 5. Mean monthly discharge (cfs) for Shitike Creek near Warm Springs, USGS Station 14092885, 1975-1985.

Month	Discharge	Month	Discharge
January	111	July	92.4
February	135	August	59.3
March	111	September	49.3
April	98.3	October	50.8
May	127	November	78.7
June	136	December	129

Water quality data for the Deschutes River is shown in Tables 6 and 7. The mainstem Deschutes River does not have major water quality problems.

The existing water rights for the lower Deschutes River Subbasin are summarized in Table 8. Principal consumptive uses of surface waters are irrigation, industrial, and municipal uses. Nonconsumptive uses include power rights, recreation, protection of aquatic life, fish, and wildlife.

Presently the only instream water right for the purpose of supporting aquatic life in the lower Deschutes River Subbasin is in the White River from the U.S. Geological Survey streamflow gage below White River Falls to its confluence with the Deschutes River. The instream water right is 60 cfs July 1 to February 15, 100 cfs February 16 to 29, 145 cfs March 1 to May 31, and 100 cfs June 1 to 30.

The water rights of the Warm Springs Tribes have not been quantified and are not subject to determination under state law. The tribes' rights to instream and consumptive uses of water from streams flowing through and bordering the reservation and groundwater underlying the reservation are federally protected, reserved rights pursuant to Winters vs. United States/ 207 U.S. 564 (1908). The Warm Springs Tribal Council regulates the use of water on the reservation under the Warm Springs Water Code. Additionally, the Warm Springs Tribes' treaty-secured off-reservation fishing rights require the maintenance of sufficient water quantity and quality to support the salmon and steelhead runs passing usual and accustomed fishing areas.

Table 6. Physical characteristics of the Deschutes River at the mouth, USGS Station 14103000. All quantities are median values from October 1982 to January 1988.

Parameter	Fall	Winter	Spring	Summer
pH	8.1	7.7	8.2	8.4
Temperature (F)	49	43	55	64
Dissolved Oxygen (mg/l)	11.8	12.5	11.0	10.5
Specific Conductance (US/cm)	130	128	127	126
Turbidity (NTU)	2.0	4.2	7.0	2.6
Alkalinity (mg/l as CaC03)	65	67	63	60
Hardness (mg/l as CaC03)	44	46	45	43

Table 7. Water quality data for the Deschutes River. All quantities are median values for 1986 (U.S. Environmental Protection Agency's Storet System).

Parameter	Units	Station Location	
		Mouth	Warm Springs Bridge
Nitrogen			
NH_3+, NH_4-	mg/L as N	0.020	0.025
NO_2, NO_3	mg/L as N	0.02	0.13
Phosphorus			
Diss., Total	mg/L as P	0.099	0.092
Diss., Ortho	mg/L as P	0.045	0.068
Total Organic Carbon	mg/L	2.0	<1.0
Calcium, Diss.	mg/L	7.7	7.6
Magnesium, Diss.	mg/L	4.8	5.1
Sodium, Diss.	mg/L	9.1	10.0
Potassium, Diss.	mg/L	1.9	--
Chloride, Total	mg/L	2	--
Sulfate, SO_4	mg/L	2	--

Table 8. Summary of water rights (cfs) for the lower Deschutes River Subbasin. a/

Beneficial use	White River	Trout Creek	Deschutes & other tribs	Total
Aquatic Life	60.00 b/	--	--	60.00
Domestic	0.48	0.61	0.33	1.42
Domestic/Livestock	0.17	--		0.17
Fire Protection	1.38	--	--	1.38
Fish	0.20	--	71.48	71.68
Fish/Wildlife	0.07	--	--	0.07
Industrial/Manufacturing	1.61	--	--	1.61
Irrigation	138.94	44.07	12.68	195.69
Irrigation/Domestic	3.37	--	--	3.37
Irrigation/Domestic/Livestock	7.44	3.41	0.34	11.19
Irrigation/Livestock	--	0.15	--	0.15
Livestock	1.20	0.02	0.07	1.29
Livestock/Wildlife	0.03	--	--	0.03
Municipal	1.00	.23	5.06	6.29
Power	12.00	--	--	12.00
Recreation	15.01	--	0.25	15.26
Total	242.90	48.49	90.21	381.60

a/ Water rights information on the Warm Springs Indian Reservation is not available.
b/ Instream water right is 60 cfs July 1 to February 15, 100 cfs February 16 to 29, 145 cfs March 1 to May 31, and 100 cfs June 1 to 30.

Land Use

Ownership of land in the lower Deschutes River Subbasin is shown in Table 9. Forestry and timber production are major land uses of the subbasin. Most of the forestry uses occur on the westside of the subbasin on the Warm Springs Indian Reservation and the Mount Hood National Forest. The Ochoco National Forest administers a small portion of the upper Trout Creek watershed. Private timber companies also own forestlands in the White River and Trout Creek watersheds.

The Badger Creek Wilderness (24,300 acres) is located in the upper Badger Creek watershed in the White River drainage. The area became wilderness under the Oregon Wilderness Act of 1984. This is the only designated wilderness area in the lower Deschutes River Subbasin.

Table 9. Land ownership in the lower Deschutes River Subbasin.

Ownership	Area (sq miles)	Percentage of total
Indian Lands a/	560	21
U.S. Forest Service	285	11
Bureau of Land Management	108	4
State	57	2
Private	1,645	62

a/ Lands held in trust on and off the Warm Springs Reservation by the United States government for the benefit of the Warm Springs Tribes and individual Indians.

The lower Deschutes River from Pelton Reregulating Dam to the Columbia River was designated a "scenic waterway" in 1970 under the Oregon Scenic Waterways Program. The scenic waterway includes the river and its shoreline and all land and tributaries within one quarter of a mile of the Deschutes River, except for that portion of the river and its tributaries within the boundaries of the Warm Springs Indian Reservation and off-reservation Indian trust land. The Oregon Scenic Waterways Program is administered by the State Parks and Recreation Division of the Oregon Department of Transportation.

Agriculture is a major land use in the subbasin. Dryland farming is the dominant type of agriculture with irrigated farming playing a minor role.

Grazing is widespread throughout the subbasin. Grazing occurs on private lands, the Warm Springs Indian Reservation, and public lands administered by the Bureau of Land Management (BLM), the U.S. Forest Service, and the Oregon Department of Fish and' Wildlife.

Municipalities in the subbasin include Maupin, Tygh Valley, Wamic, Antelope, and Warm Springs.

Portland General Electric Company's Pelton-Round Butte hydroelectric project and the Warm Springs Tribes' Pelton Reregulating Dam hydroelectric project at the southern boundary of the lower Deschutes River Subbasin are the only hydroelectric facilities in the subbasin. Northern Wasco County Public Utility District has applied for a permit to develop a hydroelectric facility at White River Falls near Tygh Valley.

PART II. HABITAT PROTECT&N NEEDS

History and Status of Habitat

Fish production potential in the subbasin is limited by physical and environmental factors and impacts of land and.water uses. Constraints to fish production include low flow and high temperatures in tributaries during summer and fall, sediment in tributaries and the Deschutes River, and loss of fish at unscreened irrigation diversions.

The amount and seasonal pattern of precipitation affects the flow regime of the streams in the subbasin. Average annual precipitation ranges from about 120 inches in the Cascade Range to 10 inches in the eastern portion of the subbasin. Annual snowfall is about 200 inches at the crest of the Cascade Range and decreases to about 15 inches at lower elevations. Very little rain falls from May to October, although occasional intense thunderstorms may occur over the subbasin during summer. Rain falling on snow in late winter and spring when the ground is already saturated can cause rapid increases in streamflow and destructive flooding. Summer thunderstorms can result in flash flooding in eastside tributaries.

Riparian areas in the subbasin have been impacted in several ways since white settlers came to the area over 100 years ago. Grazing by cattle, sheep, and horses, farming practices, timber harvest, road construction and maintenance, and railroad construction and maintenance have degraded riparian areas throughout the subbasin. These land uses have changed the character of the riparian areas by reducing or eliminating vegetation, compacting soil, and decreasing streambank stability.

Many of the eastside tributaries and westside tributaries with little or no drainage area on the slope of the Cascade Range have very little flow or are intermittent in summer and fall. Degradation of the riparian areas of the tributaries accentuates the seasonality of the flows. Vegetation loss and compacted soils along the streambank reduce infiltration rates and increase runoff during precipitation events. The result is higher flows in winter and spring and low or intermittent flows in summer and fall.

A well developed riparian area can act to reduce the extremes of flow. Developed stream channels and higher water tables associated with developed riparian areas hold more water during the wet season and release water slowly during the dry season allowing streams to flow year-round.

Riparian areas also act to maintain cool water temperatures during summer. Shading by vegetation, particularly on small streams, helps keep water temperatures cool. The slow release of cool water from the water table throughout the summer also maintains cool stream temperatures.

Healthy riparian areas also reduce sediment inputs in the aquatic environment. Streamside vegetation reduces the erosive power of a stream and stabilizes and builds up banks by filtering and depositing sediments.

Riparian protection projects throughout the subbasin have shown dramatic benefits within several years of implementation. Riparian fencing in the Trout Creek and Warm Springs River systems and along the Deschutes River has allowed vegetation to reestablish and stabilize streambanks. In some instances, tributaries to Trout Creek that were dry in the summer are now flowing year-round after excluding livestock from the streambanks. Alders are now growing along the Deschutes River where they had not been growing before riparian fencing to control livestock use.

Croplands are a source of sediment reaching the aquatic environment. Cropland runoff from storm flooding and irrigation waste water carry sediment from the uplands to the streams. Intensive farming of dryland wheat occurs in the northern end of the subbasin and irrigated farming of potatoes, mint, grass seed, hay, and other crops occurs in the southern end of the subbasin. Much of the cropland in the northern portion of the subbasin is classified as highly erodible and thus is subject to compliance with the Food Security Act of 1985. Some of the cropland is now in the Conservation Reserve Program and has been taken out of agricultural production for at least 10 years. Farmers have planted these Conservation Reserve Program lands with cover crops to reduce erosion. Alternative tillage methods, terracing, and sediment dams are being used on agricultural lands in production to reduce erosion.

Unscreened irrigation diversions reduce fish production in the subbasin. Fish, particularly downstream migrants, can enter unscreened diversions and end up in agricultural fields where they die. Screening of 10 irrigation diversions in the Trout Creek system saved approximately 13,000 steelhead smolts in 1988 that would otherwise have been lost to production. Three of five unscreened diversions in the Trout Creek watershed will be screened in 1989, but there are no plans to screen the remaining two diversions. None of the 18 diversions in the White River watershed are screened even though Oregon law (ORS 509.615) requires that all diversions be screened.

Constraints and Opportunities for Protection

General institutional considerations for management of land and water in the lower Deschutes River Subbasin are described in Part III.

Management of Bureau of Land Management lands in the subbasin is guided by the Two-Rivers Resource Management Plan adopted in 1986. Objectives of the plan include managing riparian areas along the Deschutes River and-its major tributaries to full potential, with a minimum of 60 percent of the vegetative potential to be achieved within 20 years. The objectives also include managing all streams with fisheries or fisheries potential to achieve a good to excellent aquatic habitat condition (BLM 1986).

Management of U.S. Forest Service lands in the subbasin is based on Forest Service policies and federal legislation. Land and resource management plans for the Mount Hood and Ochoco national forests are being developed. These plans will establish standards and guidelines for management of habitat. Federal legislation that guides management of Forest Service lands in the subbasin includes the National Environmental Policy Act, National Forest Management Act, Wilderness Act, Multiple Use and Sustained Yield Act, and the Northwest Power Planning Act. The U.S. Forest Service is also following guidelines set by the national Wild and Scenic Rivers Act for management along the White River; the river from the headwaters to the mouth is designated part "wild," part "scenic," and part "recreational." Forest Service policy for management of lands in Oregon is to meet or exceed the standards of the Oregon Forest Practices Act and state water quality standards.

The primary role of the Oregon Department of Fish and Wildlife in habitat protection is to review activities of land managers and recommend practices to minimize negative impacts on fish habitat. The ODFW has several policies that involve protection of fish habitat. The Habitat Conservation Division of the ODFW has a fish and wildlife habitat protection policy that states in part ". ..the Department will cooperate fully with other agencies to implement laws and to develop coordinated resource management programs which protect fish and wildlife habitat. The Department will also work with private organizations and individuals to achieve, where possible, mutually satisfactory solutions to conflicts between the objectives of other parties and the Department's habitat protection policy." Paragraph 6 of the Fish Management Policy (OAR 635-07-515) states "Available aquatic and riparian habitat shall be protected and enhanced to optimize fish production of desired species."

Habitat Protection Objectives and Stratesies

Objectives

1. Maximize the protection and enhancement of aquatic and riparian habitat on all land bordering the Deschutes River and its tributaries to result in a net increase in habitat quantity and quality over time.

   High quality aquatic and riparian habitat is necessary for optimum fish production. The aquatic environment must provide the requirements for every life history phase of fish. Adequate amounts of clean, cool water, food organisms, cover, and spawning areas for salmonids are components of high quality habitat.

   Habitat management is the basis of wild fish management. Management objectives for natural fish production cannot be obtained without all the elements of habitat to support fish production. Habitat protection is more effective than restoration or enhancement, but habitats that have been degraded should be restored to return fish production to optimum levels. Habitat restoration and enhancement can increase natural production, but should not be considered a panacea for habitat protection.

2. Maintain or improve watershed conditions for the sustained, long-term production of fisheries and high quality water.

   The stream is the product of its watershed. A watershed in poor condition will not produce high quality water. High quality water is necessary for optimum fish production. Management objectives for fish production cannot be obtained without clean, cool water.

   band uses in the watershed can adversely affect water quality. Agriculture, livestock grazing, and timber harvest practices have the potential to degrade watershed conditions **and** decrease water quality.

3. Maintain or improve flow for fish production in the tributaries of the Deschutes.

   Water quantity is as important as water quality for fish production. Fish production is limited **by** streamflow in some tributaries in the subbasin. Restoration of optimum streamflows will increase the fish production capacity of the subbasin.

Strategies

1. Support enforcement of existing laws and regulations concerning habitat protection by agencies with enforcement authority.

   Existing laws and regulations provide adequate protection of fish habitat. Funding of enforcement activities does not always receive high priority within agencies. The priority given to enforcement of existing laws and regulations can vary among agencies and among districts within agencies.

2. Support implementation of existing land and resource management plans.

   Existing land and resource management plans provide adequate protection of fish habitat. Funding for implementation of management plans does not always give high priority to protection of fisheries or maintenance of high water quality. Funding is often politically motivated and the largest and most vocal interest group often influences the implementation of management plans.

3. The ODFW should apply for instream water rights for fish protection.

   The acquisition of instream water rights can be politically unpopular with local landowners and water users. Some streams in the subbasin are overappropriated with water rights. Some of these water rights undoubtedly have not been used in five consecutive years and should be cancelled.

PART III. CONSTRAINTS AND OPPORTUNITIES FOR ESTABLISHING PRODUCTION OBJECTIVES

Institutional Considerations

Land and water in the lower Deschutes River Subbasin is managed by federal, state and-tribal agencies and several irrigation districts...

The Mount Hood National Forest manages approximately 235 square miles of land in the White River drainage. Portions of the Bear Springs and Barlow ranger districts are drained by White River and tributaries. The dominant land use is timber management. Other uses include recreation, grazing, and fish and wildlife management. Badger Creek Wilderness is in the White River drainage. Mount Hood National Forest is currently developing a land and resource management plan that will make further land use designations and establish standards and guidelines for management.

The Ochoco National Forest manages approximately 27 square miles of land in the headwaters of the Trout Creek drainage. The U.S. Forest Service also manages approximately 23 square miles of the Crooked River National Grasslands in the Trout Creek drainage.

The Prineville District of the Bureau of Land Management manages approximately 108 square miles of land throughout the subbasin, much of it in the Deschutes River canyon. The Two Rivers Resource Management Plan, adopted by the BLM in 1986, establishes guidelines for management of resources on public lands in the Deschutes and John Day subbasins. The plan has not been fully implemented because of a lack of funding and personnel.

The Warm Springs Indian Reservation is approximately 1,000 square miles in size, most of which is included in the lower Deschutes River Subbasin. Almost all land within the boundaries of the reservation is held in trust by the Bureau of Indian Affairs for the benefit of the Warm Springs Tribes or individual Indians. Also within the reservation is a small amount of deeded land, most of which is owned by individual tribal members. In addition, the tribes hold various parcels of trust land off-reservation, the most important of which is an 888-acre section along both sides of the Deschutes River at Sherars Falls. The tribe, with assistance from the Bureau of Indian Affairs, manages tribal trust lands on and off the reservation as well as tribal natural resources. The major land uses on the reservation are timber management and grazing.

The U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), Oregon Department of Fish and Wildlife, and U.S. Forest Service review federal projects (such as U.S. Army Corps of Engineers projects), permits and licenses (Federal Energy Regulatory Commission hydroelectric licenses), and other activities involving federal funds to evaluate their impacts on fish and wildlife.

The Oregon Department of Fish and Wildlife manages land in the Lower Deschutes Fish and Wildlife Area and the White River Wildlife Management Area. The Lower Deschutes Fish and Wildlife Area encompasses approximately 12.5 square miles along the lower 18 miles of the Deschutes River. The area is managed primarily for fish and wildlife habitat and recreation. Management practices include riparian enhancement, shrub and tree planting, spring development, and livestock grazing. The White River Wildlife Management Area encompasses approximately 44 square miles in the White River drainage. This area is managed primarily as winter range for deer and elk. Management practices include irrigated and dryland agriculture, livestock grazing, controlled burning, winter feeding, rangeland seeding, and timber management.

Except for the reserved water rights of the Warm Springs Tribes, the Oregon Water Resources Commission regulates and the Oregon Water Resources Department administers water uses in the subbasin. Water rights have been granted for irrigation, livestock, domestic, industrial, recreation, and fish uses.

The Oregon Department of Forestry regulates commercial timber production and harvest on private land in the subbasin. The Forest Practices Act established standards for protection of fish habitat on private and state forest land.

The Oregon Division of Lands and U.S. Army Corps of Engineers regulate the removal of material from the beds and banks or filling of the waters in the state. Permits are required for projects involving 50 cubic yards or more of material. The Oregon Department of Fish and Wildlife, National Marine Fisheries Service, U.S. Fish and Wildlife Service, and the Soil and Water Conservation District review applications for permits and may request specific protective conditions or deny the permit based on impacts of the project on fish resources. The Division of Lands and the Corps make the final decision on permits.

Portland General Electric manages the Pelton-Round Butte hydroelectric project in cooperation with Warm Springs Power Enterprises, which owns and operates the Warm Springs tribal hydroelectric project at the Pelton Reregulating Dam and regulates the discharge of the Deschutes River at RM 100.

Guidelines for flow regulation below Pelton Reregulating Dam are described in the Part I of this plan.

Several irrigation and water improvement districts have water rights for domestic and irrigation uses in the White River drainage. These districts obtain their water from diversions of tributaries of White River and reservoirs built on tributaries.

The Bureau of Land Management is developing'a wild and scenic river management plan for-the Deschutes River in cooperation with the state of Oregon and the Deschutes River Management Committee. The committee consists of representatives of the Warm Springs Tribes, user groups, county governments, and landowners.

Legal considerations

The lower Deschutes River was designated a "scenic waterway" in 1970 under the Oregon Scenic Waterways Program. The scenic waterway includes the river and its shoreline and all tributaries within a quarter of a mile of its banks from Pelton Reregulating Dam to the Columbia River, excluding the river and its tributaries within the boundaries of the Warm Springs Indian Reservation and off-reservation Indian trust land and the city of Maupin. The, program protects the free-flowing character of designated rivers for fish, wildlife, and recreation. Dams, reservoirs, impoundments, and placer mining are not allowed on scenic waterways. The program is designed to protect and enhance scenic, aesthetic, natural, recreation, scientific, and fish and wildlife qualities along scenic waterways. New development or changes in existing uses proposed within a scenic waterway are reviewed before they may take place.

The Deschutes and White rivers were added to the national Wild and Scenic Rivers System in 1988. Wild and scenic river designation strengthens protection given the Deschutes River under the state scenic waterways program and gives federal protection to White River. Timber harvest, road building, mining, and grazing can be regulated to reduce adverse impacts on the designated rivers. Designation of these rivers within the wild and scenic system provides access to increased federal funding for management of the rivers.

The Confederated Tribes of the Warm Springs Reservation of Oregon is the modern-day political successor to the seven bands of Wasco- and Sahaptin-speaking Indians of the mid-Columbia area whose representatives were signatories to the Treaty with the Tribes of Middle Oregon of June 25, 1855, 12 Stats. 963. Article I of the treaty describes the 10-million-acre area of eastern Oregon ceded by the tribes to the United States and sets out the boundaries of the Warm Springs Indian Reservation. Article I also contains the express reservation by the tribes to "the exclusive right of taking fish in the streams running through and bordering said reservation... and at all other usual and accustomed stations, in common with citizens of the United States."

Streams running through and bordering the reservation to which the tribes have exclusive fishing rights pursuant to Article I of the treaty include the Deschutes, Metolius, and Warm Springs River systems. Streams within the ceded area where the tribes have primary off-reservation rights at usual and accustomed fishing stations include the John Day River, Fifteenmile Creek, and Hood River. Additionally, the tribes claim off-reservation rights at usual and accustomed stations on streams outside of the ceded area, which may be primary, secondary, or co-equal with the treaty rights of other tribes.

The Warm Springs Tribes' role as a management entity for purposes of subbasin planning in the upper Columbia River Basin is based on the tribes' exclusive fishing rights in the Deschutes, Warm Springs, and Metolius river systems; primary fishing rights in the John Day River, Fifteenmile Creek, and Hood River; and on the provisions of the recently executed Columbia River Fish Management Plan.

Currently no riparian easements exist within the subbasin. A recreational easement exists with a landowner along the east bank of the Deschutes River in the Dry Creek vicinity to allow public access to the riverbank in this area.

PART IV. ANADROMOUS FISH PRODUCTION PLANS

SPRING CHINOOK SALMON

Fisheries Resources

Natural Production

History and Status-

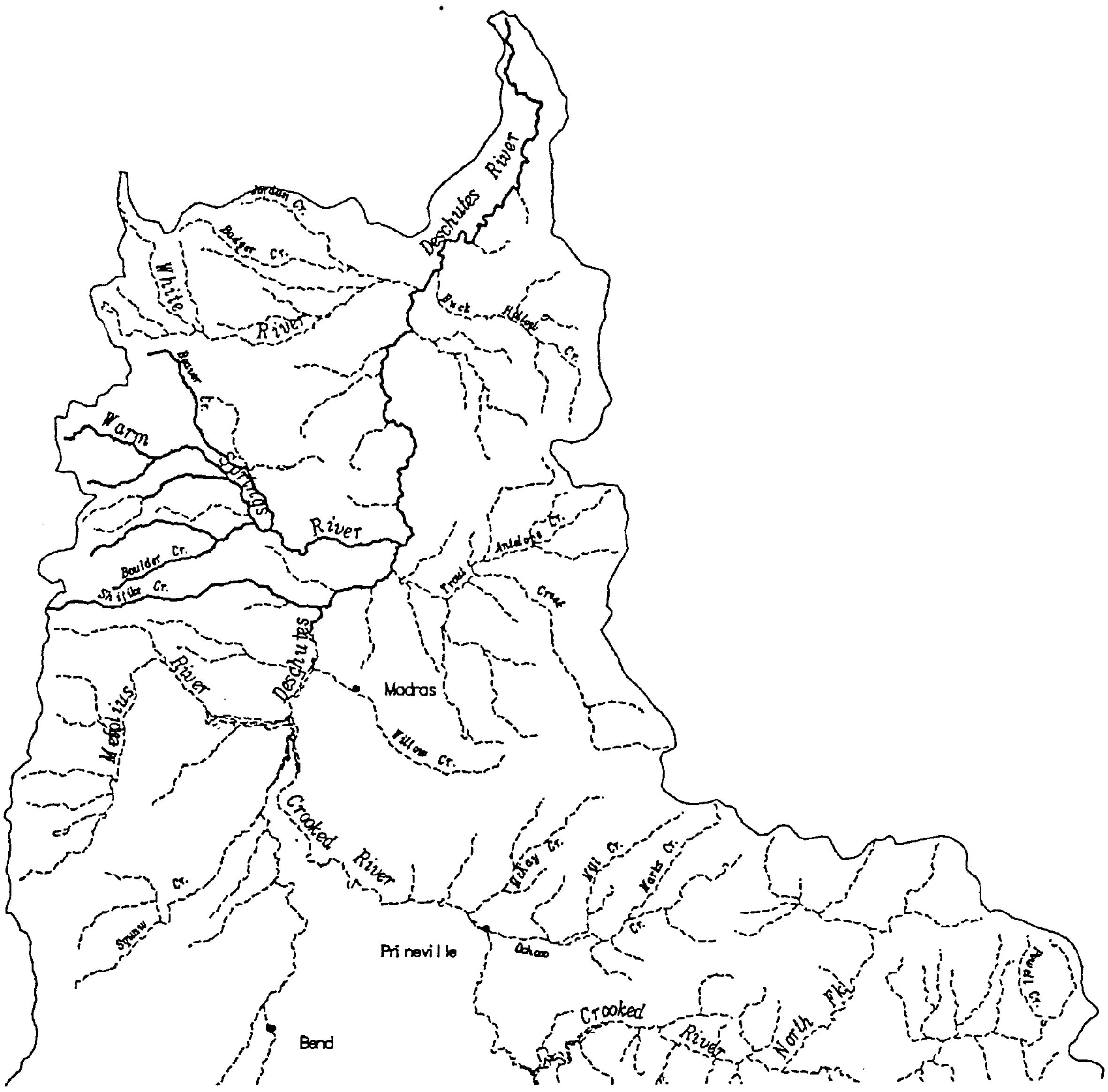
Spring chinook salmon (*Oncorhynchus tshawytscha*) spawned historically in the mainstem Deschutes River up to Steelhead Falls- (RM 128), in Squaw Creek, in the Metolius River, the Warm Springs River system and in Shitike Creek. Historic use of Crooked River by spring chinook salmon is unknown. Construction of Pelton and Round Butte dams, completed in 1958 and 1964, respectively, included upstream passage facilities for adult spring chinook salmon and steelhead and downstream facilities for migrating juveniles. By the late 1960s it became apparent that the upriver runs could not be sustained naturally with these facilities and in 1970 Portland General Electric agreed to build and finance the operation of an anadromous fish hatchery at the base of Round Butte Dam to mitigate for losses above the dams.

Current natural production is limited to Warm Springs River and Shitike Creek, both located on the Warm Springs Indian Reservation. Spawning occurs in the Warm Springs River and tributaries Mill Creek and Beaver Creek, and in Shitike Creek.

Life History and Population Characteristics

Natural spring chinook adults enter the Deschutes River in April and May (Table 10). The run arrives at Sherars Falls in mid-April and peaks in early to mid-May with the last spring chinook salmon passing the falls in mid-June. The date for separating spring and fall races of chinook salmon at Sherars Falls is June 15.

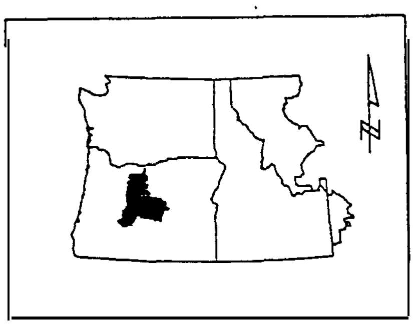
DESCHUTES SUBBASIN



SPRING CHINOOK DISTRIBUTION*

——————— PRESENT/POTENTIAL

--------------- ABSENT

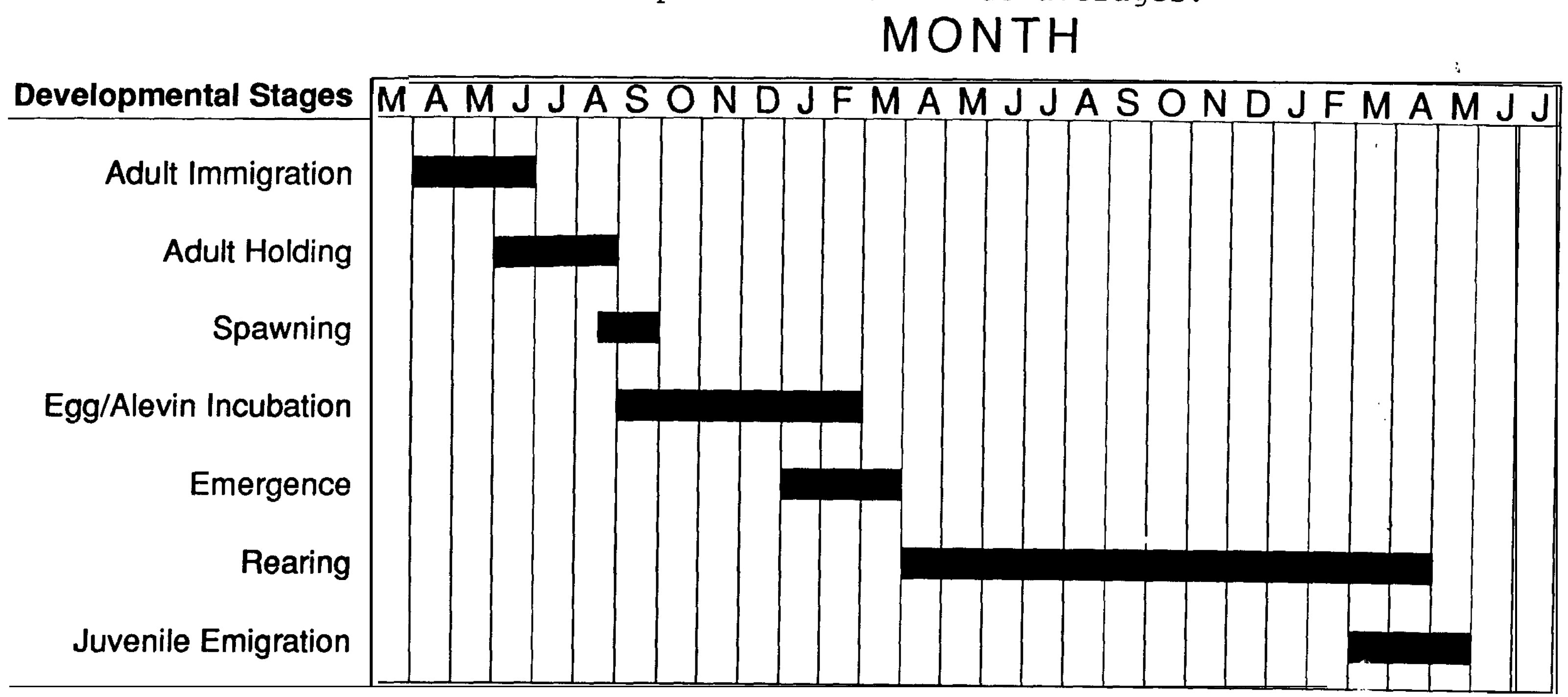


GEOGRAPHIC INFORMATION SYSTEM

BONNEVILLE POWER ADMINISTRATION

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

Table 10. Freshwater life history for spring chinook salmon in the Deschutes River. Developmental stage timing represents basin-wide averages.



Natural spring chinook salmon spawning in the Warm Springs River primarily occurs above Warm Springs National Fish Hatchery located at RM 9. All fish passing Warm Springs Hatchery must enter a trap at the hatchery to gain access to the spawning areas. Natural spring chinook salmon begin arriving at Warm Springs Hatchery in late April or early May, once water temperatures exceed 50 degrees Fahrenheit, and continue until late September. The run peaks at the hatchery by the first of June, with a second smaller peak in late August or early September. In most years, approximately 70 percent of the run arrives at Warm Springs Hatchery by June 1 and 90 percent by July 1 (Lindsay et al. 1989). Most of the fish that pass Warm Springs National Fish Hatchery hold in the Warm Springs River canyon within about seven miles of the hatchery until August when they continue upstream to the spawning areas. Time of entry into Shitike Creek and locations of holding areas is unknown.

Spawning in the Warm Springs River system begins the last week in August and peaks by the second week in September. Spawning is completed by the last week in September (Table 10) (Lindsay et al. 1989). Spawning in Shitike Creek occurs at about the same time.

The recommended escapement goal for the Warm Springs River system above Warm Springs Hatchery is 1,300 adults based on a stock-recruitment model developed by Lindsay et al. (1989).

Fisheries managers have estimated the run size of natural spring chinook salmon in the Deschutes River annually since 1977 using creel surveys of the sport and Indian subsistence fisheries at Sherars Falls and counts at Warm Springs Hatchery. The average run size from 1977 through 1988 was 2,290 natural spring chinook salmon, with a range of 1,290 to 3,895 natural fish (Table 11). Redd counts in Shitike Creek indicate a spawning escapement of nine to 72 adult spring chinook during 1978 through 1986. Most of these fish appear to be wild, however, some spring chinook salmon from Round Butte Hatchery have been observed in Shitike Creek.

Natural adult spring chinook return predominantly as age-4 fish (78 percent) with age-5 fish comprising 18 percent of the return and age-3 fish (jacks) about 4 percent (Table 12). Females comprise about 62 percent of the age-4 and age-5 fish returning to the Warm Springs River. The average fecundity of spring chinook salmon returning to Warm Springs National Fish Hatchery (natural and hatchery stocks) was 3,300 eggs per female for 1978 through 1985.

Emergence of spring chinook salmon in the Warm Springs River probably begins in mid-March (Table 10) (Lindsay et al. 1989). Information on completion of emergence in the Warm Springs River is not available, but may be similar to the John Day River where emergence begins in mid-March and is completed in May or June (Lindsay et al. 1986).

Juvenile spring chinook migrate from the Warm Springs River in two peaks -- a fall migration from September through December, and a spring migration from February through May (Lindsay et al. 1989). The fish migrating in the fall are age 0,, range in size from 3.1 inches to 4.3 inches fork length, and do not have the appearance of smolts. Most spring migrants are age-1 fish, range in size from 3.5 inches to 5.1 inches fork length, and have the bright silver coloration of smolts. The total number of fall and spring migrants from the Warm Springs River ranged from 35,235 fish to 131,943 fish for the 1975 through 1981 broods (Table 13).

Managers estimate the current smolt production capacity to be 132,000 smolts in the Warm Springs River system and 8,125 smolts in Shitike Creek (ODFW 1987). The standard method estimate of potential smolt production of spring chinook salmon in the lower Deschutes River Subbasin is 666,852 smolts. This total estimate is comprised of 554,719 smolts from the Warm Springs River system and 112,133 smolts from Shitike Creek. The standard estimate is based on a subjective evaluation of the habitat and assumptions about smolt densities at different levels of habitat quality.

Table 11. Run size of natural spring chinook salmon (adults and jacks) in the Deschutes River, 1977-1988.

Year	Harvest Tribal	Harvest Recreational	Brood Stock for RBH	Escapement to WSH	Total
1977	391	1,107	194	2,203 a/	3,895
1978	173	512	115	2,660	3,460
1979	199	345	89	1,395	2,028
1980	113	337	60	1,002	1,512
1981 b/	0	0	0	1,575	1,575
1982	201	515	0	1,454	2,170
1983	190	338	0	1,541	2,069
1984 b/	0	0	0	1,290	1,290
1985	195 c/	453	0	1,155	1,803
1986	d/	d/	44 e/	1,711	d/
1987	408	503	157 e/	1,783	2,851
1988	240	629	55 e/	1,647	2,571

a/ Includes an estimated 603 fish (201 redds X 3 fish/redd) that spawned below Warm Springs Hatchery.
b/ Fishery closed.
c/ Because there was no creel survey of the Indian fishery catch was estimated from the mean ratio of Indian to recreational'catch in 1977-80, 1982-83.
d/ No creel survey, harvest and run size unknown.
e/ Unmarked spring chinook that entered Pelton trap.

Table 12. Percentage age composition of natural spring chinook salmon in the lower Deschutes River Subbasin, 1974-1980 broods.

Brood Year	Total Age 3	4	5
1974	9	76	15
1975	4	78	18
1976	7	72	21
1977	2	72	26
1978	2	82	16
1979	5	83	12
1980	4	81	15

Table 13. Number of natural juvenile spring chinook that migrated from the Warm Springs River, 1975-1981 broods.

Brood	Time of Migration: Fall	Spring	Total
1975	25,795	43,250	69,045
1976	47,041	26,043	73,084
1977	25,125	25,204	50,329
1978	74,727	57,216	131,943
1979	24,930	25,628	50,558
1980	20,579	14,656	35,235
1981	29,238	14,647	43,885

Natural spring chinook salmon that migrate from the Warm Springs River in fall at age 0 appear to rear overwinter in the Deschutes or Columbia rivers before entering the ocean the following spring at age 1. Spring chinook salmon that were marked in fall as age-0 migrants from the Warm Springs River were recaptured in the Deschutes River the following spring. Natural spring chinook salmon smolts generally migrate through the Columbia River in April and May at age 1 (Table 10) based on recoveries of marked smolts (Lindsay et al. 1989).

Survival of juvenile spring chinook salmon in the Warm springs River appears to be density dependent (Lindsay et al. 1989). Survival of 1975 through 1981 broods from egg deposition to migration was highest at low egg densities, which compensated for low spawner abundance (Table 14). Survival from smolt to adult was also highest when juvenile migrants numbered 50,000 or less (Table 14).

Fish Production Constraints

Major habitat constraints to production of spring chinook salmon in the lower Deschutes River **Subbasin** are shown in Table 15. Problems in the Warm Springs River system are related to degraded streambanks and riparian areas. High water temperature, sedimentation and gravel quality are problems in lower Warm Springs River and Beaver Creek. Temperature problems in lower Shitike Creek are related to channelization and streambank degradation.

Information is needed on the factors limiting production of juvenile spring chinook salmon in the Warm Springs River system. The relative importance of the tributaries of the Warm Springs River for rearing juvenile spring chinook is also unknown. Additional run size data is needed to refine the **stock-**recruitment model developed by Lindsay et al. (1989).

Table 14. Abundance and survival of spring chinook salmon at various life stages in the Warm Springs River, 1975-1982.

Brood year	Females (redds)	Males	Millions of eggs	Migrants	Adults returns	Survival (%) Egg to migrant	Survival (%) Migrant to adult
1975	808	539 a/	2.669	69,045	1,891	2.6	2.7
1976	1,066	653 a/	3.521	73,084	1,541	2.1	2.1
1977	699	428 a/	2.309	50,329	1,691	2.2	3.4
1978	796	467	2.671	131,943	2,009	4.9	1.5
1979	359	220	1.309	50,558	2,077	3.0	4.1
1980	117	63	0.403	35,235	1,162	8.7	3.3
1981	- 157	114	0.539	43,885	1,603 b/	8.1	3.7 b/
1982	433	233	1.430	---	---	6.9	---

a/ Number of males based on average percentages of males (0.38) in 1977-1985 runs.
b/ Return of age-3 and age-4 fish only.

Table 15. Major habitat constraints to spring chinook salmon production in the lower Deschutes River Subbasin.

Location	Habitat constraints a/
Warm Springs River	TEM, SED, GQL, SBD, GRA, CVR
Beaver Creek and tributaries	TEM, SED, GQL, SBD, FLO, CVR, CHN
Mill Creek and tributaries	GQN, GRA, PSI, DIV, CVR, FLO
Badger Creek	FLO, GQN, PSI
Warm Springs River, South Fork	FLO, GQN
Shitike Creek	CHN, TEM, SBD, FLD, PSI
White River	PSI

a/ CHN=channelization, CVR=instream cover, DIV=unscreened or poorly operating diversion, FLD=flash flooding, FLO=low flow, GQL= gravel quality, GQN=gravel quantity, GRA=gradient, PSI=passage impeded, SBD=streambank degradation, SED=sedimentation, TEM=high temperature.

Hatchery Production

Description of Hatcheries

Portland General Electric constructed Round Butte Hatchery to mitigate for lost production of wild spring chinook salmon and summer steelhead above-the Pelton-Round Butte hydroelectric project. Round Butte Hatchery is operated by the Oregon Department of Fish and Wildlife. Operation of the hatchery began in 1972. The Warm Springs National Fish Hatchery was constructed after the Warm Springs Tribal Council requested the Bureau of Sport Fisheries and Wildlife (now the U.S. Fish and Wildlife Service) to determine the feasibility of a permanent fish hatchery on the reservation. The U.S. Fish and Wildlife Service operates the Warm Springs Hatchery, located on the Warm Springs River nine miles upstream from its confluence with the Deschutes River. Spring chinook salmon have been released into the lower Deschutes River Subbasin from only these two hatcheries since 1972. Prior to 1972, managers released spring chinook salmon from Fall River, Oak Springs, and Wizard Falls hatcheries into the mainstem Deschutes River. Eggs obtained from Carson National Fish Hatchery were hatched in egg boxes and in a pilot hatchery on the Warm Springs River.

Managers rear spring chinook salmon at Round Butte Hatchery. Mitigation requirements for the hatchery are 1,200 spring chinook salmon returning to Pelton trap, the hatchery's brood stock collection facility. To meet this requirement, the hatchery releases 270,000 spring chinook smolts.

The spring chinook salmon production program at Round Butte Hatchery consists of two different rearing scenarios. One scenario involves rearing 60,000 juvenile chinook salmon at the hatchery until the spring of the second year following egg-take, and then trucking them 10 miles downstream for release immediately below Pelton Reregulating Dam. The second scenario involves rearing 210,000 juvenile chinook salmon at the hatchery until fall of the year following egg-take and trucking them to Pelton ladder in November where they rear overwinter until they are allowed to migrate volitionally the following March or April. Chinook in Pelton ladder are fed once per day, five days per week. Fish migrating from Pelton ladder enter the Deschutes River immediately below Pelton Reregulating Dam. Spring chinook salmon released from Round Butte Hatchery are shown in Table 16.

Table 16. Juvenile spring chinook salmon released from Round Butte Hatchery into the Deschutes River, 1972-1983 broods. a/

Brood year	Release date	Release site	Number	Fish/lb	Mark or tag code
1972	04/27/73	Pelton Ladder	50,122	76.6	DLP
1972	04/27/73	Lake Simtustus	182,283	63.7	LP
1972	06/05/73	Rereg. Reservoir	65,678	50.6	LP
1972	03/04,05/74	Rereg. Dam	145,214	6.7-7.2	ADLP
1973	04/10,16/74	Lake Simtustus	81,110	65.0	LV
1973	04/19/74	Lake Simtustus	65,635	61.0	No Mark
1973	04/23/74	Rereg. Reservoir	81,704	63.0	RV
1973	04/23/74	Rereg. Reservoir	86,775	65.0	No Mark
1973	04/23/74	Rereg. Reservoir	1,320	60.0	AN
1973	05/10/74	Pelton Ladder	23,964	55.0	AN
1973	06/03/74	Rereg. Dam	61,560	26.2	DRP
1973	06/11/74	Lake Billy Chinook	15,000	75.0	No Mark
1973	02/14,18/75	Rereg. Dam	103,629	5.5	LVLM
1974	06/03/75	Rereg. Dam	20,150	30.0	DLP
1974	10/20/75	Rereg. Dam	4,267	5.6	DLV
1974	12/19/74	Rereg. Dam	14,448	13.0	DLV
1975	10/05/76	Rereg. Reservoir	27,579	9.3	09 04 06
1975	10/05/76	Rereg. Reservoir	12,051	9.3	09 04 07
1976	05/02/77	Rereg. Dam	62,040	44.5	09 16 01 & 02
1976	06/03/77	Rereg. Dam	36,675	29.1	09 16 03
1976	06/03/77	Rereg. Dam	35,625	29.1	09 16 04
1977	05/31/78	Rereg. Dam	47,802	28.4	07 16 11
1977	05/31/78	Rereg. Dam	47,598	32.3	07 16 12
1977	05/31/78	Rereg. Dam	26,394	23.7	07 16 15
1977	10/04/78	Rereg. Dam	26,640	13.0	07 16 54
1977	10/04/78	Rereg. Dam	25,908	13.2	07 16 55
1977	04/09/79	Rereg. Dam	42,000	9.1	07 16 53
1978	05/10/79	Pelton Ladder b/	14,579	91.0	07 18 24
1978	05/30/79	Rereg. Dam	54,300	22.0	07 18 25
1978	04/14/80	Rereg. Dam	32,865	8.0	07 19 49
1978	04/14/80	Rereg. Dam	30,758	8.8	07 19 50
1978	04/14/80	Rereg. Dam	29,993	8.0	07 19 51

(continued)

Table 16 continued. Juvenile spring chinook salmon released from Round Butte Hatchery into the Deschutes River, 1972-1983 broods. a/

Brood year	Release date	Release site	Number	Fish/lb	Mark or tag code
1979	05/12/80	Pelton Ladder b/	22,245	101.1 c/	07 21 53
1979	10/06/80	Rereg. Dam	29,264	5.9	07 21 54
1979	03/10/81	Rereg. Dam	30,450	6.6	07 23 10
1979	04/24/81	Rereg. Dam	29,200	5.0	07 23 09
1979	03/02/81	Pelton Ladder d/	25,446	8.8	07 23 11
1980	10/05/81	Rereg. Dam	48,472	5.7	07 23 47
1980	10/05/81	Rereg. Dam	29,430	11.4	07 23 49
1980	03/02/82	Pelton Ladder d/	28,656	7.0	07 23 48
1980	03/23/82	Rereg. Dam	25,010	5.0	07 23 50
1981	10/11/82	Rereg. Dam	28,538	6.4	07 25 20
1981	10/11/82	Rereg. Dam	59,118	22.8	07 27 15
1981	03/21/83	Rereg. Dam	57,340	9.3	07 27 14
1981	03/02/83	Pelton Ladder d/	48,495	12.2	07 27 16
1981	03/21/83	Pelton Ladder d/	24,847	12.2	07 27 17
1982	05/24/83	Rereg. Dam	28,979	19.2	07 28 36
1982	10/05/83	Rereg. Dam	53,550	16.3	07 28 43
1982	10/06/83	Rereg. Dam	28,200	5.6	07 28 37
1982	04/16/84	Rereg. Dam	28,790	5.2	07 28 39
1982	04/16/84	Rereg. Dam	28,991	5.2	07 28 40
1982	03/05/84	Pelton Ladder d/	54,000	9.5	07 28 42
1982	04/15/84	Pelton Ladder d/	51,000	8.4	07 28 41
1983	10/08/84	Rereg. Dam	60,797	12.4	07 31 31
1983	10/09/84	Rereg. Dam	30,394	6.5	07 31 32
1983	04/02/85	Rereg. Dam	57,749	5.8	07 31 28
1983	03/09/85	Pelton Ladder d/	60,725	7.6	07 31 29
1983	04/01/85	Pelton Ladder d/	60,770	7.6	07 31 30

a/ Experimental releases totaling 70,013 were made into Pelton ladder from 1975 to 1979 (1974-1977 broods) to determine migration timing, but were not included in this table.
b/ Fish were transferred from the hatchery to Pelton ladder in March and allowed to migrate on their own volition beginning on the release date.
c/ Weight at time of transfer to the ladder March 5, 1980.
d/ Fish were transferred from the hatchery to Pelton ladder in late October or early November and allowed to migrate on their own volition beginning on the release date.

Managers collect brood stock for the program at Round Butte Hatchery from returns to Pelton trap at the Pelton Reregulating Dam. Managers collected additional brood stock from the natural run passing Sherars Falls during the low run years of 1977 through 1980. All brood stock for Round Butte Hatchery has been collected from fish returning to Pelton trap since 1981. Fish for brood stock are collected from throughout the run, proportionate to their abundance to maintain diversity in the time of return. Managers hold approximately 300 adults and 30 jacks. Marked (hatchery) and unmarked (presumably wild) fish are spawned.

The Warm Springs National Fish Hatchery also rears spring chinook salmon. The design capacity of the hatchery is 1.2 million smolts. Current spring chinook production is approximately 700,000 smolts. Spring chinook salmon released from Warm Springs Hatchery are shown in Table 17.

The Warm Springs Hatchery releases spring chinook salmon in fall and spring. The fall release group consists of the faster growing fish, usually more than 5.5 inches fork length, than smolts in the fall of their first year. The number of fish released in the fall depends on the number of fish attaining 5.5 inches. The remainder of the fish are kept overwinter at the hatchery and released in mid-April.

Managers collect brood fish for the program at Warm Springs National Fish Hatchery throughout the run in proportion to their time of return. Approximately 70 percent of the fish are collected from late April through May, with a minimum of 90 percent collected by July 1. To reach full capacity at the hatchery, managers may use natural fish in excess of the 1,250 fish escapement goal above Warm Springs Hatchery for hatchery brood stock. To maintain genetic diversity in the hatchery stock, managers will use a minimum of 10 percent natural brood stock each year in the hatchery if natural fish returns are sufficient to meet escapement goals above Warm Springs Hatchery.

Run size of hatchery spring chinook in the Deschutes River has ranged from 24 fish to 4,384 fish between 1977 and 1988. Return to the two hatcheries have ranged from 24 fish to 2,728 fish between 1977 and 1988 (Table 18). The increase in run size in recent years is believed to be a result of improvements in rearing practices at the two hatcheries.

Hatchery spring chinook salmon enter the Deschutes River from early April to early June. Adult spring chinook salmon first arrive at Pelton trap in early May. Fifty percent of the adults enter the trap by the first week in June and 75 percent enter by mid-June. Jacks tend to arrive at Pelton trap a week later than adults. Timing of hatchery fish to Warm Springs

Hatchery is similar to that of natural spring chinook salmon; approximately 70 percent of the run arrives at Warm Springs Hatchery by June 1 and 90 percent by July 1.

Fisheries managers take eggs from adult spring chinook from late August to early September at Round Butte Hatchery. At Warm Springs National Fish Hatchery, spawning usually begins about August 15 once a week until mid-September.

Eggs are incubated at 42 F at Round Butte Hatchery and hatch in December and January. At Warm Springs Hatchery, managers initially incubate eggs in water chilled to 52 F. As ambient water temperatures fall to below 52 F, eggs are incubated at ambient temperatures and hatch in November or December.

Smolts are released as yearlings in April at five to 12 fish per-pound from Round Butte Hatchery and Pelton ladder. The Warm Springs Hatchery releases smolts in October at six to 10 fish per pound and as yearlings in April at 15 to 19 fish per pound. Smolts released in spring emigrate to the Columbia River from several days to several months after release. Some of the smolts released in fall overwinter in the Deschutes or Columbia rivers and enter the ocean the following spring (Lindsay et al. 1989).

Deschutes River spring chinook enter the ocean at age 1 and return at age 3 through age 5. Round Butte Hatchery spring chinook return primarily as age-4 fish, followed by age-3 and age-5 fish (Table 19). Warm Springs Hatchery spring chinook primarily return as age-4 fish, followed by age-5 and age-3 fish (Table 20).

Average fecundity of age-4 spring chinook at Round Butte and Warm Springs hatcheries is 3,500 and 3,300 eggs per female, respectively. On average, age-3 spring chinook salmon have 2,300 eggs per female at Round-Butte Hatchery.

Table 17. Juvenile spring chinook salmon released from Warm Springs National Fish Hatchery into the Warm Springs River, 1978-1984 broods.

Brood Year	Date Released	Number	Size (fish/lb)	Mark or Tag Code
1978	04/7,14/80	168,000	19	05 06 27
1978	04/1,14/80	10,890	19	05 06 28
1979	11/06/80	26,852	9	05 08 20
1979	11/06/80	27,816	9	05 08 21
1979	04/02/80	66,700	8	05 08 22
1979	04/09,16/81	170,167	18	05 08 23
1979	04/02/81	32,300	8	05 08 24
1980	11/16,12-18/81a/	65,303	12	No Mark
1980	03/29/82	142,884	12	No Mark
1981	10/05/82	68,557	10	OTC b/
1981	10/05/82	13,965	10	RV; OTC
1981 c/	10/05/82	25,950	6	LV; OTC
1981	04/12/83	154,954	15	2-OTC
1981 c/	04/12/83	27,645	15	LV;2-OTC
1981	04/12/83	27,257	15	RV;2-OTC
1982	10/24/83	61,864	9	LV; OTC
1982	04/13/84	625,995	18	LV
1983	10/16/84	345,544	9	RV; OTC
1983 c/	10/16/84	77,937	10	LV; OTC
1983	04/09/85	321,194	19	RV
1983 c/	04/09/85	61,650	17	LV
1984 d/	10/01/85	46,822	9	RV
1984	10/01/85	279,001	9	LV
1984	04/09/86	62,011	17	RV; OTC
1984	04/09/86	358,353	17	LV; OTC

a/ Volitional release.
b/ Oxytetracycline mark, 2= two feedings.
c/ Fish obtained from Round Butte Hatchery.
d/ In 1984, fish with low levels of bacterial kidney disease (BKD) were given an LV fin clip and those with moderate levels, an RV fin clip.

Table 18. Run size of hatchery spring chinook salmon (adults and jacks) returning to the Deschutes River, 1977-1988.

Year	Harvest: Tribal	Harvest: Recreational	Return to: RBH	Return to: WSH	Total
1977	0	7	47	0	54
1978	0	0	"24	0	24
1979	0	0	50	0	50
1980	0	60	102	0	162
1981 a/	0	0	453	85	538
1982	138	522	463	916	2,039
1983	125	310	623	371	1,429
1984 a/	0	0	604	992	1,596
1985	477 b/	1,179	1,649	1,079	4,384
1986	c/	c/	1,820	346	c/
1987	372	763	1,348	725	3,208
1988	347	1,311	1,472	824	3,954

a/ Fisheries closed.
b/ Because there was no creel survey of the Indian fishery, catch was estimated from the mean ratio of Indian to recreational catch in 1977-1980, 1982-1983.
c/ No creel survey, harvest and run size unknown.

Table 19. Percent age composition of Round Butte Hatchery spring chinook salmon, 1977-1981 broods.

Brood Year	Total Ase		
	3	4	5
1977	21	79	0
1978	29	70	1
1979	22	76	2
1980	18	81	1
1981	22	76	2

Table 20. Percent age composition of Warm Springs National Fish Hatchery spring chinook salmon, 1978-1980 broods.

Brood Year	Total Age		
	3	4	5
1978	6	86	8
1979	7	88	5
1980	2	91	7

Average survival rates at Round Butte Hatchery are 85 percent from egg to fry and 91 percent from fry to smolt, for a rate of 77 percent from egg to smolt. Average survival rates at Warm Springs Hatchery are 90 percent for egg to fry and 80 percent for fry to smolt, for a rate of 72 percent from egg to smolt.

Recent average return rates to the subbasin of spring chinook salmon from Round Butte Hatchery are 0.5 percent for fish released as yearlings in spring from the hatchery and 1.6 percent for fish released as yearlings in spring from Pelton ladder (Lindsay and Jonasson 1988). Return rates of Warm Springs Hatchery spring chinook salmon have averaged 0.3 percent (Lindsay and Jonasson 1988).

Anticipated Production Facilities

No new production facilities for spring chinook salmon are anticipated in the lower Deschutes River Subbasin. However, the Northwest Power Planning Council has adopted an amendment to determine the feasibility of propagating salmon and/or steelhead in Pelton ladder [Section 703(g)(3) of the 1987 Columbia River Basin Fish and Wildlife Program]. An increase in the number of fish reared in Pelton ladder could require an increase in incubation and rearing capacity at Round Butte Hatchery, depending on the production regime.

Constraints to Hatchery Production

Although Round Butte Hatchery has problems with disease in the spring chinook program, the mitigation requirement of 1,200 spring chinook salmon returning to Pelton trap has been met since 1985 with the increase in production from Pelton ladder. Bacterial kidney disease (BKD) has been a problem with spring chinook salmon at Round Butte Hatchery. Prophylactic treatment of juveniles and adults in recent years appears to have reduced the disease load in the hatchery and allowed the release of healthier smolts. Spring chinook salmon at Round Butte Hatchery are carriers of the viral disease infectious hematopoietic necrosis (IHN) and viral erythrocytic necrosis (VEN). Although there has never been an outbreak of either disease in spring chinook salmon at Round Butte Hatchery, the presence of the virus has prevented Deschutes River stock from being transferred to other river basins (Lindsay et al. 1989).

An increase in production of spring chinook salmon at Round Butte Hatchery probably could not occur without an increase in rearing ponds or a decrease in summer steelhead production. Round Butte Hatchery is operating at full capacity with the preferred rearing programs of spring chinook salmon and summer steelhead.

Spring chinook salmon production at Warm Springs Hatchery is constrained by an inadequate return of hatchery adults for brood stock due to low survival from smolt to adult. A brood stock of approximately 900 adults is needed to produce 1.2 million smolts, the capacity of Warm Springs Hatchery. Water quality and disease are constraints reducing production of smolts and adults at Warm Springs Hatchery. Water temperatures are too high in summer and too low in winter for optimum growth of spring chinook salmon. BKD is also a problem at this hatchery. Efforts are being made to reduce mortality from BKD by culling obviously infected adults from the brood stock. Managers are screening brood stock using enzyme linked immuno sorbant assay (ELISA) and florescent antibody technique (FAT), one-to-one spawning of males and females, and separate incubation to allow culling of carrier eggs.

Harvest

Harvest of spring chinook salmon in the Deschutes River occurs primarily in a l-mile section from Sherars Falls downstream to Buck Hollow Creek. This section of river is the only area of the lower Deschutes River where the use of bait by recreational anglers is permitted. A large recreational fishery and a tribal fishery for spring chinook salmon occurs from early April to mid-June.

Recreational and tribal harvests of spring chinook salmon in the Deschutes River are shown in Tables 11 and 18. The harvests of hatchery and natural spring chinook have averaged 620 fish and 760 fish, respectively, from 1977 through 1988. Harvest rates of natural and hatchery spring chinook salmon are similar, averaging 29 percent for the natural stock and 31 percent for the hatchery stock. Anglers expend an average of 3,300 angler days and 16,800 hours annually in the recreational fishery and 1,200 hours in the tribal fishery at the falls (Lindsay et al. 1989). The catch and effort in the recreational fishery has increased since 1982 as the hatchery programs have become more successful.

Spring chinook salmon returning to Pelton trap in excess of brood stock requirements at Round Butte Hatchery are provided to the Warm Springs Tribes (Table 21) or recycled through the recreational and tribal fisheries at Sherars Falls (Table 22). The low harvest rate of the fish recycled through the fisheries is due to the time of the recycling. Sufficient numbers of spring chinook salmon do not enter Pelton trap until the third or fourth week in May and thus most of the fish are trucked below Sherars Falls after the fishing effort declines after Memorial Day. In 1988 only one truckload of 126 fish was recycled through the fisheries prior to Memorial Day.

Table 21. Spring chinook salmon provided to Warm Springs Tribes from fish returning to Pelton trap, 1984-1988.

Year	Adults	Jacks
1984	0	216
1985	858	196
1986	1,117	250
1987	717	231
1988	669	278

Table 22. Spring chinook salmon recycled through the fishery at Sherars Falls, 1985-1988.

Year	Adults	Jacks	Harvest rate (%)
1985	313	3	14
1986	430	31	2
1987	318	35	9
1988	107	19	15

The Oregon Fish and-wildlife Commission sets harvest regulations for recreational fisheries in the subbasin. In recent years, the salmon season has been from April 1 to October 31 below Sherars Falls and from the fourth Saturday in April to October 31 above Sherars Falls. The commission has restricted the recreational fishery to barbless flies and lures only, except for the l-mile section from Buck Hollow Creek to Sherars Falls where bait may be used with barbless hooks. The catch limit for salmon and steelhead has been two adults per day in any combination, six adults per week, and 10 jack salmon per day, 20 per week.

The Warm Springs Tribes regulate all on-reservation fishing by both members and non-members. The tribes also regulate off-reservation fishing by tribal members exercising treaty rights. Tribal regulations for the on-reservation recreational fishery are consistent with Oregon Department of Fish and Wildlife regulations. The off-reservation treaty fishery, however, is not subject to a tribally imposed bag limit. Rather, the tribal council regulates this fishery through time and area closures, depending on stock and run-size status.

The Oregon Fish and Wildlife Commission and the Warm Springs Tribal Council closed the recreational and tribal fisheries for spring chinook in the Deschutes River in 1981 and 1984. The need for closures was based on predicted low returns of natural spring chinook to the subbasin.

Currently, no specific harvest management goals or treaty and non-treaty harvest allocation agreements exist for spring chinook salmon in the lower Deschutes River Subbasin.

Managers have monitored harvest of spring chinook salmon at Sherars Falls with a creel survey of the recreational and tribal fisheries. For specific information about the creel surveys, see Lindsay et al. (1989).

Oregon State Police and the Warm Springs Tribal Police enforce fishing regulations in the subbasin.

Specific Considerations

Spring chinook salmon are produced at two hatcheries in the subbasin. Round Butte Hatchery releases 270,000 smolts annually to meet the mitigation requirement of 1,200 spring chinook salmon returning annually to Pelton trap. Warm Springs National Fish Hatchery releases approximately 700,000 smolts annually with plans to increase production within four years to the hatchery capacity of 1.2 million smolts. The average run size of hatchery spring chinook salmon in the subbasin was 2,770 fish from 1982 through 1988.

Natural spring chinook salmon are produced in the Warm Springs River and Shitike Creek. The Warm Springs River above Warm Springs Hatchery and Shitike Creek are currently managed for natural fish only; hatchery spring chinook salmon are not routinely released in either system, although hatchery spring chinook salmon were allowed to spawn in the Warm Springs River above Warm Springs Hatchery from 1982 to 1986 as some hatchery fish were not externally marked and could not be differentiated from natural fish. Marking of all juvenile spring chinook salmon released from Round Butte Hatchery and Warm Springs Hatchery is necessary to differentiate them from natural fish on return as adults and to allow only natural fish to spawn above Warm Springs Hatchery. The current escapement goal for the Warm Springs River above Warm Springs Hatchery is 1,250 spring chinook salmon. This goal has been met in seven of the last 11 years. The average run size of natural spring chinook salmon in the subbasin was 2,290 fish from 1977 through 1988.

A large recreational fishery and a tribal fishery for spring chinook salmon occurs in a l-mile section from Sherars Falls downstream to Buck Hollow Creek from April to June. The harvest of hatchery and natural spring chinook salmon has averaged 620 fish and 760 fish, respectively, from 1977 through 1988. Tribal. fishermen take approximately 30 percent of the harvest, while recreational fishermen take 70 percent. Harvest rates of natural and hatchery stocks are similar, averaging 29 percent for the natural stock and 31 percent for the hatchery stock. Anglers expend an average of 3,300 angler days and 16,800 hours annually in the recreational fishery and 1,200 hours in the tribal fishery at Sherars Falls. The catch and effort in the recreational fishery has increased since 1982 as the hatchery programs have become more successful.

Recreational and Warm Springs tribal fisheries for spring chinook salmon were closed in 1981 and 1984 to protect the natural stock from overharvest. The hatchery programs at Round Butte Hatchery and Warm Springs Hatchery were not returning more adults than required for brood stock during those years. Restrictions on the harvest of natural spring chinook salmon (catch and release) may be an option in the future if predicted returns of the natural stock are low and all hatchery fish are externally marked.

Managers could increase hatchery production of spring chinook by rearing additional smolts in Pelton ladder. The actual number of smolts reared in the ladder would depend on a feasibility study to determine the capacity of the ladder and return rates that could be expected at higher production levels.

Planners have identified several opportunities for increasing natural production of spring chinook salmon in the subbasin. Ongoing habitat enhancement projects in Shitike Creek and the Warm Springs River watershed are expected to increase the natural production capacity for spring chinook salmon. A proposed fish passage facility at White River Falls would open up approximately 100 miles of stream to spring chinook salmon and would be expected to produce an additional 1,400 to 2,100 salmon in the subbasin (ODFW et al. 1985). Proposed development of upstream and downstream passage past the Pelton-Round Butte hydroelectric project could possibly reestablish anadromous fish production above Round Butte Dam. Feasibility studies of White River Falls and Pelton-Round Butte passage projects would determine the actual increases in natural production that could result from implementing the projects.

Introduction of spring chinook salmon into White River above the falls would result in a reduction of the native trout population in White River because of competitive interactions. Native trout management areas would be maintained above impassable waterfalls on Tygh and Jordan creeks and in Rock Creek above the reservoir. Native trout stocks in Little Badger and Threemile creeks would be protected by installing barriers to prevent anadromous fish passage into the upper areas of these creeks.

Managers expect fishing effort and harvest to increase in the subbasin as the run size increases. Increases in hatchery production should be balanced by increases in natural production so that overharvest of the natural stock does not occur. Hatchery stocks can withstand higher harvest rates than natural stocks because higher survival from egg to smolt in the hatchery requires fewer spawners to maintain production.

Critical Uncertainties

The following is a list of major uncertainties within the Deschutes Subbasin.

- The ability of the natural stock to maintain itself when hatchery production increases and harvest increases is unknown.
- The impact of increased production of spring chinook salmon on resident fish species is unknown.
- Actual factors limiting production of spring chinook salmon in the Warm Springs River system are unknown.
- The actual increase in spring chinook salmon production in the Warm Springs River system and Shitike Creek as a result of riparian improvement and instream habitat projects is difficult to quantify.

Objectives

Management Guidelines

1. Spring chinook salmon will be managed for wild and hatchery fish (Option B of the Oregon Wild Fish Policy) in the mainstem of the Deschutes River.
2. Spring chinook salmon will be managed exclusively for wild fish (Option A of the Oregon Wild Fish Policy) in the Warm Springs River above Warm Springs National Fish Hatchery and in Shitike Creek.

Biological Objectives

1. Achieve optimum use of existing and potential habitat for natural production in the subbasin by achieving a spawning escapement level of 1,400 to 2,500 natural spring chinook salmon. This level of spawning escapement should maintain the genetic diversity of-the natural stock.,

2. Achieve and maintain a return of 8,500 to 12,000 fish annually to the Deschutes River.

Utilization Objectives

1. Provide 5,500 to 8,000 spring chinook salmon (jacks and adults) available for harvest in recreational and Warm Springs tribal fisheries in the Deschutes River.

2. Provide the opportunity for equitable harvest sharing of spring chinook salmon in recreational and Warm Springs tribal fisheries in the subbasin.

3. Increase harvest opportunities for spring chinook salmon in the Deschutes River.

   Approximately 30 percent of the spring chinook salmon entering the subbasin are harvested in recreational and Warm Springs tribal fisheries. The System Planning Model indicates approximately 50 percent of the natural stock and 70 percent of the hatchery stocks will be available for harvest, taking into consideration spawning escapement and hatchery brood stock needs.

   Hatchery spring chinook salmon returning to subbasin hatchery facilities-in excess of brood stock requirements will be provided to the Warm Springs Tribes or recycled through the recreational and tribal fisheries at Sherars Falls.

Alternative Strategies

Modeling results for each strategy are presented in Table 23 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 23. 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.

The SMART (Simple Multi-Attribute Rating Technique) values (Table 24) were derived by subjective ratings of five different criteria for each strategy (see Appendix B). Estimated costs of the alternative strategies below are summarized in Table 25.

STRATEGY 1: Enhance natural production in Shitike Creek and Warm Springs River and increase production at Round Butte and Warm Springs hatcheries.

Proposed natural production enhancement projects should increase juvenile rearing habitat and adult holding areas in the subbasin, and decrease juvenile losses at a diversion. The net effects will be increases in egg-to-smolt survival, smolt-to-smolt survival, smolt capacity, and pre-spawning survival. Proposed hatchery production projects will increase hatchery smolt capacity and smolt-to-adult survival.

ACTIONS: 1, 2, 4, 5

1. Shitike Creek Habitat Enhancement. Riparian projects along the lower 10 miles of stream should increase channel and bank stability, increase summer streamflow, reduce summer water temperature, and decrease sedimentation. Instream projects in the lower eight miles of Shitike Creek should increase rearing habitat quality and adult holding area and enhance passage of adults to upstream areas. A reduction in water temperature in the lower eight miles should allow year-round rearing of juvenile spring chinook salmon in this

area. Installing a screen at a diversion for a mill pond will reduce losses of juvenile fish.

Estimated cost of this project over a 50-year life span is $1,006,000 based on 10 miles of enhancement and the cost estimation procedure provided by the System Planning Group.., This action is the same as summer steelhead Action 4.

2. Warm Springs River Habitat Enhancement. Riparian and instream projects in 20.5 miles of Coyote and Quartz creeks should increase channel and bank stability, establish perennial streamflow, and reduce sediment input into Beaver Creek and Warm Springs River. Riparian and instream projects in 9.5 miles of Warm Springs River should increase over-wintering habitat and adult holding area.

   Estimated cost of this project over a 50-year life span is $2,378,000 based on 30 miles of enhancement and the cost estimation procedure provided by the System Planning Group. This action is the same as summer steelhead Action 5.

4. Round Butte Hatchery Production Increase. Increase the number of spring chinook smolts released annually from Round Butte Hatchery by 200,000 to 500,000 smolts to a total of 470,000 to 770,000 smolts released annually. Pelton ladder will be used to rear the additional spring chinook salmon smolts. The actual number of additional smolts produced will be decided after a study to determine the rearing capacity of Pelton ladder.

5. Warm Springs National Fish Hatchery Production Increase. Increase the number of spring chinook salmon smolts released from Warm Springs National Fish Hatchery to the capacity of 1.2 million smolts, consistent with the hatchery operational plan developed by the Warm Springs Tribes and the U.S. Fish and Wildlife Service. Increase return rates to the subbasin to 0.3 percent to 0.5 percent through an evaluation program of rearing and release practices.

STRATEGY 2: Enhance natural production in Shitike Creek and Warm Springs River, and expand natural production into the White River drainage above White River Falls. Current hatchery production levels at Round Butte and Warm Springs hatcheries would be maintained.

Proposed natural production enhancement projects should increase juvenile rearing habitat and adult holding areas in the subbasin, and decrease juvenile losses at a diversion. The net effects will be increases in egg-to-smolt survival, smolt-to-smolt survival, smolt capacity, and pre-spawning survival.

ACTIONS: 1-3

1. -
2. -

3. White River Falls Passage. Passage of adult spring chinook salmon above White River Falls would provide access to 100 miles of spawning and rearing habitat that is currently unavailable.

   Waste water from the Clear Creek ditch shall be diverted away from the Oak Springs Hatchery water supply to prevent possible contamination of the hatchery with diseases from spring chinook salmon. Screening of 18 irrigation ditches in the White River system will be necessary to protect juvenile spring chinook salmon and resident fish.

   Sanctuaries for resident trout should be designated prior to spring chinook salmon introductions because some rainbow trout stocks in White River are genetically unique. The wild trout could be protected above existing barriers to upstream migration and by constructing new barriers. These wild trout areas should provide protection for the three groups of native trout identified in the basin.

   Native stocks of spring chinook salmon from Deschutes River populations will be used in White River. Fish for introduction should be surplus to present production needs and should not affect existing hatchery programs.

   The run of spring chinook salmon returning to the White River system must be self-sustaining within two generations (10 years) after initial introduction above the falls. The need to stock the system with spring chinook salmon each year would indicate that the system is not capable of supporting a run of spring chinook salmon.

   The preferred method for passage of adult spring chinook salmon at White River Falls is a trap and haul facility located 900 feet below the lower falls.

Alternatives to a free-fall passage for juvenile fish over White River Falls will depend on the timing of juvenile outmigrations of the introduced fish and on the distribution of migrants in the river channel above the falls. If a hydroelectric project is constructed at the falls, the developer will have to screen the penstock intake and-might have to provide downstream passage facilities if diversion of water causes mortality to fish passing over the -falls.

Access for adult fish above diversion dams in lower Tygh and Badger creeks will be necessary to ensure use of these productive creeks. Methods for providing access to the creeks will depend on the timing of the adult run and on when the diversion dams are installed. Modifications to diversion structures, if needed, will not affect the water user or use of the water.

Supplemental stocking of hatchery catchable trout to support trout fisheries in White River and Badger Creek could be continued without affecting the spring chinook salmon program. Existing trout angling regulations in the basin should not be altered unless there is observed biological justification.

A fishery for adult spring chinook salmon in White River above the falls would be considered after runs were established. Success or failure of the White River Falls passage project should not dictate angling regulation changes on the Deschutes River.

Evaluation should be an integral part of the implementation plan. The estimated cost of the project in 1985 was $4.3 million for construction of facilities and operation and maintenance for the passage of salmon and steelhead. Planners estimate costs to be about $2,984,000 in capital and $62,700 in annual O&M.

STRATEGY 3: Increase production at Round Butte and Warm Springs hatcheries. Current natural production levels would be maintained in Shitike Creek and Warm Springs River.

Proposed hatchery production projects will increase hatchery smolt capacity and smolt-to-adult survival.

ACTIONS: 4, 5 (see above)

STRATEGY 4: Enhance natural production in Shitike Creek and Warm Springs River. Hatchery-production at Round Butte and Warm Springs hatcheries would be maintained at current levels.

Proposed natural production enhancement projects should increase juvenile rearing habitat and adult holding areas in the subbasin, and decrease juvenile losses at a diversion. The net effects will be increases in egg-to-smolt survival, smolt-to-smolt survival, smolt capacity, and pre-spawning survival.

ACTIONS: 1, 2 (see above)

STRATEGY 5: Enhance natural production in Shitike Creek and Warm Springs River, expand natural production into the White River drainage above White River Falls, and increase production at Round Butte and Warm Springs hatcheries.

Proposed natural production enhancement projects should increase juvenile rearing habitat and adult holding areas in the subbasin, and decrease juvenile losses at a diversion. The net effects will be increases in egg-to-smolt survival, smolt-to-smolt survival, smolt capacity, and pre-spawning survival. Proposed hatchery production projects will increase hatchery smolt capacity and smolt-to-adult survival.

ACTIONS: l-5 (see above)

Table 23. System Planning Model results for spring chinook in the Deschutes Subbasin. Baseline value is for pre-mainstem implementation, all other values are post-implementation.

Utilization Objective:

1. Provide 5,500 to 8,000 spring chinook salmon (jacks and adults) available for harvest in recreational and Warm Springs tribal fisheries in the Deschutes River.
2. Provide the opportunity for equitable harvest sharing of spring chinook salmon in recreational and Warm Springs tribal fisheries-in the subbasin.
3. Increase harvesf opportunities for this stock in the subbasin.

Biological Objective:

1. Achieve optimum utilization of existing ard potential habitat for natural production in the subbasin by achieving spawning escapement level of 1,400 to 2,500 natural spring chinook salmon. This level of spawning escapement should maintain the genetic diversity of the natural stock.
2. Achieve and maintain a return of 0,500 to 12,000 fish annually to the subbasin.

Strategy[1]	Maximum[2] Sustainable Yield (MSY)	Total[3] Spanning Return	Total' Return to Subbasin	out of[5] Subbasin Harvest	Contribution[6] To Council's Goal (Index)
Base1 ine	1,633 -N	2,090	4,535	721	0(1.00)
All Nat	3,999 -C	2,109	6,778	1,094	3,162(1.50)
1	5,206 -C	2,153	7,888	1,238	4,686(1.74)
2	3,999 -c	2,109	6,778	1,094	3,162(1.50)
3	2,906 -N	3,626	7,648	1,198	4,347(1.68)
4	3,411 -C	1,682	5,591	895	1,488(1.23)
5*	5,722 -C	2,652	9,082	1,437	6,370(2.00)

*Recommended strategy.

[1] Strategy descriptions:

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

I. Enhance natural production in Shitike Creek and Uarm Springs River and increases production at Round Butte and Warm Springs hatcheries. Post Mainstem Implementation.

2. Enhance natural production in Shitike Creek and Warm Springs River, and expand natural production into the Uhite River drainage above Uhite River Falls. Current hatchery production levels would be maintained. Post Mainstem Implementation.

3. Increase production at Round Butte and Warm Springs hatcheries. Current natural production levels would be maintained. Post Mainstem Implementation.

4. Enhance natural production in Shitike Creek and Uarm Springs River. Hatchery production would be maintained at current levels. Post Mainstem Implementation.

5. Strategies I-5. Post Uainstem Implementation.

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

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

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

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

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

Table 24. Values obtained from the SMART analysis of each strategy proposed for spring chinook in the Deschutes River drainage.

Strategies	Total Value	Discount Value	Confidence Value
1	700	384	0.549
2	700	378	0.540
3	600	324	0.540
4	720	432	0.600
5 *	720	396	0.550

*Recommended strategy.

Table 25. Estimated costs of alternative strategies for Deschutes spring chinook. Cost estimates represent neu 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]	805,000	0	805,000	0	805,000
O&M/yr[2]	87,500	0	87,500	0	87.500
Other Costs					
Capital[3]	1,864,000	4,848,000	0	1,864,000	4,848,000
O&M/yr[4]	30,400	93,100	0	30,400	93,100
Total Costs					
Capital	2,669,000	4,848,000	805,000	1,864,000	5,653,000
O&M/yr	117,900	93,100	87,500	30,400	180,600

* Recommended strategy.

[1] Estimated capital costs of constructing a neu, 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 uater 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 neu hatchery production. For consistency, O&M costs are based on 50 years.

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

A) Solve the problem of limited harvest opportunity in the one-mile section from Sherars Falls to Buck Hollow Creek. The ability of the subbasin recreational and tribal fisheries to harvest more spring chinook as run size increases is believed to be limited by available area in the one-mile section from Sherars Falls to Buck Hollow Creek. Currently the recreational fishery is concentrated in this area as it is the only area where use of bait is permitted. The tribal fishery is also concentrated in this one-mile section of river. Alternative actions are:

1) Allow the use of bait from Sherars Falls to Pine Tree (RM 39) in the recreational fishery. This action would extend the bait fishing area four miles below Buck Hollow Creek.

2) Educate the angling public about alternative areas and methods of catching spring chinook salmon in the subbasin. Encourage tribal fishermen to expand the fishery into other areas of the Deschutes River.

B) Continue the spring chinook salmon run size monitoring program in the subbasin to evaluate success of achieving the objectives. The monitoring program includes statistical creel surveys at Sherars Falls, fish counts at Warm Springs National Fish Hatchery and Round Butte Hatchery, and spawning ground surveys. Marking of all hatchery spring chinook salmon is necessary to differentiate natural and hatchery fish for monitoring purposes and also for wild fish management in the Warm Springs River.

C) Continue operating the juvenile trap in the Warm Springs River to estimate abundance of juvenile migrants from the Warm Springs River. This data, along with that on adult returns, has been used to predict adult returns in future years.

D) Conduct a study to determine the feasibility of providing passage for spring chinook salmon adults and juveniles past the Pelton-Round Butte hydroelectric project. If passage is feasible, production from the area above the hydroelectric project could be used when the subbasin plan is updated. The passage project would provide access to historic spawning and rearing habitat that is now unavailable because of blockage by the hydroelectric project. Pelton fish ladder would not be used for fish passage under this action. The estimated cost of this study is $500,000 according to the application for amendment to the Columbia River Basin Fish and Wildlife Program.

Recommended Strategy

Strategy 5 (increased natural production through habitat and passage enhancement and passage barrier removal together with increased hatchery production) is the recommended strategy for increasing Deschutes River spring chinook salmon production.

Rationale for selecting Strategy 5 includes:

1) The selected strategy maximizes spring chinook salmon productivity in the subbasin through diverse means including both natural and artificial production enhancement.

2) The Deschutes River lies above only two mainstem Columbia River dams. Maximizing productivity in this subbasin can probably be achieved more feasibly and economically than in subbasins farther upriver.

3) Deschutes River spring chinook salmon are not underescaped. Therefore, habitat expansion and enhancement can be expected to result in relatively immediate production increases.

4) The production objective cannot be met through natural production alone. Enhancement of artificial production is required to realize the production objective.

5) Spring chinook salmon production in the subbasin is currently supplemented through artificial production. Expanding existing artificial production programs would have a minimal impact on the genetic character of the subbasin population.

6) The subbasin has both the brood stock and the water resources to allow inbasin expansion of current artificial production programs. Inbasin expansion would avoid potential problems associated with transfers of spring chinook salmon into the subbasin from outside sources.

7) Potential impacts on resident fish that could occur as a result of anadromous fish introductions above White River Falls can be avoided through precautionary measures and proper management.

8) Passage above White River Falls would add approximately 100 miles to the habitat available for natural production of spring chinook salmon.

9) The presence of anadromous fish in the White River system would result in higher values placed on the stream resource and more protection for the watershed in future resource planning.

The SMART analysis ranked Strategy 5 second only to Strategy 4. Strategy 4 is the most conservative and least productive alternative, while Strategy 5 is the most productive and diversified alternative. Strategy 5 is the only alternative that meets the spring chinook salmon production objective for the subbasin.

FALL CHINOOK SALMON

Fisheries Resource

Natural Production

History and Status

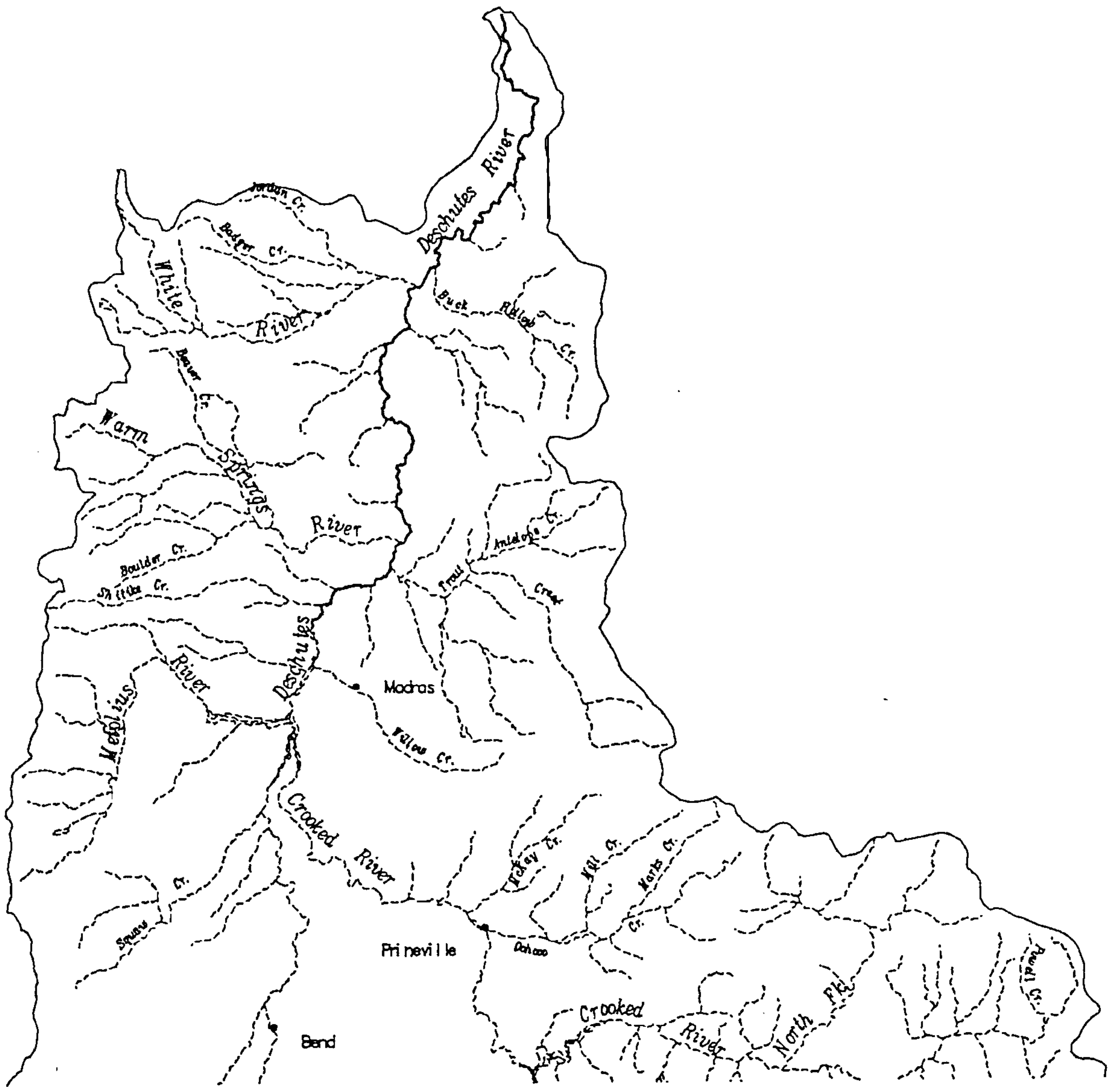
Fall chinook salmon (Oncorhvnchus'tshawvtscha) occur throughout the mainstem Deschutes River below Pelton Reregulating Dam. All production of fall chinook salmon in the subbasin is from the wild stock. Summer and fall flows may have limited the distribution of fall chinook salmon to the 44 miles of river below-Sherars Falls before a fish ladder was built at the falls in the 1940s. Construction of the Pelton-Round Butte hydroelectric project in 1958 inundated spawning areas above RM 100. Downstream passage facilities at the dams proved insufficient to sustain natural runs above the dams.

The mainstem spawning stock of chinook salmon in the lower Deschutes River Subbasin may be composed of both summer and fall runs or a single fall run with a protracted time of entry into the subbasin. This stock enters the subbasin from late June to October (Table 26). Evidence for the existence of summer and fall runs is that there appears to be two peaks in the run at Sherars Falls -- an early peak occurring in July and a late peak in September. Evidence for the existence of one run is that there does not appear to be reproductive isolation between the early and late segments of the run. Both segments spawn in the same areas with considerable overlap in time of spawning. Planners compiled harvest and escapement information for this stock under the assumption that it is one run of chinook salmon.

Fall chinook salmon-spawn throughout the Deschutes River from the river mouth to Pelton Reregulating Dam. The upper six miles of the Deschutes River (Dry Creek to Pelton Reregulating Dam) is heavily used for spawning. Since 1972, 46 percent of all redds counted were counted in four sample areas above Dry Creek, which represents only 16 percent of the area surveyed for redds from the river mouth to the dam (Jonasson and Lindsay 1988). Huntington (1985) found approximately 55 percent of the suitable spawning gravel for chinook salmon in the upper three miles of the river, from Shitike Creek to Pelton Reregulating Dam.

The run size of fall chinook salmon in the lower Deschutes River Subbasin from 1977 through 1988 averaged 9,420 fish annually, ranging from 5,219 fish to 12,254 fish (Table 27). Annual spawning escapement of jacks and adults averaged 2,910 fish and 3,620 fish, respectively, in this period (Tables 28 and 29).

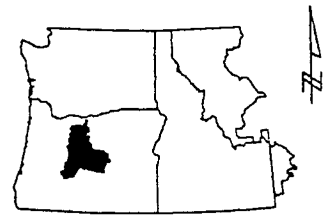
DESCHUTES SUBBASIN



FALL CHINOOK DISTRIBUTION*

———————— PRESENT/POTENTIAL

---------------- ABSENT

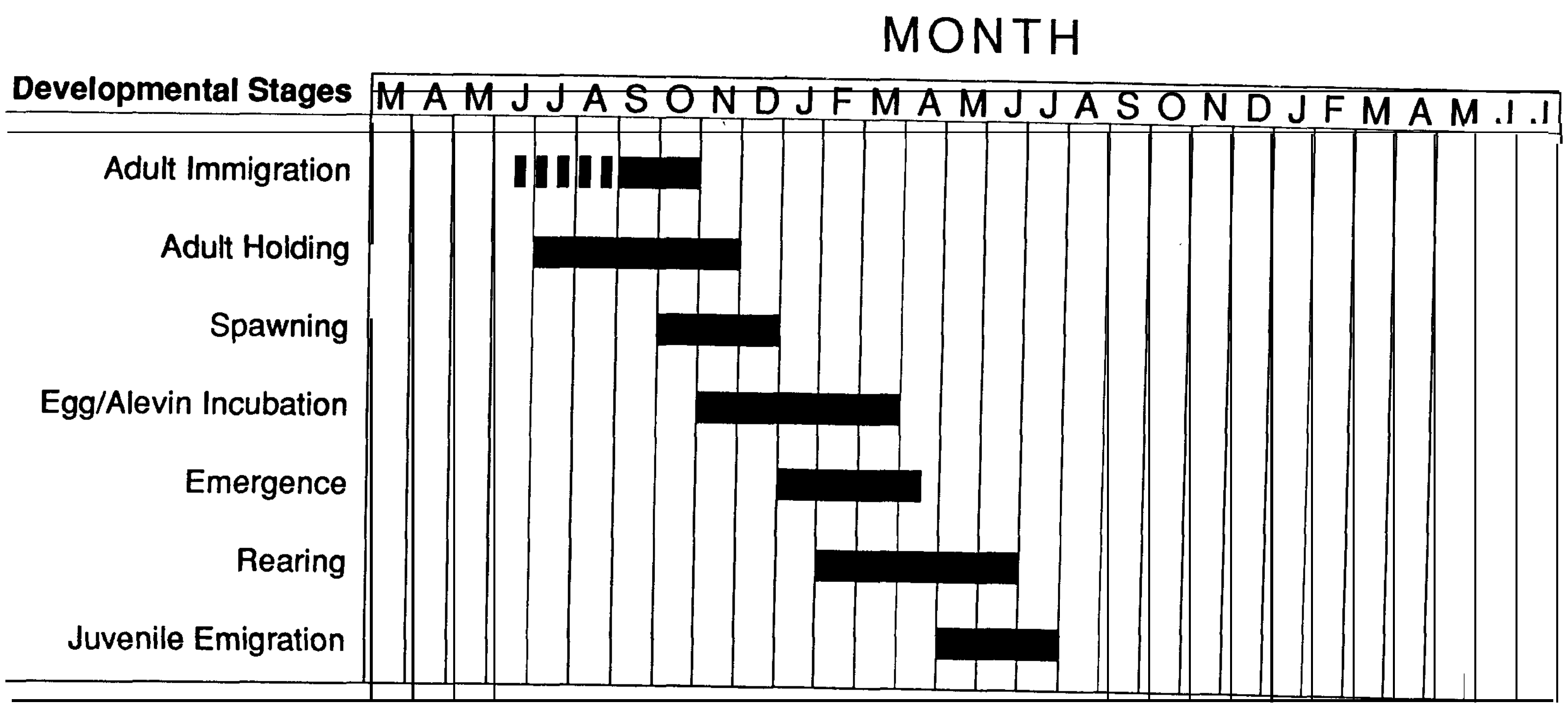


GIS GEOGRAPHIC INFORMATION SYSTEM

BONNEVILLE POWER ADMINISTRATION

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

Table 26. Freshwater life history for fall chinook salmon in the Deschutes River. Developmental stage timing represents basin-wide averages.



Solid bars indicate periods of heaviest adult immigration, spawning and juvenile emigration.

Table 27. Run size of wild fall chinook salmon (adults and jacks) in the Deschutes River, 1977-1988.

Year	Harvest		Escapement	Run Size
	Tribal	Recreational		
1977	2,280	1,253	7,756	11,289
1978	2,037	1,531	6,862	10,430
1979	1,991	1,601	7,629	11,221
1980	2,133	1,325	4,446	7,904
1981	1,786	1,345	6,911	10,042
1982	1,826	1,696	8,250	11,772
1983	1,549	625	4,528	6,702
1984	1,184	773	3,262	5,219
1985	1,449	812	8,029	10,290
1986	1,282	1,299	9,673	12,254
1987	1,697	697	5,612	8,006
1988	1,884	619	5,379	7,882

Table 28. Run size of wild jack fall chinook salmon in the Deschutes River, 1977-1988.

Year	Harvest		Escapement	Run Size
	Tribal	Recreational		
1977	723	949	2,125	3,797
1978	518	1,079	2,708	4,305
1979	616	1,384	4,338	6,338
1980	510	997	1,904	3,411
1981	366	928	3,728	5,022
1982	366	1,140	3,360	4,866
1983	369	309	859	1,537
1984	393	594	1,237	2,224
1985	789	665	5,384	6,838
1986	344	1,084	5,872	7,300
1987	66	211	1,515	1,792
1988	60	183	1,859	2,102

Table 2 Run size of wild adult fall chinook salmon in the Deschutes River, 1977-1988.

Year	Harvest Tribal	Harvest Recreational	Escapement	Run Size
1977	1,557	304	5,631	7,492
1978	1,519	452	4,154	6,125
1979	1,375	217	3,291	4,883
1980	1,623	328	2,542	4,493
1981	1,420	417	3,183	5,020
1983	1,460	556	4,890	6,906
1983	1,180	316	3,669	5,165
1984	791	179	2,025	2,995
1985	660	147	2,645	3,452
1986	938	215	3,801	4,954
1987	1,631	486	4,097	6,214
1988	1,824	436	3,520	5,780

air surveys - redds expanded?

Life History and Population Characteristics

The average age structure of a brood year is 34 percent age-2 fish, 30 percent age-3 fish, 31 percent age-4, 5 percent age-5, and less than 1 percent age-6 fish. Approximately 96 percent of the adults from a brood year had entered the ocean at age 0, and 4 percent had entered the ocean at age 1 (Jonasson and Lindsay 1988).

Mean lengths of the four most common ages at return are shown in Table 30. In the lower Deschutes River Subbasin, 21.3 inches is the criterion to differentiate jacks and adults for inventory purposes. Only 2 percent of age-2 fish are larger than 21.3 inches, and only 15 percent of age-3 fish are smaller than 21.3 inches (Jonasson and Lindsay 1988).

Information is not available regarding sex ratio, fecundity, or adult length-weight relationship.

Table 30. Age-specific lengths of fall chinook salmon sampled at Sherars Falls, 1978-1983. Age was determined by scale analysis. CI=Confidence interval.

Age	Lenath (inches)			
	N	Mean	95 % CI	Range
2	866	17.3	±0.1	8-23
3	644	24.3	±0.4	13-35
4	852	33.7	±0.2	24-43
5	153	36.6	±0.4	29-43

Researchers have observed carcasses of spawned fall chinook salmon from late September to mid-December with the peak of carcass recovery usually in the last half of November. Ripe males and females have been captured in Pelton trap in early December. Spawning of fall chinook probably begins in late September, reaches a peak in November, and is completed in December (Table 26) (Jonasson and Lindsay 1988).

Emergence of fry from the gravel begins in January or February and is completed in April or May (Table 26) (Jonasson and Lindsay 1988).

From 1978 through 1980, abundance of juvenile fall chinook salmon was highest in the area from Dry Creek to Pelton Reregulating Dam and progressively decreased downriver. Distribution of juveniles generally corresponded to distribution of spawning (Jonasson and Lindsay 1988).

Most juvenile fall chinook salmon leave the Deschutes River from May to July at age 0 (Table 26). In 1979 and 1980, the peak of migration occurred earliest from the river mouth to Sherars Falls and progressively later in upriver sections. Emigration through the Columbia River occurs from April to August, with the median passage in June and July. A small percentage of the juvenile fall chinook remain in the Deschutes River over winter and emigrate in spring at age 1.

Information on survival rates for fall chinook salmon in the lower Deschutes River Subbasin is not available.

The standard method estimate of potential smolt production of fall chinook salmon in the lower Deschutes River Subbasin is 2,418,387 smolts. The standard method estimate is based on a subjective evaluation of the habitat and assumptions about smolt densities at different levels of habitat quality.

Deschutes River fall chinook are susceptible to ceratomyxosis. Juvenile fall chinook salmon seined from the Deschutes River before May 4 in 1978 and June 8 in 1979 were not infected with Ceratomvxa Shasta. Infection rates increased for groups of fish seined from the river until July 7 of 1978 (56 percent infected) and July 16 of 1979 (90 percent infected), and then steadily decreased to low infection rates in September of both years (Ratliff 1981). Most juvenile fall chinook salmon avoid contracting ceratomyxosis by emigrating to the ocean before July when high numbers of infective units of C. shasta are present in the river.

Schreck et al. (1986) classified stocks of Columbia River chinook salmon (wild and hatchery; spring, summer, and fall) into several broad groups of similar stocks by cluster analysis of characters associated with body shape, meristics, biochemistry, and life history. Wild fall chinook salmon from the Deschutes River were similar to eight hatchery and wild fall chinook salmon stocks that occur from the Cowlitz River to the Hanford Reach of the Columbia River and two hatchery spring chinook salmon stocks from the lower Columbia River. Deschutes River fall chinook salmon were not closely grouped with summer chinook salmon from the upper Columbia River or from the Salmon River. Details of the gene frequencies, meristic characters, and body shape characters of Deschutes River fall chinook salmon can be found in Schreck et al. (1986).

Fish Production Constraints

Major habitat constraints to production of fall chinook salmon in the Deschutes River are listed in Table 31. Spawning gravel quality and quantity are the major constraints identified. Planners identified sedimentation from the glacial silt from White River as a problem in the entire Deschutes River below White River. Streambank degradation, primarily caused by livestock and recreational use, may also limit production by being a source of sedimentation. Disease, specifically ceratomyxosis, may limit fall chinook salmon production by killing the late emigrating smolts.

Table 31. Major habitat constraints to fall chinook salmon production in the lower Deschutes River Subbasin.

Location	Habitat Constraints a/
Deschutes River, mouth to White River	GQL, GQN, SED, SBD, CVR
Deschutes River, White River to Rereg. Dam	GQL, GQN, SBD, PTR, CVR

a/ CVR=in-stream cover, GQL= gravel quality, GQN=gravel quantity, PTR= pool-to-riffle ratio, SBD=streambank degradation, SED=sedimentation.

Hatchery Production

Fisheries managers outplanted hatchery stocks of fall chinook salmon in the Warm Springs River without success in 1958, 1967, and 1968 (Table 32). No future supplementation of fall chinook salmon in the lower Deschutes River subbasin is anticipated.

Table 32. Releases of hatchery fall chinook salmon in the lower Deschutes River Subbasin.

Release Year	Hatchery and Stock	Number	Size	Location
1958	Spring Creek	300,000	Eggs	Warm Springs R.
1967	Little White Salmon	502,500	1,139/lb	Warm Springs R.
1968	Little White Salmon	1,000,000	856/lb	Warm Springs R.

Harvest

Harvest of fall chinook salmon in the Deschutes River occurs primarily in a l-mile section from Sherars Falls downstream to Buck Hollow Creek. This section of river is the only area of the lower Deschutes River where the use of bait by recreational anglers is'permitted. A large recreational fishery and a tribal subsistence fishery for fall chinook salmon typically occurs from early July, when the first fish arrive at Sherars Falls, to October 31. Fall chinook salmon are caught incidentally throughout the river in the recreational fishery for summer steelhead.

Recreational and tribal harvests of fall chinook salmon in the Deschutes River are shown in Tables 27, 28 and 29. From 1977 through 1988, the recreational harvest averaged 1,130 fish and the tribal harvest averaged 1,760 fish. Of the fall chinook salmon that entered the Deschutes River from 1977 through 1988, 32 percent of the adults and 30 percent of the jacks were harvested in recreational and tribal fisheries. Fall chinook salmon and summer steelhead provide an average of 4,200 angler days and 21,500 angler hours annually in the recreational fishery at the falls and 4,900 fishing hours annually in the tribal subsistence fishery.

No specific harvest management goals or treaty and non-treaty harvest allocation agreements for fall chinook salmon exist in the lower Deschutes River Subbasin.

The Oregon Fish and Wildlife Commission sets harvest regulations for recreational fisheries in the subbasin. In recent years, the salmon season has been April 1 to October 31 below Sherars Falls, and the fourth Saturday in April to October 31 above Sherars Falls. The recreational fishery has been restricted to use of barbless flies and lures only, except in the l-mile section from Buck Hollow Creek up to Sherars Falls where anglers may use bait with barbless hooks. The catch limit for salmon and steelhead has been two adults per day in any combination, six adults per week, and 10 jack salmon per day, 20 per week.

The Warm Springs Tribes regulate all on-reservation fishing by both members and non-members. The tribes also regulate off-reservation fishing by tribal members exercising treaty rights. Tribal regulations for the on-reservation recreational fishery are consistent with Oregon Department of Fish and Wildlife regulations. The off-reservation treaty fishery, however, is not subject to a tribally imposed bag limit. Rather, the tribal council regulates this fishery through time and area closures, depending on stock and run-size status.

Harvest of fall chinook at Sherars Falls has been monitored with a creel survey of the recreational and tribal fisheries. For specific information about the creel surveys see Jonasson and Lindsay (1988).

Oregon State Police and the Warm Springs Tribal Police enforce fishing regulations in the subbasin.

Specific Considerations

Fall chinook salmon in the subbasin are currently managed for wild fish only: no hatchery fall chinook salmon are released in the subbasin. No harvest or escapement objectives currently exist for Deschutes River fall chinook salmon.

This stock enters the subbasin from late June to October. This stock may be composed of both summer and fall runs or a single fall run with a protracted time of entry into the subbasin.

The run size of fall chinook salmon in the lower Deschutes River subbasin from 1977 through 1988 averaged 9,420 fish annually, and ranged from 5,219 fish to 12,254 fish. Annual spawning escapement of jacks and adults averaged 2,910 fish and 3,620 fish, respectively, in this period.

Deschutes River fall chinook salmon support important recreational and Warm Springs tribal fisheries in the subbasin and contribute to ocean and Columbia River fisheries. The harvest of fall chinook salmon averaged 2,890 fish from 1977 through 1988. Approximately 40 percent of the harvest is taken by recreational fishermen and 60 percent is taken by tribal fishermen. Harvest rates in the recreational and tribal fisheries have averaged 32 percent for adults and 30 percent for jacks entering the Deschutes River.

All fall chinook salmon production in the subbasin occurs in the mainstem Deschutes River. Factors believed to limit production in the subbasin are the quantity and quality of spawning gravel throughout the river. Reduction of sediment input into the aquatic environment throughout the subbasin or flushing flows in the mainstem to clean the gravel bars should benefit fall chinook salmon production.

Critical Data Gaps

Critical missing information includes 1) whether this stock consists of distinct summer and fall runs or one run with a protracted migration, 2) factors limiting production, 3) an accurate estimate of potential smolt production, 4) smolt-to-adult survival rate, 5) data for stock-recruitment analysis, and 6) an accurate way to quantify the actual increase of fall chinook production in the subbasin as a result of riparian habitat improvement and enhancement of spawning gravel. Other less critical missing information is the stock sex ratio, fecundity, and length-weight relationship.

Objectives

Management Guideline

Fall chinook salmon will be managed exclusively for wild fish (Option A of the Oregon Wild Fish Policy) in the lower Deschutes River Subbasin.

Biological Objective

Achieve a spawning escapement of 6,000 to 7,000 wild fall chinook salmon through the return of 10,000 to 12,000 fish annually to the Deschutes River. This level of escapement should maintain the genetic diversity of this wild stock.

Utilization Objectives

1. Provide 4,000 to 5,000 fall chinook salmon (jacks and adults) available for harvest in recreational and Warm Springs tribal fisheries in the Deschutes River.

2. Provide the opportunity for equitable harvest sharing of fall chinook salmon in recreational and Warm Springs tribal fisheries in the subbasin.

Alternative Strategies

Modeling results for each strategy are presented in Table 33 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 33. 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 34.

STRATEGY 1: Natural Production, Level I. This strategy maintains the existing condition of the riparian areas along the Deschutes River at 40 percent of the vegetative potential, and enhances the spawning gravel in the upper three miles of the mainstem.

Proposed natural production enhancement projects should maintain existing juvenile habitat and enhance spawning habitat. The net effect will be an increase in egg-to-smolt survival and smolt capacity.

ACTIONS: 1, 4

1. Deschutes River Riparian Enhancement I. Manage all riparian areas along the mainstem Deschutes River to achieve or maintain 40 percent of the vegetative potential. This action would maintain the existing condition of the riparian areas.

   Estimated cost of this project over a 50-year life span is $1,330,000 based on maintenance of 35 miles of fence and the cost estimation procedure provided by the System Planning Group.

4. Deschutes River Spawning Gravel Enhancement. Periodic introduction of spawning gravel to the Deschutes River should increase spawning success. Gravel should be placed in the upper three miles of river (Warm Springs Bridge to Pelton Reregulating Dam) as this is the most heavily used area for spawning and the quality of the existing spawning habitat is gradually degrading from the loss of gravel recruitment. This action will begin to replace spawning gravel lost when construction of

the hydroelectric dams stopped gravel recruitment from upriver areas.

Estimated cost of this project is $70,500 based on placement of 500 cubic yards of spawning gravel annually for five years and the cost estimation procedure provided by the System Planning Group.

STRATEGY 2: Natural Production, Level II. This strategy enhances the riparian areas along the Deschutes River to 60 percent of the vegetative potential, and enhances the spawning gravel in the upper three miles of the mainstem.

Proposed natural production enhancement projects should increase juvenile habitat and enhance spawning habitat. The net effect will be an increase in egg-to-smolt survival and smolt capacity.

ACTIONS: 2, 4

2. Deschutes River Riparian Enhancement II. Manage all riparian areas along the mainstem Deschutes River to achieve or maintain 60 percent of the vegetative potential. This action should reduce sediment input and enhance rearing areas along the margins of the river.

   Estimated cost of this project over a 50-year life span is $2,259,000 based on construction of 20 miles of fence, maintenance of 55 miles of fence, and the cost estimation procedure provided by the System Planning Group.

4. -

STRATEGY 3: Natural Production, Level III. This strategy enhances the riparian areas along the Deschutes River to 80 percent of the vegetative potential, and enhances the spawning gravel in the upper three miles of the mainstem.

Proposed natural production enhancement projects should increase juvenile habitat and enhance spawning habitat. The net effect will be an increase in egg-to-smolt survival and smolt capacity.

ACTIONS: 3, 4

3. Deschutes River Riparian Enhancement III. Manage all riparian areas along the mainstem Deschutes River to achieve or maintain 80 percent of the vegetative potential. This action should reduce sediment input and enhance rearing areas along the margins of the river.

Estimated cost of this project over a 50-year life span is $3,188,000 based on construction of 40 miles of fence, maintenance of 75 miles of fence, and the cost estimation procedure provided by the System Planning Group.

4. -

Table 33. System Planning Model results for fall chinook in the Deschutes Subbasin. Baseline value is for pre-mainstem implementation, all other values are post-irrplementation.

Utilization Objective:

1. Provide 4,000 to 5,000 fall chinook salmon (jacks and adults) available for harvest in recreational and Warm Springs tribal fisheries in the Deschutes River.
2. Provide the opportunity for equitable harvest sharing of fall chinook salmon in recreational and Uarm Springs tribal fisheries in the s&basin.

Biological Objective:

Achieve a spawning escapement of 6,000 to 7,000 wild fall chinook salmon through the return of 10,000 to 12,000 fish annually to the Deschutes River. This level of escapement should maintain the genetic diversity of this wild stock.

Strategy[1]	Maximum[2] Sustainable Yield (MSY)	Total[3] Spawning Return	Total' Return to Subbasin	out of[5] Subbas in Harvest	Contribution[6] To Council's Goal (Index)
Baseline	3,866 -c	5,072	9,205	26,902	0(1.00)
All Nat	a,774 -C	7,101	16,249	47,486	29,749(1.77)
1	4,647 -c	5,395	10,326	30,175	4,732(1.12)
2*	6,446 -C	5,653	12,397	36,228	13,479(1.35)
3	a,774 -C	7,101	16,249	47,486	29,749(1.77)

*Recommended strategy.

[1] Strategy descriptions:

For comparison, an "all natural" strategy uas 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. Maintain existing condition of riparian areas along mainstem at 40% of the vegetative potential, and enhance spawning gravel in the upper 3 miles of the mainstem. Post Hainstem Implementation.
2. Enhance the riparian areas along the mainstem to 60% of the vegetative potential, and enhance the spawning gravel in the upper 3 miles of the mainstem. Post Mainstem Implementation.

3. Enhance the riparian areas along the rnainstem to 80% of the vegetative potential, and enhance the spawning gravel in the upper 3 miles of the mainstem. 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 Colunbia harvest.

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

Table 34. Estimated costs of alternative strategies for Deschutes fall chinook. Cost estimates represent new or additional costs to the 1987 Columbia River Basin Fish and Wildlife Program; they do not represent projects funded under other programs, such as the Lower Snake River Compensation Plan or a public utility district settlement agreement. (For itemized costs, see Appendix C.)

	Proposed Strategies		
	1	2*	3
Hatchery Costs			
Capital[1]	0	0	0
O&M/yr[2]	0	0	0
Other Costs			
Capital[3]	70,500	239,500	408,500
O&M/yr[4]	26,600	41,800	57,000
Total Costs			
Capital	70,500	239,500	408,500
O&M/yr	26,600	41,800	57,000

* 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, D&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 primarily monitoring and evaluation procedures that managers would implement in concert with the actions discussed above.

A) Determine whether this run of chinook salmon is actually comprised of summer chinook and fall chinook. If a distinct summer run of chinook salmon exists, determine the status of that run. Currently this run is managed as, one run of fall chinook salmon. If the run is comprised of summer and fall chinook salmon, then different management actions may be appropriate for the two runs. For example, if spawning escapement of one run is determined to be low then it may be beneficial to protect it by restricting harvest to help it rebuild, or to supplement it with hatchery fish. Alternative actions include:

   1) Determine time and location of spawning of this mainstem spawning stock of chinook salmon. Activities should include tagging of chinook salmon at Sherars Falls from June 16 to October 31 and beginning redd counts and carcass surveys in the Deschutes River in mid-September.

   2) Determine life history characteristics of the June to July and August to October segments of the chinook salmon run. Activities should include scale analysis to determine differences in juvenile life history.

   3) Determine genetic characteristics of the June to July and August to October segments of the chinook salmon run.

B) Continue the fall chinook salmon run size monitoring program in the subbasin to evaluate success of achieving the objectives. The monitoring program should include statistical creel surveys at Sherars Falls to estimate harvest, tagging and tag recovery to estimate escapement above Sherars Falls, aerial redd counts to estimate escapement below Sherars Falls, and scale collections to assign fish to brood year.

Recommended Strategy

Strategy 2 (enhancement and maintenance of riparian habitat to 60 percent of the vegetative potential and spawning gravel enhancement below Pelton Reregulating Dam) is the recommended strategy for enhancement of fall chinook salmon production in the Deschutes River. This intermediate level of enhancement effort appears to be the most realistically achievable, and it meets the fall chinook production objective for the subbasin.

Fall Chinook - 80

SUMMER STEELHEAD

Fisheries Resource

Natural Production

History and Status

Summer steelhead (Oncorhynchus mvkiss, formerly- Salmo sairdneri) occur throughout the mainstem Deschutes River below Pelton Reregulating Dam and in most tributaries below the dam. Before construction of the Pelton-Round Butte hydroelectric project in 1958, summer steelhead were also found in the Deschutes River to Steelhead Falls (RM 128), in Squaw Creek, the Metolius River, and in Crooked River. Downstream passage facilities at the dams proved insufficient to sustain natural runs above the dams.

Summer steelhead enter the subbasin from June through October (Table 35). Steelhead pass Sherars Falls from July through October with peak movement in September or early October.

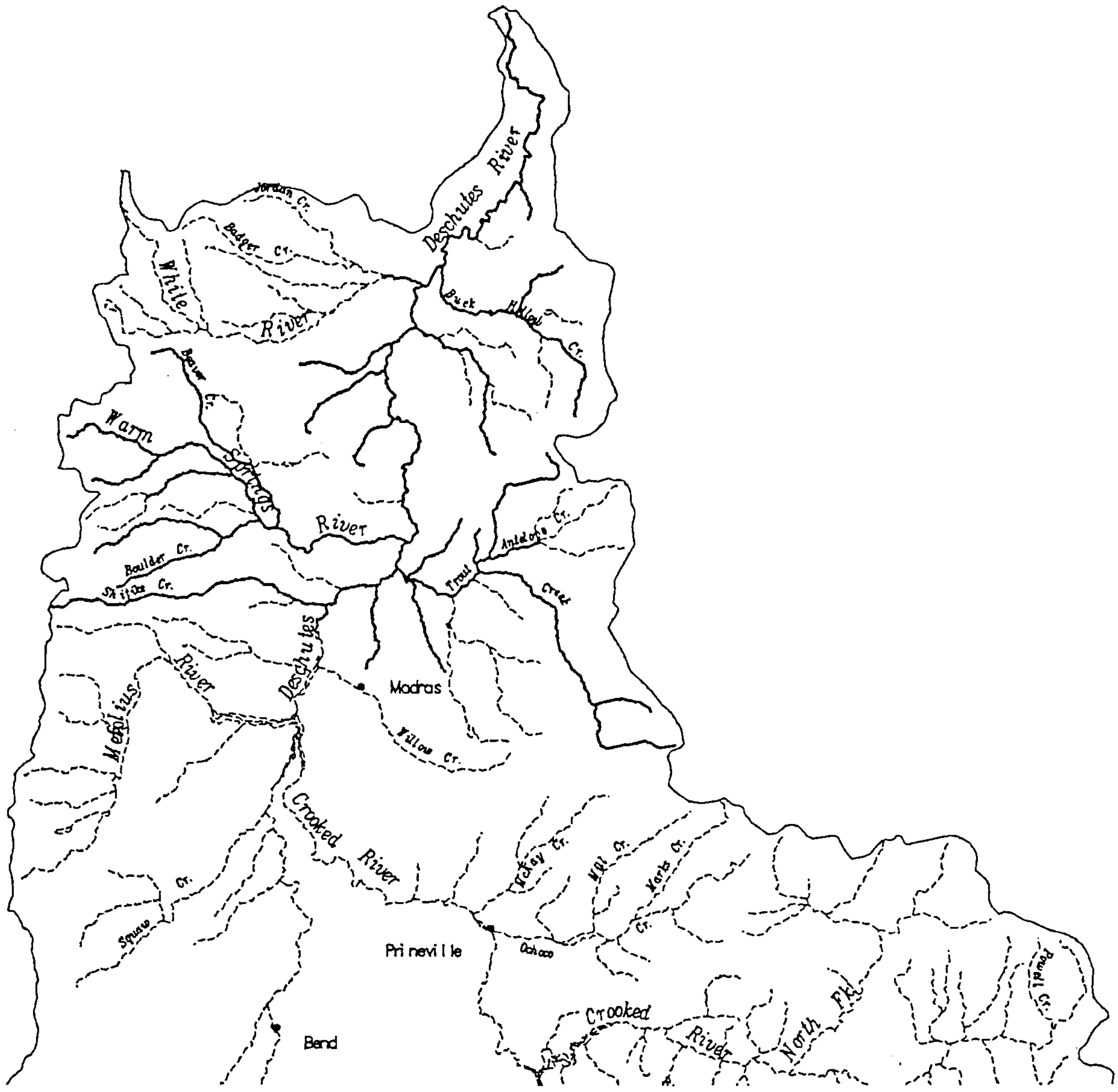
A large number of steelhead, natural and hatchery, from other Columbia Basin production areas stray into the Deschutes River. Many of these stray steelhead leave the Deschutes River and continue their migration up the Columbia River. Others are harvested in fisheries in the Deschutes River, and some remain to spawn in the subbasin.

Managers have estimated the run size of natural summer steelhead in the Deschutes River annually since 1977 using creel surveys of the recreational and tribal fisheries below Sherars Falls and escapement estimates above the falls. The average run size from 1977 to 1987 was 7,780 natural summer steelhead, with a range of 4,445 fish to 12,225 fish (Table 36) (Olsen, draft).

Life History and Population Characteristics

Natural summer steelhead return after one or two years in the Pacific Ocean (termed l-salt or 2-salt steelhead). Additional information on adult age structure is not available, however fisheries managers generally believe that the ratio of 1-salts to 2-salts is approximately l-to-l for a brood year. That ratio may be considerably different for a run year because of differences in survival of brood years. Very few steelhead return to spawn a second time in the lower Deschutes River Subbasin.

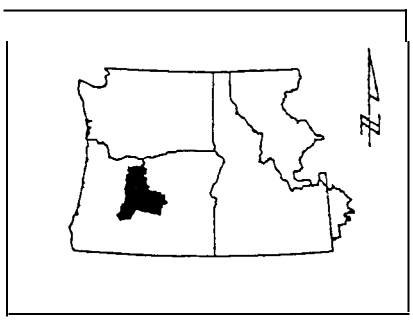
DESCHUTES SUBBASIN



SUMMER STEELHEAD DISTRIBUTION*

PRESENT/POTENTIAL

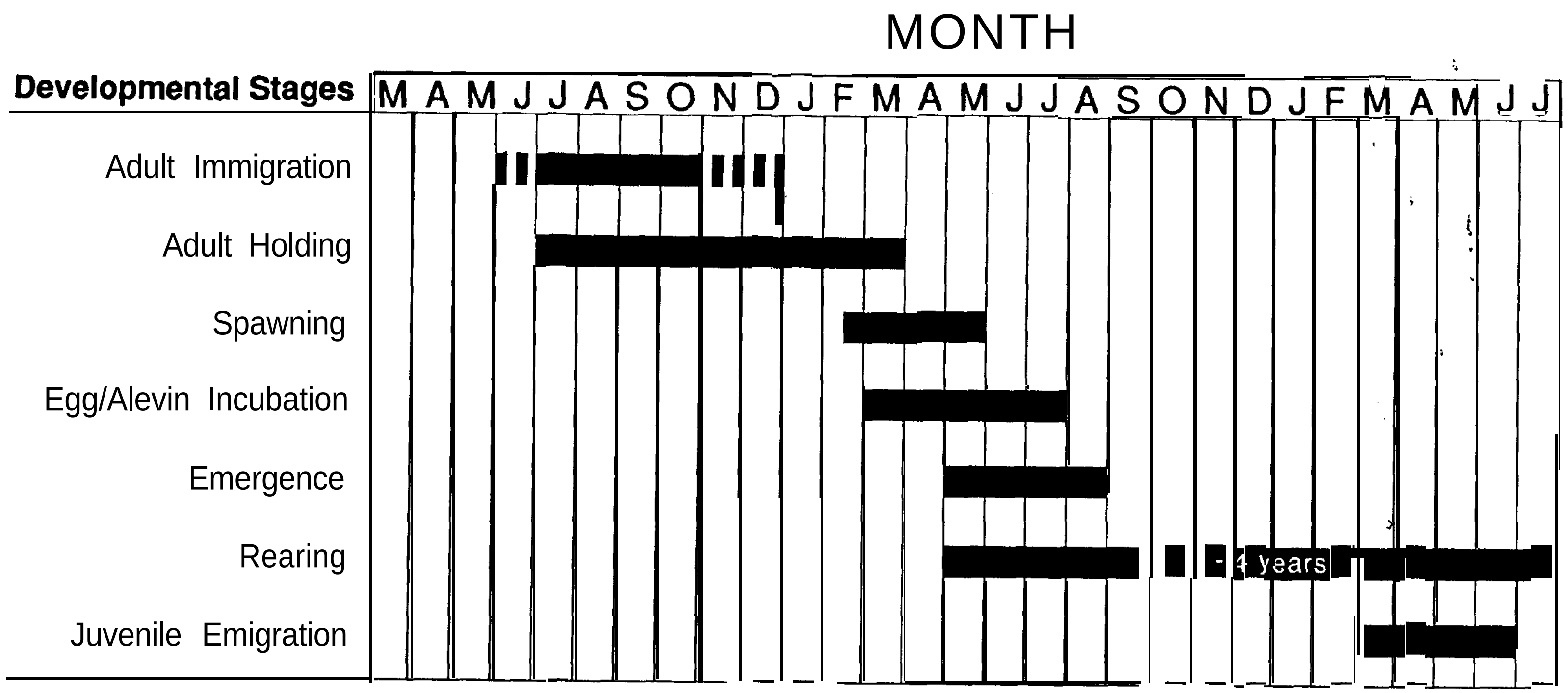
ABSENT



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 35. Freshwater life history for summer steelhead in the Deschutes River. Developmental stage timing represents basin-wide averages.



Solid bars Indicate periods of heaviest adult Immlgratlon, spawnlng and juvenlle emlgratlon.

Females consistently outnumber males in a run year (Table 37). Information on sex ratio by age at return, and length-weight ratio of natural summer steelhead is not available.

Table 36. Harvest and escapement of natural steelhead in the Deschutes River, 1977-1987.

Year	Harvest Recreational	Harvest Tribal	Escapement	Total
1977	4,657	968	6,600	12,225
1978 a/	1,265	380	2,800	4,445
1979 a/	22 c/	411	4,200	4,633
1980	43 c/	981	4,100	5,124
1981	32 c/	688	6,900	7,600
1982	15 c/	549	6,600	7,164
1983	236 d/	901	8,200	9,337
1984 b/	317 d/	1,652	7,700	9,669
1985 b/	383 d/	1,491	9,600	11,474
1986 b/	66 e/	1,247	6,200	7,513
1987	32 e/	992	5,400	6,424

a/ No creel survey at the river mouth. Recreational harvest estimates are based on catch rate at Sherars Falls.
b/ No creel survey at the river mouth and Macks Canyon Road. Recreational harvest estimates are based on catch rate at Sherars Falls.
c/ Illegal harvest - fish had to have clipped fin.
d/ Unmarked fish with dorsal fin ≤2" could be kept.
e/ Illegal harvest - fish had to have adipose fin clip.

Table 37. Sex ratio of natural summer steelhead captured at Warm Springs National Fish Hatchery, 1977-1985.

Run Year	% Males	% Females
1977	35	65
1978	23	77
1979	38	62
1980	32	68
1981	34	66
1982	22	78
1983	40	60
1984	35	65
1985	36	64

Summer steelhead spawn in the Deschutes River, Warm Springs River system, White River, Shitike Creek, Wapinitia Creek, Eagle Creek, Nena Creek, Trout Creek system, Bakeoven Creek system, and Buck Hollow Creek system. Spawning in White River is limited to the lower two miles by White River Falls, an impassable barrier.

Spawning in the Deschutes River and westside tributaries usually begins in April and continues through May (Table 35). Spawning in eastside tributaries occurs from January through mid-April (Olsen, draft).

Fecundity of natural summer steelhead, sampled in 1970 and 1971, ranged from 3,093 to 10,480 eggs per female with a mean of 5,341 eggs per female (Olsen, draft). Average fecundity by age is 4,680 eggs per female for l-salt fish and 5,930 eggs per female for 2-salt fish.

Specific information on time of emergence of natural steelhead is not available. Fry emerge in spring or early summer depending on time of spawning and water temperature during egg incubation.

Juvenile summer steelhead emigrate from the tributaries in spring at age 0 to age 3. Many of the juveniles that migrate from the tributaries continue to rear in the mainstem Deschutes River before smolting.

Scale patterns from adult steelhead indicate that smolts enter the ocean at age 1 to age 4 (Olsen, draft). Specific information on time of emigration through the Columbia River is not available, but researchers believe that smolts leave the Deschutes River from March through June (Table 35).

Information on survival rates from egg to smolt and smolt to adult is not available for natural summer steelhead in the lower Deschutes River Subbasin. .

Specific information on habitat carrying capacity for summer steelhead is not available for the lower Deschutes River Subbasin. However, the standard estimate of potential smolt production is 513,636 smolts. The standard method estimate is based on a subjective evaluation of the habitat and assumptions about smolt densities at different levels of habitat quality. Maximum steelhead production capacity based on present habitat, average fecundity of 5,130 eggs per female, egg-to-smolt survival of 0.75 percent, and estimated maximum escapement of 6,575 adults is estimated at 147,659 smolts (ODFW 1987).

Supplementation History

Managers have supplemented natural production with fry and fingerlings from Round Butte Hatchery (RBH) and Warm Springs National Fish Hatchery (WSNFH) (Table 38). Shitike Creek and tributaries of the Warm Springs River were supplemented with summer steelhead from the Warm Spring Hatchery. Fingerlings from Round Butte Hatchery were released in the Deschutes River. The steelhead released off station in the Warm Springs River tributaries were not differentially marked to distinguish them from the production lot released directly from the hatchery. In general, the off-station releases did not appear to be very successful. No future supplementation of the natural production is anticipated in the lower Deschutes River Subbasin.

Table 38. Releases of hatchery summer steelhead in the lower Deschutes River Subbasin for supplementation of natural production.

Release Year	Hatchery	Number	Size (fish/lb)	Location	Mark
1974	RBH	116,106	142	Deschutes mouth	--
1976	RBH	138,650	96.0	Deschutes mouth	--
1981	WSNFH	35,000	54.4	Warm Springs R.	AD+CWT
	WSNFH	20,000	54.4	Beaver Creek	AD+CWT
	WSNFH	28,000	54.4	Mill Creek	AD+CWT
	WSNFH	15,000	54.4	Badger Creek	AD+CWT
	WSNFH	27,332	781	Shitike Creek	--
1982	WSNFH	16,668	981	Beaver Creek	--
	WSNFH	15,000	981	Mill Creek	--
	WSNFH	35,000	981	Badger Creek	--
	WSNFH	3,000	981	Wilson Creek	--
	WSNFH	79,748	753	Shitike Creek	--
1983	WSNFH	5,000	440	Beaver Creek	--
	WSNFH	54,400	440	Badger Creek	--
	WSNFH	5,000	440	Wilson Creek	--
	WSNFH	5,000	440	Swamp Creek	--
	WSNFH	31,718	413	Shitike Creek	--
	RBH	150,006	26.6	Deschutes R.a/	ADRM
1984	WSNFH	80,481	993	Shitike Creek	--
	RBH	150,015	51.2	Deschutes R.b/	ADLM

a/ Released at Pine Tree (RM 39).
b/ Released at Mack's Canyon (RM 25), Beavertail Campground (RM 31) and Pine Tree.

Fish Production Constraints

Major habitat constraints to natural production of summer steelhead in the subbasin are shown in Table 39. Sedimentation is a problem in the mainstem Deschutes River below White River. Streambank degradation is a problem throughout the subbasin. Most of the tributaries experience low flows and high temperatures, both of which are related to streambank degradation and poor riparian conditions. Passage blocked by falls on White River and Nena Creek limits steelhead production in these streams.

Table 39. Major habitat constraints to summer steelhead production in the lower Deschutes River Subbasin.

Location	Habitat Constraints a/
Deschutes River	SED, SBD, GQL, GQN, CVR, PTR, ISP, ITC
White River	PSB, GQN, GLA, PTR
Buck Hollow Creek and tributaries	FLO, TEM, SBD, GQL, FLD
Bakeoven Creek and tributaries	FLO, TEM, SBD, FLD
Nena Creek	PSB, FLO, TEM, SBD
Warm Springs River and tributaries	TEM, SED, PTR, GQL, CVR, GQN, FLO, DIV, PSI
Trout Creek and tributaries	TEM, SBD, SED, CVR, FLO, PSB, FLD, ICE, CHN, GRA, CHM
Shitike Creek	CHN, SBD, SED, CVR, TML
Other Deschutes River tributaries	FLO, TEM, SBD, SED, PSB, GRA

a/ CHM=chemical pollution, CHN=channelization, CVR=in-stream cover, DIV=unscreened or poorly operating diversion, FLD=flash flooding, FLO=low flow, GQL= gravel quality, GQN=gravel quantity, GRA=gradient, ICE=ice, ISP=inter-specific competition, ITC=intra-specific competition, PSB=passage blocked, PSI=passage impeded, PTR=pool to riffle ratio, SBD=streambank degradation, SED=sedimentation, TEM=high temperature.

Hatchery Production

Description of Hatcheries

Round Butte Hatchery, completed in 1972 to mitigate the effects of the Pelton-Round Butte hydroelectric project, is the only hatchery releasing summer steelhead in the lower Deschutes River Subbasin. 'Portland General Electric financed the hatchery and the Oregon Department of Fish and Wildlife operates it. Warm Springs National Fish Hatchery reared and released summer steelhead in the subbasin from 1978 through 1984 (Table 40). Steelhead production at Warm Springs Hatchery discontinued after fry releases in 1984 and managers are not planning future steelhead production at Warm Springs. Prior to 1972, Cedar Creek Hatchery, Gnat Creek Hatchery, Oak Springs Hatchery, and Wizard Falls Hatchery reared Deschutes River summer steelhead for release into the Deschutes River.

Managers rear summer steelhead at Round Butte Hatchery. Mitigation requirements for the hatchery are 1,800 summer steelhead returning annually to Pelton trap, the hatchery's brood stock collection facility. To meet this requirement, the hatchery annually releases 162,000 summer steelhead smolts.

Brood stock for the summer steelhead program at Round Butte Hatchery are collected from fish returning to Pelton trap. Managers held natural, Round Butte Hatchery and stray hatchery steelhead for brood stock prior to the 1984 brood year. Brood stock for the 1984 through 1987 brood years were selected only from Round Butte Hatchery-origin steelhead because of concerns about introducing foreign strains of IHN virus into the Round Butte Hatchery steelhead program. In 1988 and 1989, managers collected natural steelhead for brood stock in addition to Round Butte Hatchery-origin steelhead. The number of fish held for brood stock has ranged from 631 adults to 1,328 adults for the 1977 through 1986 broods. A large number of adults are held for brood stock because of the potential for losses of fry to IHN virus.

Table 40. Summer steelhead production releases from Warm Springs National Fish Hatchery, 1978-1980 broods.

Brood Year	Release Date	Number of Smolts	Location	Mark
1978	05/79	89,380	Warm Springs R.	AD+CWT
1980	04/81	4,486	Warm Springs R.	AD+CWT

Managers classify brood stock into three groups based on time of entry into Pelton trap. Group-l steelhead enter Pelton trap between October 1 and December 9, Group-2 steelhead enter between December 10 and January 31, and Group-3 steelhead enter between February 1 and March 1. Biologists spawn adults from Groups 1 and 2 in late January, and Group-3 adults in mid-March. Eggs are incubated in 50 F water. Fry from Groups 1 and 2 are transferred from incubators to 6-feet circular tanks in May and fry from Group 3 are transferred in June. Fingerlings from Groups 1 and 2 are graded by size and the larger fish are transferred to Burrows Ponds in late July or early August. Fingerlings from Group 3 are graded by size and the larger fish are transferred to Burrows Ponds in late August or early September.

Managers release Round Butte Hatchery summer steelhead smolts at age 1 in April at four to six fish per pound (Table 41). Smolts are released immediately below Pelton Reregulating Dam and at Maupin, Pine Tree, or Mack's Canyon. The purpose of the lower river releases is to increase the harvest of these hatchery steelhead in the river below Sherars Falls by encouraging the adults to hold in this section of the river rather than quickly returning to Pelton trap.

Smolts migrate to the Columbia River soon after release in April. Approximately 5 percent to 10 percent of the juvenile hatchery steelhead remain in the river as residuals (Fessler 1973).

Run sizes of hatchery steelhead in the subbasin averaged 15,480 fish from 1977 through 1987 (Table 42). Stray hatchery steelhead comprised an average of 29 percent of the hatchery run. The number of stray hatchery steelhead entering the subbasin has been increasing steadily each year since monitoring began in 1977.

Table 41. Summer steelhead production releases from Round Butte Hatchery, 1973-1986 broods.

Brood Year	Release Date	Number a/	Location b/	Mark
1973	05/74	100,248 (s)	Rereg. Dam	LVRP
	05/74	84,149 (s)	Beavertail	ADLVRM
1974	05/75	33,510 (s)	Rereg. Dam	RV
	05/75	34,776 (s)	Rereg. Dam	LV
	05/75	35,004 (s)	Rereg. Dam	LVRV
	05/75	10,773 (s)	Maupin	ADRM
	05/75	53,964 (s)	Beavertail	ADRM
1975	05/76	26,483 (s)	Rereg. Dam	LVRM
	05/76	26,972 (s)	Rereg. Dam	RVLM
	05/76	27,000 (s)	Rereg. Dam	RVRM
	05/76	26,610 (s)	Beavertail	RPRM
	05/76	25,752 (s)	Beavertail	LPRM
	05/76	25,769 (s)	Beavertail	LPLM
1976	04/77	82,906 (s)	Rereg. Dam	LVRP
	03/77	27,440 (s)	Buck Hollow Cr.	ADRV
	04/77	27,515 (s)	Buck Hollow Cr.	ADLVRV
	03/77	27,030 (s)	Buck Hollow Cr.	ADLV
1977	04/78	27,195 (s)	Rereg. Dam	LV
	04/78	26,565 (s)	Rereg. Dam	RV
	04/78	27,627 (s)	Rereg. Dam	LVRV
	04/78	25,542 (s)	Buck Hollow Cr.	LPRM
	04/78	27,489 (s)	Buck Hollow Cr.	LPLM
	04/78	28,050 (s)	Buck Hollow Cr.	RPRM
1978	05/79	27,207 (s)	Rereg. Dam	LVRM
	05/79	21,334 (s)	Rereg. Dam	RVRM
	04/79	27,572 (s)	Pine Tree	LVRVLM
	04/79	49,105 (s)	Pine Tree	RVLM
	05/79	24,381 (s)	Columbia River	LVLM
1979	04/80	28,744 (s)	Rereg. Dam	LPLM
	04/80	28,056 (s)	Rereg. Dam	LP
	04/80	24,759 (s)	Rereg. Dam	LPRM
	04/80	28,837 (s)	Pine Tree	RPLM
	04/80	25,001 (s)	Pine Tree	RPRM
	05/80	27,284 (s)	Columbia River	RP

(continued)

Table 41 continued. Summer steelhead production releases from Round Butte Hatchery, 1973-1986 broods.

Brood Year	Release Date	Number a/	Location b/	Mark
1980	04/81	26,813 (s)	Rereg. Dam	LV
	04/81	27,516 (s)	Rereg. Dam	LVRV
	04/81	25,263 (s)	Rereg. Dam	LVRVRM
	04/81	25,403 (s)	Rereg. Dam	RV
	04/81	25,615 (s)	Pine Tree	RVLP
	04/81	25,897 (s)	Mack's Canyon	LVRP
1981	04/82	26,885 (s)	Rereg. Dam	RVRM
	04/82	27,144 (s)	Rereg. Dam	RVLM
	04/82	27,292 (s)	Maupin	RVRM
	04/82	26,975 (s)	Maupin	RVLM
	04/82	27,553 (s)	Pine Tree	RVRM
	04/82	26,312 (s)	Pine Tree	RVLM
1982	04/83	50,594 (s)	Rereg. Dam	LP
	04/83	57,888 (s)	Rereg. Dam	RP
	05/83	36,660 (s)	Maupin	LP
	05/83	13,067 (s)	Maupin	RP
1983	04/84	54,614 (s)	Rereg. Dam	ADRV
	04/84	56,351 (s)	Maupin	ADRV
	04/84	54,458 (s)	Pine Tree	ADRV
1984	04/85	66,511 (s)	Rereg. Dam	ADRP
	04/85	54,884 (s)	Maupin	ADRP
	04/85	54,611 (s)	Pine Tree	ADRP
1985	04/86	53,949 (s)	Rereg. Dam	ADLPRM
	04/86	63,746 (s)	Maupin	ADLPLM
	04/86	56,799 (s)	Pine Tree	ADLPLM
1986	04/87	50,431 (s)	Rereg. Dam	ADLP
	04/87	109,050 (s)	Maupin	ADRP

a/ (s)=smolts
b/ Rereg. Dam=Deschutes River, RM 100; Beavertail=Deschutes River, RM 31; Maupin=Deschutes River, RM 52; Buck Hollow Cr.=Deschutes River, RM 43; Pine Tree=Deschutes River, RM 39; Columbia River=Columbia River below Bonneville Dam.

Table 42. Harvest and escapement of hatchery (RBH, WSNFH, and stray) steelhead in the Deschutes River, 1977-1987.

Year	Harvest Recreational	Harvest Tribal	Escapement	Total
1977	1,529	1,200	7,000	9,729
1978 a/	929	567	3,500	4,996
1979 a/	2,355	645	6,000	9,000
1980	2,943	1,309	6,000	10,252
1981	2,294	772	5,000	8,066
1982	2,279	1,065	4,800	8,144
1983	4,034	3,287	15,400	22,721
1984 b/	4,139	2,770	11,800	18,709
1985 b/	9,287	2,770	12,100	24,157
1986 b/	8,896	3,800	18,400	31,096
1987	3,982	1,815	17,600	23,397

a/ No creel survey at the river mouth. Recreational harvest estimates are based on catch rates at Sherars Falls.

b/ No creel survey at the river mouth and Macks Canyon Road. Recreational harvest estimates are based on catch rates at Sherars Falls.

Returns of Round Butte Hatchery summer steelhead to Pelton trap ranged from 229 to 2,195 l-salt adults and from 262 to 1,746 2-salt adults (Table 43). The adult age structure is not consistent between brood years, as age composition has ranged from 31 percent to 63 percent l-salts, and averaged 48 percent 1-salts (Olsen, draft).

Life History and Population Characteristics

Round Butte Hatchery summer steelhead return to the subbasin from July through October, similar to natural steelhead, and migrate past Sherars Falls during these months, peaking in late September and early October. Round Butte Hatchery steelhead enter Pelton trap from October through March.

Sex ratios of Round Butte Hatchery steelhead are shown in Table 44. In general, males are predominant among l-salts and females are predominant among 2-salts.

Table 43. Returns of Round Butte Hatchery steelhead to Pelton trap, 1973-1983 broods.

Brood Year	l-Salt	2-Salt
1973	348	718
1974	365	798
1975	1,322	1,196
1976	536	417
1977	2,195	1,276
1978	919	978
1979	782	1,318
1980	229	262
1981	2,177	1,746
1982	1,532	1,452
1983	1,701	1,413

Table 44. Percentage females of l-salt and 2-salt summer steelhead from Round Butte Hatchery, 1973-1975 broods.

Brood Year	l-Salt	2-Salt
1973	38	71
1974	50	70
1975	51	--

Average lengths of l-salt and 2-salt Round Butte Hatchery steelhead are shown in Table 45 (Olsen, draft). Information on adult length-weight relationship is not available.

Table 45. Mean fork length of Round Butte Hatchery summer steelhead adults sampled at Sherars Falls, 1975-1983 broods.

Brood Year	1-Salt N	1-Salt Length (in.)	1-Salt Range	2-Salt N	2-Salt Length (in.)	2-Salt Range
1975	426	23.6	17-29	473	27.4	20-31
1976	213	23.1	20-30	178	27.1	20-31
1977	859	23.5	20-29	530	26.2	20-31
1978	462	22.8	20-28	326	26.9	20-33
1979	255	22.7	19-28	182	26.5	22-31
1980	27	23.6	20-33	33	26.4	22-31
1981	332	23.5	19-28	187	27.3	22-31
1982	93	23.2	20-28	192	27.3	22-32
1983	280	23.4	20-31	457	27.7	20-32

Average fecundity of Round Butte Hatchery steelhead is shown in Table 46. Average fecundity for l-salts and 2-salts is 4,860 eggs per female (Olsen, draft). Information on age-specific fecundity is not available.

Average egg-to-smolt survival rate for Round Butte Hatchery summer steelhead is 66 percent. Rate of return to the subbasin of Round Butte Hatchery summer steelhead released immediately below Pelton Reregulating Dam ranged from 0.40 percent to 8.9 percent and averaged 4.8 percent for the 1975 through 1980 brood years (Olsen, draft).

Table 46. Fecundity of Round Butte Hatchery summer steelhead, 1977-1987.

Year	Eggs/Female
1977	4,355
1978	4,297
1979	5,148
1980	4,798
1981	4,550
1982	5,488
1983	5,511
1984	4,177
1985	5,502
1986	5,052
1987	4,605

Anticipated Production Facilities

No new production facilities are anticipated in the subbasin. However, the Northwest Power Planning Council has adopted an amendment to determine the feasibility of propagating salmon and/or steelhead in Pelton ladder [Section 703(g)(3) of the Columbia River Basin Fish and Wildlife Program]. An increase in the number of fish reared in Pelton ladder could require an increase in incubation and rearing capacity at Round Butte Hatchery, depending on the production regime decided upon.

Constraints to Hatchery Production

Although Round Butte Hatchery has problems with disease in the summer steelhead program, the mitigation requirement of 1,800 summer steelhead returning to Pelton trap has been met almost every year since 1972. IHN has been a problem with summer steelhead, but its effects on production have been ameliorated by changes in hatchery practices. Fisheries managers spawn a large number of adults to produce about 750,000 juvenile steelhead to produce 162,000 smolts. Fry are reared in small groups so that if IHN virus infects a tank, those fish can be destroyed while the others are reared for release. Managers have also found infectious pancreatic necrosis (IPN), furunculosis, and cold water disease in Round Butte Hatchery steelhead.

An increase in production of summer steelhead at Round Butte Hatchery probably could not occur without an increase in rearing ponds or a decrease in spring chinook salmon production. Currently, Round Butte Hatchery is operating at full capacity with the preferred rearing programs of spring chinook salmon and summer steelhead.

Harvest

Harvest of summer steelhead in the Deschutes River begins in July, when the adults enter the river, and continues until December 31. The recreational fishery occurs throughout the mainstem Deschutes River, whereas the tribal fishery primarily occurs in the area immediately below Sherars Falls.

Recreational harvest below Sherars Falls and tribal harvest of summer steelhead in the Deschutes River is shown in Tables 36 and 42. Tribal harvest of natural steelhead has averaged 930 fish from 1977 through 1987. Sport harvest of natural steelhead below Sherars Falls averaged 130 fish from 1979 through 1987; sport harvest of natural steelhead was restricted in 1979 and has been prohibited since 1986. Harvest of hatchery steelhead averaged 1,820 fish in the tribal fishery and 3,880 fish in the recreational fisheries below Sherars Falls from 1977 through 1987. Recreational harvest of summer steelhead above Sherars Falls is unknown, but effort has increased since 1982 when the season was extended from October 31 to December 31.

Managers provide stray hatchery steelhead entering Pelton trap to the Warm Springs Tribes, as they do with most Round Butte Hatchery steelhead in excess of brood stock requirements (Table 47). Natural steelhead and some Round Butte Hatchery steelhead entering Pelton trap are returned to the Deschutes River at the Warm Springs bridge (RM 94) to be recycled through the fishery in the upper river or be allowed to spawn (Table 48). Steelhead were recycled to areas below Sherars Falls, but this was discontinued due to low harvest of these fish.

Currently no specific harvest management goals or treaty or non-treaty harvest allocation agreements exist for summer steelhead in the lower Deschutes River Subbasin.

Harvest regulations for recreational fisheries in the subbasin are set by the Oregon Fish and Wildlife Commission. In recent years the steelhead season has been April 1 to December 31 below Sherars Falls, and the fourth Saturday in April to December 31 above Sherars Falls. The recreational fishery has been restricted to use of barbless flies and lures only, except for the one-mile section from Buck Hollow Creek up to Sherars Falls where anglers can use bait with barbless hooks. Only adipose-clipped steelhead may be taken in the recreational fishery.

Other steelhead must be released unharmed. The catch limit for salmon and steelhead has been two adults per day in any combination and six adults per week.

Table 47. Summer steelhead provided to Warm Springs Tribes from fish returning to Pelton trap, 1974-1986.

Year	Number
1974	1,209
1975	106
1976	0
1977	893
1978	1
1979	0
1980	296
1981	566
1982	217
1983	2,030
1984	1,802
1985	2,350
1986	2,259

Table 48. Summer steelhead recycled through the fisheries in the Deschutes River, 1972-1986.

Year	Below Sherars Falls	Warm Springs Bridge
1972	1,667	0
1973	3,695	0
1974	2,339	0
1975	0	0
1976	0	0
1977	0	0
1978	667	476
1979	984 a/	1,299
1980	373	1,000
1981	0	956
1982	0	995
1983	0	1,241
1984	0	711
1985	0	1,033
1986	0	746

a/ Includes 77 fish recycled at Maupin City Park.

The Warm Springs Tribes regulate all on-reservation fishing by both members and non-members. The tribes also regulate off-reservation fishing by tribal members exercising treaty rights. Tribal regulations for the on-reservation recreational fishery are consistent with Oregon Department of Fish and Wildlife regulations. The off-reservation treaty fishery, however, is not subject to a tribally imposed bag limit. Rather, the tribal council regulates this fishery through time and area closures, depending on stock and run-size status.

Harvest of summer steelhead at Sherars Falls has been monitored with a creel survey of the recreational and tribal fisheries. For specific information about the creel surveys see Olsen (draft).

Oregon State Police and the Warm Springs Tribal Police enforce fishing regulations in the subbasin.

Specific Considerations

All hatchery steelhead released in the subbasin are produced at Round Butte Hatchery. Round Butte Hatchery releases 162,000 smolts annually to meet the mitigation requirement of 1,800 summer steelhead returning annually to Pelton trap. Smolts are released immediately below Pelton Reregulating Dam and in the lower river at-Maupin, Pine Tree, or Macks Canyon. The purpose of the lower river releases is to increase the harvest of these hatchery steelhead-in the river below Sherars Falls by encouraging the adults to hold in this area rather than quickly returning to Pelton trap. Although the lower river smolt releases increase the recreational harvest below the falls relative to the reregulating dam releases, more of the adults from these lower river releases spawn in the mainstem or tributaries and do not return to Pelton trap relative to the reregulating dam releases. To reduce the spawning of hatchery steelhead in the natural production areas, the lower river releases of hatchery steelhead smolts should be discontinued and the releases limited to immediately below Pelton Reregulating Dam.

A large number of steelhead from other Columbia River Subbasins enter the Deschutes River. The number of stray steelhead entering the subbasin will probably increase as production in upriver hatcheries increases and downriver transportation of smolts increases. Tagging studies in the subbasin have shown 1) hatchery and natural steelhead stray into the Deschutes River, 2) some stray steelhead eventually leave the Deschutes River and continue up the Columbia River to other subbasins, and 3) some stray hatchery steelhead remain in the Deschutes River from summer to the following spring and probably spawn in the lower Deschutes River Subbasin.

Natural production of summer steelhead in the subbasin occurs in the mainstem and most tributaries. Biologists have recovered carcasses of spawned hatchery steelhead during spawning ground surveys. The current escapement goal of 10,000 natural steelhead above Sherars Falls has not been met from 1977 through 1987.

Harvest of natural steelhead in the recreational fishery was restricted in 1979 and has been prohibited since 1986 because the escapement goal has not been met. This regulation also protects natural steelhead from other Columbia River subbasins that stray into the Deschutes River.

Tribal harvest averaged 930 natural steelhead and 1,820 hatchery steelhead from 1977 through 1987. Recreational harvest averaged 3,880 hatchery steelhead from Sherars Falls to the river mouth from 1977 through 1987. Recreational harvest of summer steelhead above Sherars Falls has not been estimated.

Hatchery production of summer steelhead could be increased. by rearing smolts in Pelton ladder, but fisheries managers have assigned a higher priority to rearing spring chinook salmon in the ladder. Rearing both summer steelhead and spring chinook salmon in Pelton ladder would not be practical due to disease considerations of the two species.

Planners have-identified several opportunities for increasing natural production of summer steelhead in the subbasin. Habitat enhancement projects to rehabilitate the tributaries and restore adequate perennial streamflows would increase natural production capacity for summer steelhead. Ongoing habitat projects in the Trout Creek and Warm Springs River watersheds and in Shitike Creek are expected to increase steelhead production capacity. Development of a fish passage facility at White River Falls to open up approximately 140 miles of stream to summer steelhead would be expected to produce an additional 2,100 to 3,500 steelhead in the subbasin (ODFW et al. 1985).

Introduction of summer steelhead into White River above the falls would result in a reduction of the native trout population in White River because of competitive interactions. Native trout management areas would be maintained above impassable waterfalls on Tygh and Jordan creeks and in Rock Creek above the reservoir. Native trout stocks in Little Badger and Threemile creeks would be protected by installing barriers to prevent anadromous fish passage into the upper areas of these creeks.

When considering increasing production of summer steelhead in the subbasin, the impact on the rainbow trout population must be taken into account. The Deschutes River supports a well known rainbow trout fishery that must be protected. Planners should choose strategies to increase summer steelhead production that minimize impacts on rainbow trout.

Critical Uncertainties

- The ability of the natural stock to maintain itself when hatchery production increases and harvest increases is unknown.
- The impact of increased production of summer steelhead on anadromous and resident fish species is unknown.
- Actual factors limiting production of summer steelhead in the subbasin are unknown.

- The increase in summer steelhead production in the subbasin as a result of riparian improvement and instream habitat projects in the tributaries is difficult to quantify with a high degree of certainty.

Objectives

Management Guidelines..

1. Summer steelhead will be managed for wild-and hatchery fish (Option B of the Oregon Wild Fish Policy) in the mainstem and the tributaries except the Warm Springs River above the hatchery. Continue stocking hatchery smolts in the mainstem and do not stock hatchery steelhead in the tributaries.

2. Summer steelhead will be managed for wild fish only(Option A of the Oregon Wild Fish Policy) in the Warm Springs River above the hatchery. Do not allow adult hatchery steelhead above the hatchery.

Biological Objectives

1. Achieve optimum use of existing and potential habitat for natural production in the subbasin by providing a spawning escapement of 10,000 natural spawners and 600 to 1,000 hatchery brood stock fish through the return of 16,000 to 22,000 summer steelhead annually to the Deschutes River. This level of spawning escapement should maintain the genetic diversity of this natural stock.

2. Minimize the potential impact of hatchery summer steelhead on natural steelhead.

Utilization Objectives

1. Provide 5,000 to 11,000 summer steelhead available for harvest in recreational and Warm Springs tribal fisheries in the Deschutes River.

2. Provide the opportunity for equitable harvest sharing of summer steelhead in recreational and Warm Springs tribal fisheries in the subbasin.

3. Maximize harvest of hatchery steelhead in the lower Deschutes River Subbasin.

   Hatchery summer steelhead returning to subbasin hatchery facilities in excess of brood stock requirements will be provided to the Warm Springs Tribes.

Alternative Strategies

Modeling results for each strategy are presented in Table 49 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 49. 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.

Table 50 summarizes the SMART analysis for all proposed strategies (see Appendix B). Estimated costs of the alternative strategies below are summarized in Table 51.

STRATEGY 1: Enhance natural production in Trout Creek, Shitike Creek, and Warm Springs River. Maintain current natural production levels in all other areas of the subbasin. Maintain current hatchery production levels at Round Butte Hatchery.

Proposed natural production enhancement projects should increase juvenile rearing habitat and adult holding areas in the subbasin, and decrease juvenile losses at irrigation diversions. The net effects will be increases in egg-to-smolt survival, smolt-to-smolt survival, smolt capacity, and pre-spawning survival.

ACTIONS: 1, 4, 5

1. Trout Creek Habitat Enhancement. Implementation of this project began in 1986 with 120 miles of stream proposed for rehabilitation by 1991. Riparian projects will stabilize banks, increase low summer streamflows, reduce summer water temperature, and decrease sediment input. Instream projects will increase adult holding area, increase quality of juvenile rearing habitat, and enhance spawning areas. An adult passage project has been completed on Brocher Creek to provide access to more spawning and rearing area. Seventeen. irrigation pump screens and 10 rotary bypass screens have been installed to reduce losses of smolts. Rotary bypass screens may be installed on four to seven additional irrigation diversions.

   The total cost of this ongoing project is $2.5 million.

4. Shitike Creek Habitat Enhancement. Riparian projects along the lower 10 miles of stream will increase channel and bank stability, increase summer streamflows, reduce summer water temperature, and decrease sedimentation. Instream projects in the lower eight miles of Shitike Creek will increase rearing habitat quality and adult holding area and enhance passage of adults to upstream areas. A reduction in water temperature in the lower eight miles will allow year-round rearing of juvenile steelhead in this area. Installing a screen at a diversion for a mill pond will reduce smolt losses.

   Estimated cost of this project over a 50-year life span is $1,006,000 based on 10 miles of enhancement and the cost estimation procedure provided by the System Planning Group. This action is the same as spring chinook salmon-Action 1.

5. Warm Springs River Habitat Enhancement. Riparian and instream projects in 20.5 miles of Coyote and Quartz creeks will increase channel and bank stability, establish perennial streamflows, and reduce sediment input into Beaver Creek and Warm Springs River. Riparian and instream projects in 9.5 miles of Warm Springs River will increase overwintering habitat and adult holding area.

   Estimated cost of this project over a 50-year life span is $2,378,000 based on 30 miles of enhancement and the cost estimation procedure provided by the System Planning Group. This action is the same as spring chinook salmon Action 2.

STRATEGY 2 Enhance natural production in Trout, Shitike, Bakeoven and Buck Hollow creeks, and in Warm Springs River. Maintain current natural production levels in all other areas of the subbasin. Maintain current hatchery production levels at Round Butte Hatchery.

Proposed natural production enhancement projects should increase juvenile rearing habitat and adult holding areas in the subbasin, and decrease juvenile losses at irrigation diversions. The net effects will be increases in egg-to-smolt survival, smolt-to-smolt survival, smolt capacity, and pre-spawning survival.

ACTIONS: l-5

-1. -

2. Bakeoven Creek Habitat Enhancement. Riparian projects along 20 miles of stream throughout the watershed will increase channel and bank stability, increase summer streamflows, reduce summer water temperature, and decrease sedimentation. Instream projects in three miles of the lower eight miles of Bakeoven Creek will increase rearing habitat quality and adult holding area.

   Estimated cost of this project over a 50-year life span is $1,257,000 based on 20 miles of enhancement and the cost estimation procedure provided by the System Planning Group.

3. Buck Hollow Creek Habitat Enhancement. Riparian projects along 30 miles of stream throughout the watershed will-increase channel and bank stability, increase summer streamflows, reduce summer water temperature, and decrease sedimentation. Instream projects in three miles of the lower 15 miles of Buck Hollow Creek will increase rearing habitat quality and adult holding area.

   Estimated cost of this project over a 50-year life span is $1,845,000 based on 30 miles of enhancement and the cost estimation procedure provided by the System Planning Group.

4. -
5. -

STRATEGY 3: Enhance natural production in Trout, Shitike, Bakeoven and Buck Hollow creeks and Warm Springs River, and expand natural production into the White River drainage above White River Falls. Maintain current natural production levels in all other areas of the subbasin. Maintain current hatchery production levels at Round Butte Hatchery.

Proposed natural production enhancement projects should increase juvenile rearing habitat and adult holding areas in the subbasin, and decrease juvenile losses at irrigation diversions. The net effects will be increases in egg-to-smolt survival, smolt-to-smolt survival, smolt capacity, and pre-spawning survival.

ACTIONS: l-6

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

6. White River Falls Passage. Passage of adult steelhead above White River Falls would provide access to 164 miles of spawning and rearing habitat that is currently unavailable.

   Waste water from the Clear Creek ditch shall be diverted away from the Oak Springs Hatchery water supply to prevent possible contamination of the hatchery with diseases from steelhead. Screening of 18 irrigation ditches in the White River system will be necessary to protect juvenile steelhead and resident fish.

   Sanctuaries for resident trout should be designated prior to steelhead introductions because some rainbow trout stocks in White River are genetically unique. The wild trout could be protected above existing barriers to upstream migration and by constructing new barriers. These wild trout areas should provide protection for the three groups of native trout identified in the basin.

   Native stocks of summer steelhead from Deschutes River populations will be used in White River. Fish for introduction should be surplus to present production needs and should not affect existing hatchery programs.

The run of summer' steelhead returning to the White River system must be self-sustaining within two generations (10 years) after initial introduction above the falls. The need to stock the system with summer steelhead each year would indicate that the system is not capable of supporting a run of summer steelhead.

The preferred method for passage of adult steelhead at White River Falls is a trap and haul facility located 900 feet-below the lower falls.

Alternatives to a free-fall passage for juvenile fish over White River Falls will depend on the timing of juvenile outmigrations of the introduced fish and on the distribution of migrants in the river channel above the falls. If a hydroelectric project is constructed at the falls, the developer will have to screen the penstock intake and might have to provide downstream passage facilities if diversion of water causes mortality to fish passing over the falls.

Access for adult fish above diversion dams in lower Tygh and Badger creeks will be necessary to ensure use of these productive creeks. Methods for providing access to the creeks will depend on the timing of the adult run and on when the diversion dams are installed. Modifications to diversion structures, if needed, will not affect the water user or use of the water.

Supplemental stocking of hatchery catchable trout to support trout fisheries in White River and Badger Creek could continue without affecting the steelhead program. Existing trout angling regulations in the basin should not be altered unless there is observed biological justification.-

A fishery for adult steelhead in White River above the falls would be considered after runs were established. Success or failure of the White River Falls passage project should not dictate angling regulation changes on the Deschutes River.

Evaluation should be an integral part of the implementation plan. The estimated cost of the project in 1985 was $4.3 million for construction of facilities and operation and maintenance for the passage of salmon and steelhead. This cost may change with changes in design of the facilities.

STRATEGY 4: Enhance natural production in Trout Creek, Shitike Creek and Warm Springs River, and expand natural production into the White River drainage above White River Falls. Maintain current natural production levels in all other areas of the subbasin. Maintain current hatchery production levels at Round Butte Hatchery.

Proposed natural production enhancement projects should increase juvenile rearing habitat and adult holding areas in the subbasin,-and decrease juvenile losses at irrigation diversions. The net effects will be increases in egg-to-smolt survival, smolt-to-smolt survival, smolt capacity, and pre-spawning survival.

ACTIONS: 1, 4-6 (see above)

STRATEGY 5: Enhance natural production in Trout Creek, Shitike Creek, and Warm Springs River and increase production at Round Butte Hatchery. Maintain current natural production levels in all other areas of the subbasin.

Proposed natural production enhancement projects should increase juvenile rearing habitat and adult holding areas in the subbasin, and decrease juvenile losses at irrigation diversions. The net effects will be increases in egg-to-smolt survival, smolt-to-smolt survival, smolt capacity, and pre-spawning survival. The proposed hatchery production project will increase hatchery smolt capacity and smolt-to-adult survival.

ACTIONS: 1, 4, 5, 7

1. -
4. -
5. -

7. Round Butte Hatchery Production Increase. Increase the number of summer steelhead smolts released annually from Round Butte Hatchery by 100,000 smolts to a total of 262,000 smolts. Additional rearing facilities will be constructed to accommodate the increase in production.

Table 49. System Planning Model results for summer steelhead (A's) in the Deschutes Subbasin. Baseline value is for pre-mainstem implementation, all other values are post-implementation.

utilization Objective:

1. Provide 5,000 to 11,000 summer steelhead available for harvest in recreational and Warm Springs tribal fisheries in the Deschutes River.
2. Provide the opportunity for equitable harvest sharing of sunner steelhead in recreational and Uarm Springs tribal fisheries in the subbasin.
3. Maximize harvest of hatchery steelhead in-the louer Deschutes River subbagin.

Biological Objective:

1. Achieve optimum use of habitat by providing a spawning escapement of 10,000 natural spauners and 600 to 1,000 hatchery brood stock fish through the return of 16,000 to 22,000 fish annually to the Deschutes River. This level of escapement should maintain the genetic diversity of this natural stock.
2. Minimize the potential impact of hatchery summer steelhead on natural steelhead.

Strategy[1]	Maximum[2] Sustainable Yield (MSY)	Total[3] Spauning Return	Total[4] Return to Subbasin	out of[5] Subbasin Harvest	Contribution[6] To Council's Goal (Index)
Baseline	6,379 -C	3,647	10,811	1,529	0(1.00)
All Nat	10,111 -c	8,042	19,444	2,750	12,010(1.80)
1	8,948 -C	5,971	15,978	2,260	7,188(1.48)
2	9,647 -C	7,050	17,865	2,527	9,814(1.65)
3*	10,111 -C	8,042	19,444	2,750	12,010(1.80)
4	9,378 -C	7,106	17,693	2,502	9,575(1.64)
5	12,381 -C	6,351	19,969	2,824	12,741(1.85)

*Recommended strategy.

[1] Strategy descriptions:

For comparison, an "all natural" strategy uas 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. Enhance natural production in Trout Creek, Shitike Creek, and Uarm Springs River. Current net. prod. levels would be maintained in all other areas. Current hatchery prod. levels at Round Butte Hatchery would be maintained. Post Hainstem Implementation.
2. Enhance nat. prod. in Trout, Shitike, Bakeoven, and Buck Hollow creeks, and Warm Springs R. Current nat. prod. in all other areas. Current hatchery production. Post Mainstem Implementation.
3. Strategy 2 plus expand production into the White River drainage above Uhite River Falls. Post Mainstem Implementation.
4. Enhance nat. prod. in Trout and Shitike creeks, and Uarms Springs R., and expand nat. prod. above White River Falls. Current nat. prod. levels in all other areas. Current hatchery prod. levels. Post Mainstem Implementation.
5. Enhance net. prod. in Trout and Shitike creeks, and Uarm Springs R., and increase prod. at Round Butte Hatchery. Current nat. prod. levels in all other areas. 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 spauning component exceeds 500 fish. N = the model projection where sustainable yield is maximized for the naturally spauning component and is shown when the combined MSY rate results in a natural spauning escapement of less than 500 fish.

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

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

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

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

Table 50. Values obtained from the SMART analysis of each strategy proposed for summer steelhead in the Deschutes River drainage.

Strategies	Total Value	Discount Value	Confidence Value
1	700	384	0.549
2	680	372	0.547
3 *	680	372	0.547
4	660	360	0.545
5	700	384	0.549

*Recommended strategy.

Table 51. Estimated costs of alternative strategies for Deschutes summer steelhead. Cost estimates represent new or additional costs to the 1987 Columbia River Basin Fish and Uildlife Program; they do not represent projects funded under other programs, such as the Lower Snake River Compensation Plan or a public utility district settlement agreement. (For itemized costs, see Appendix C.)

	Proposed Strategies				
	1	2	3*	4	5
Hatchery Costs					
Capital[1]	0	0	0	0	460,000
O&M/yr[2]	0	0	0	0	50,000
Other Costs					
Capital[3]	1,864,000	3,066,000	6,050,000	4,848,000	1,864,000
O&M/yr[4]	30,400	68,400	131,100	93,100	30,400
Total Costs					
Capital	1,864,000	3,066,000	6,050,000	4,848,000	2,324,000
O&M/yr	30,400	68,400	131,100	93,100	80,400

* Recommended strategy.

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

2 Estimated operation and maintenance costs per year directly associated uith neu 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 uith new hatchery production. For consistency, D&M costs are based on 50 years.

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

A) Increase harvest of hatchery steelhead in the recreational and Warm Springs tribal fisheries. Hatchery steelhead are underutilized in the recreational and Warm Springs tribal fisheries-in the subbasin. Currently more hatchery steelhead return to Round Butte Hatchery than are required for brood stock. Alternative actions are:

1) Incorporate angler-caught steelhead into the brood stock at Round Butte Hatchery. There is concern that hatchery brood stock selection practices select for steelhead that are less susceptible to harvest by angling ("non-biters").

2) Incorporate natural fish into the steelhead brood stock at Round Butte Hatchery. There is concern that hatchery brood stock selection practices select for steelhead that are less susceptible to harvest by angling ("non-biters").

3) Allow the use of bait from Sherars Falls to Pine Tree (RM 39) to increase the harvest of hatchery summer steelhead. This action would extend the bait fishing area four miles below Buck Hollow Creek.

4) Allow year-round angling for summer steelhead in the Deschutes River between the north boundary of the Warm Springs Indian Reservation and the river mouth to increase the harvest of hatchery summer steelhead.

5) Examine existing data regarding time of steelhead passage past Sherars Falls and time of entry into Pelton trap. Modify hatchery brood stock selection to lengthen the time summer steelhead are in the Deschutes River and are available for harvest.

B) Reduce the potential of returning hatchery fish interbreeding with natural stocks. Production of natural stocks can be adversely impacted by interbreeding with hatchery fish. An unknown number of Round Butte Hatchery steelhead do not return to Pelton trap and presumably spawn in the Deschutes River or tributaries. Carcasses of spawned hatchery summer steelhead have been recovered during spawning ground surveys on Deschutes River tributaries. Alternative actions are:

1) Limit the release of hatchery steelhead smolts to immediately below Pelton Reregulating Dam (RM 100) to reduce straying of returning adults.

2) Limit the downstream recycling of hatchery steelhead captured at Pelton trap by releasing them above the Warm Springs Bridge (RM 97) to reduce straying of. returning hatchery steelhead into natural spawning areas in tributaries below the bridge.

3) Incorporate natural fish into the steelhead brood stock at Round Butte Hatchery to maintain wild characteristics in the hatchery stock.

C) Continue the summer steelhead run size monitoring program in the subbasin to evaluate success of achieving the objectives. The monitoring should include statistical creel surveys at the river mouth, Mack's Canyon Access Road, and Sherars Falls, and tagging and tag recovery to estimate escapement above Sherars Falls. Additional harvest information could be obtained from creel surveys from Sherars Falls to Pelton Reregulating Dam.

D) Conduct a study to determine the feasibility of providing passage for summer steelhead adults and juveniles past the Pelton-Round Butte hydroelectric project. If passage is feasible, production from the area above the hydroelectric project could be used when the subbasin plan is updated. The passage project would provide access to historic spawning and rearing habitat that is now unavailable because of blockage by the hydroelectric project. Pelton fish ladder would not be used for fish passage under this action. The estimated cost of this study is $500,000 according to the application for amendment to the Columbia River Basin Fish and Wildlife Program.

<u>Recommended Strategy</u>

Strategy 3 (habitat and passage enhancement and continuation of the present hatchery program) is the recommended alternative for Deschutes River summer steelhead production enhancement.

Strategy 3 was chosen over Strategies 1, 2, and 4 because it maximizes natural productivity of steelhead in the subbasin and it meets the utilization objective for the subbasin. Strategy 3 ranked third according to the SMART analysis. Strategy 5, which included increased artificial production and exceeded the subbasin production objective, scored highest according to SMART. Strategy 1 was ranked second by SMART. While Strategy 1 is estimated to be 15 percent less productive (in total steelhead returning to the subbasin) 'than Strategy 3, there was only a six-point difference between the SMART values. Strategy 3 includes passage enhancement at White River Falls, which would add approximately 164 miles to the habitat available for natural production of steelhead. The presence of anadromous fish in the White River system would result in higher values placed on the stream resource and more protection for the watershed in future resource planning. Potential impacts on resident fish, which could occur as a result of anadromous fish introductions above White River Falls, can be avoided through precautionary measures (establishment of wild trout management areas above fish passage barriers) and proper management.

Strategy 3 (no increase in artificial production) was chosen over Strategy 5 (increase in artificial production) because of the higher priority given to increasing the artificial production of spring chinook salmon at Round Butte Hatchery and the subbasin, and the limited space available at Round Butte Hatchery to rear both summer steelhead and spring chinook. Concern for impacts of hatchery steelhead on natural steelhead production also led to choosing Strategy 3 over Strategy 5.

SOCKEYE SALMON

Fisheries Resource

Natural Production

Sockeye salmon (*Oncorhynchus nerka*) historically occurred in the Deschutes River Subbasin (Nielsen 1950, Haas and Warren 1961, Fulton.1970). The run originated in Suttle Lake. Construction of a small power dam and installation of screens at the outlet of Suttle Lake in the 1930s reduced passage of sockeye salmon to and from the lake (Nielsen 1950; Fulton 1970), but did not eliminate the run in the Deschutes River. Access to the upper Deschutes Basin was impeded to anadromous salmonids with the completion of Pelton and Round Butte dams in 1958 and 1964, respectively. Adult passage past the dams continued until 1968 when downstream passage facilities at the dams proved insufficient to sustain natural runs above the dams. Poor passage of downstream migrants at Round Butte Dam was attributed to early stratification of the reservoir and surface currents that attracted downstream migrants away from the dam (Korn et al. 1967). Lake Billy Chinook now has a large population of kokanee (landlocked sockeye salmon). Currently, a small run of sockeye salmon is maintained by incidental passage of smolts through the dam turbines.

The native sockeye run was most likely the parent stock that developed into the landlocked population in Lake Billy Chinook. This population may have been influenced by the kokanee stocking programs in the upper lakes and reservoirs.

Adult sockeye salmon enter the Deschutes River from June to September (Table 52). The run arrives at Sherars Falls in July and peaks in late July to early August with the last sockeye salmon passing the falls-in late September (Table 53).

Biologists have counted sockeye salmon at Pelton trap since 1956 (Table 54). Run size has been estimated annually since 1977 by creel surveys of the recreational and tribal fisheries at Sherars Falls and counts at Pelton trap. The run size from 1977 through 1988 averaged 127 sockeye salmon, with a range of 29 fish to 338 fish (Table 55). Adult sockeye salmon captured at the Sherars Falls trap averaged 21 inches fork length with a range of 16.5 inches to 26.2 inches.

Researchers have not documented spawning of sockeye salmon in the lower Deschutes River. Before the hydroelectric complex terminated adult passage, spawning occurred from mid-September to November in the upper subbasin.

Table 52. Freshwater life history for sockeye salmon in the Deschutes River. Developmental stage timing represents basin-wide averages.

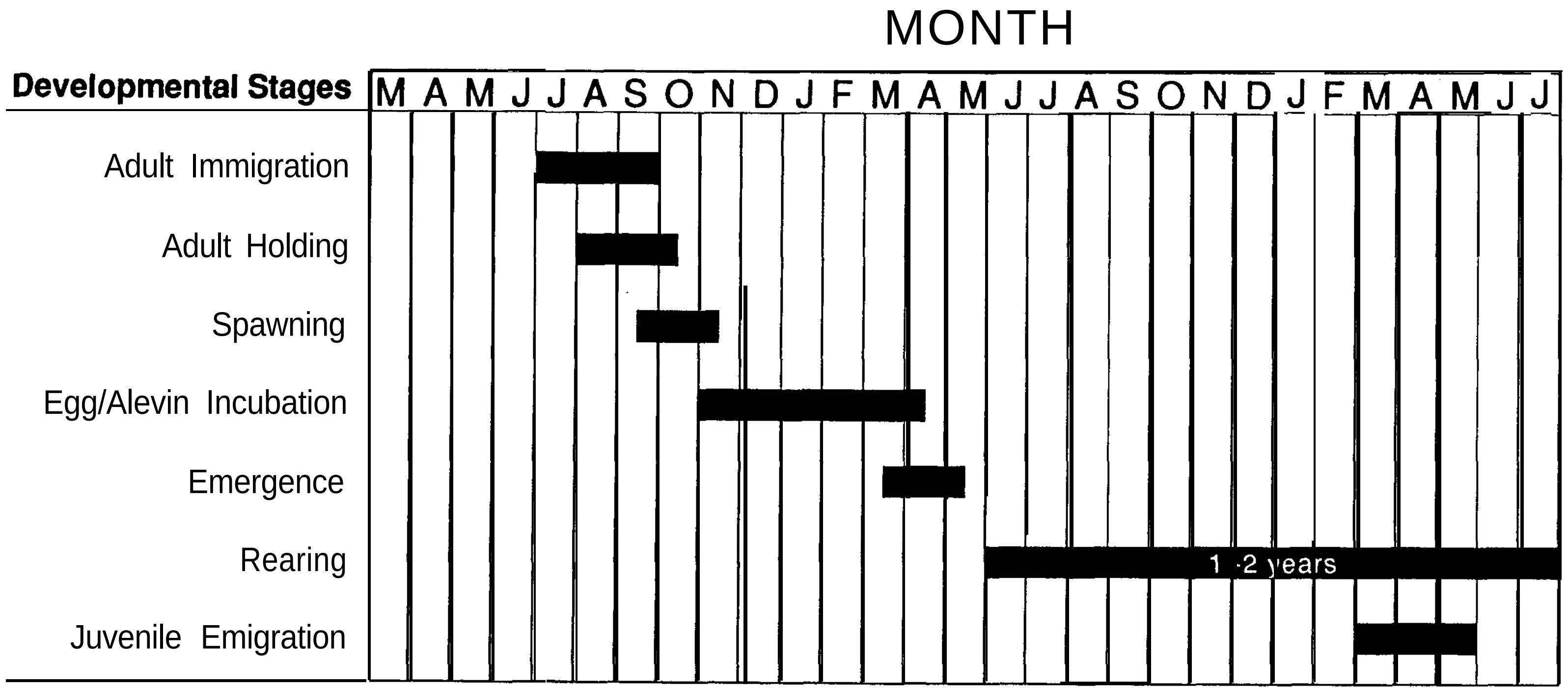


Table 53. Sockeye salmon counted at Sherars Falls Trap, June through October 1977-1988.

Year	June 16-30	July 1-15	July 16-31	August 1-15	August 16-31	September 1-15	September 16-30	October 1-15	Total
1977	0	2	3	3	1	1	0	0	10
1978	0	1	3	1	0	0	0	0	5
1979	0	0	3	8	1	3	1	0	16
1980	0	1	7	1	0	1	0	0	10
1981	0	2	2	0	0	0	0	0	4
1982	a/	1	2	1	0	1	0	0	5
1983	a/	a/	a/	3	5	0	1	0	9
1984	a/	a/	a/	0	1	0	0	0	1
1985	a/	a/	2	4	1	3	1	0	11
1986	a/	1					1	0	4
1987	a/	a/	a/	20	20	11	0	0	5
1988	0	0	4	1	4	0	0	0	9
Total	0	8	27	24	15	11	4	0	89

a/ Trap not operated.

Table 54. Monthly counts of upstream-migrant sockeye salmon at Pelton trap, 1956-1988.

Year	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1956	0	0	1	1			0
1957	0	5	10	12	3	1	0
1958	0	1	51	4	0	0	0
1959	0	18	57	22	2	0	0
1960	0	0	0	0	0	0	0
1961	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0
1963-	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0
1969	0	0	0	2	0	0	0
1970	0	0	0	0	0	0	0
1971	0	33	5	8	1	0	0
1972	0	3	24	33	2	0	0
1973	0	92	185	40	10	0	0
1974	0	1	39	16	6	0	0
1975	0	5	30	31	3	0	0
1976	0	132	163	0	0	0	0
1977	0	0	18	0	9	0	0
1978	0	0	5	21	0	0	0
1979	0	0	34	36	14	0	0
1980	0	1	22	19	1	0	0
1981	0	7	29	4	2	0	0
1982	0	12	110	56	2	0	0
1983	0	1	62	25	6	0	0
1984	0	3	0	65	1	0	0
1985	0	2	0	0	26	0	0
1986	0	0	9	5	0	0	0
1987	0	0	4	0	0	0	0
1988	0	0	23	26	0	0	0
Total	0	316	881	426	88	1	0

Table 55. Run, size of wild sockeye salmon in the Deschutes River, 1977-1988.

Year	Harvest Tribal	Harvest Recreational	Escapement to Pelton trap	Total
1977	99	0	27	126
1978	10	3	-26	39
1979	58	4	84	146
1980	0	0	43	43
1981	55	3	42	100
1982	139	19	180	338
1983	92	0	94	186
1984	59	5	69	133
1985	202	17	28	247
1986	19	2	14	35
1987	20	5	4	29
1988	51	4	49	104

Prior to completion of the hydroelectric complex, juvenile sockeye salmon reared in fresh water for one to two years and migrated from the subbasin in March to July, with the peak in April (Gunsolus and Eicher 1962).

The major constraint to production of sockeye salmon in the subbasin is passage of juveniles and adults past the Pelton-Round Butte hydroelectric complex.

Hatchery Production

The earliest recorded stocking of kokanee in the Deschutes Basin occurred in Odell Lake in 1950, with the highest stocking rates in the early 1960s. Stocking occurred in 14 lakes and reservoirs from 1950 to 1982 in the upper Deschutes Basin, excluding Lake Billy Chinook and Lake Simtustus. Lake Billy Chinook was stocked in 1970, 1971, and 1973. Lake Simtustus has been stocked annually since 1965, except in 1975 and 1979. Managers stock kokanee from Wizard Falls Hatchery annually in Lake Simtustus and in Crescent and Paulina lakes. Managers do not stock sockeye salmon in the lower Deschutes River Subbasin.

Harvest

Ceremonial and subsistence tribal fisheries for sockeye salmon existed in the Deschutes Basin historically. Today, few sockeye salmon are harvested in recreational and tribal fisheries in the Deschutes River.

Annual recreational and tribal harvest of sockeye salmon in the Deschutes River has averaged nine sockeye and 67 sockeye, respectively, since 1977 (Table 55).

Specific Considerations

Sockeye salmon historically spawned in the Deschutes River Subbasin. Since the construction of Pelton and Round Butte dams, a small run has been maintained by the incidental passage of smolts from Lake Billy Chinook through turbines.

The Columbia River Basin Fish and Wildlife Program includes a measure calling for a study of the feasibility of returning anadromous salmonids to the Deschutes River above Round Butte Dam. If passage is developed, the current sockeye salmon run could be greatly enhanced.

Critical Uncertainties

- The technology has not been developed for providing downstream passage for sockeye smolts produced above Round Butte Dam.
- The sockeye smolt production potential of Lake Billy Chinook is unknown.
- If downstream passage past the hydroelectric complex is feasible, the actual adult sockeye salmon production is unknown.

Objectives

Management Guideline

Present and future management of sockeye salmon is dependent upon further investigation into passage at the Pelton-Round Butte hydroelectric project and development of the upper Deschutes Subbasin Plan.

Biological Objective

Develop and maintain a self-sustaining run of anadromous sockeye salmon returning to the subbasin that will provide recreational and tribal harvest opportunities in the Columbia and lower Deschutes rivers.

Planners estimate that the Deschutes River Subbasin may be able to support an average annual run size of approximately 5,000 fish returning to the mouth of the subbasin. This is a preliminary estimate that may be revised after-further study.

Utilization Objective

Achieve an average annual harvest of 1,500 sockeye salmon in the Deschutes River Subbasin.

This is an interim number that will be dependent on the ability to achieve the stated biological objective. The number of fish that will be available for harvest is based on the assumption that the run will be able to sustain a 25 percent harvest rate. The utilization objective may change as more data becomes available.

Alternative Strategies

MSY run size and harvest for the following strategy were not modeled with the System Planning Model. Estimated costs are summarized in Table 56.

STRATEGY 1: Pelton-Round Butte Hydroelectric Project Passage. Conduct a study to determine the feasibility of providing passage for sockeye-salmon adults and juveniles past the Pelton-Round Butte hydroelectric project. If passage is feasible, production from the area above the hydroelectric project could be used to reestablish the sockeye salmon run in the lower subbasin. The passage project would provide access to historic spawning and rearing habitat that is now unavailable because of blockage by the hydroelectric project. Pelton fish ladder would not be used for fish passage under this action.

The estimated cost of this study is $500,000 according to the application for amendment to the Columbia River Basin Fish and Wildlife Program.

Table 56. Estimated costs of alternative strategies for Deschutes sockeye. Cost estimates represent new or additional costs to the 1987 Columbia River Basin Fish and Uildlife Program; they do not represent projects funded under other programs, such as the Louer Snake River Compensation Plan or a public utility district settlement agreement. (For itemized costs, see Appendix C.)

	Proposed Strategies
	1*
Hatchery Costs	
Capital[1]	0
O&M/yr[2]	0
Other Costs	
Capital[3]	100,000
O&M/yr[4]	8,000
Total Costs	
Capi tat	100,000
O&M/yr	8,000

• Recommended strategy.

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

2 Estimated operation and maintenance costs per year directly associated uith neu 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 neu hatchery production. For consistency, O&M costs are based on 50 years.

Recommended Strategy

Pelton-Round Butte hydroelectric project passage is the recommended strategy for Deschutes River sockeye salmon production enhancement.

This strategy proposes examining the feasibility of providing passage for the sockeye salmon population that is currently landlocked above Round Butte Dam. Planners have not identified another source of sockeye salmon production, either natural or hatchery, that is acceptable in the Deschutes River Subbasin. Depending upon the outcome of the feasibility study it will be determined whether or not it will be possible to develop a run of sockeye at, or possibly above, the preliminary estimate defined in the biological objective.

PART V. SUMMARY AND IMPLEMENTATION

Objectives and Recommended Strategies

Spring Chinook

The objective calls for providing 5,500 to 8,000 spring chinook salmon (jacks and adults) available for harvest in recreational and Warm Springs tribal fisheries in the Deschutes River through the return of 8,500 to 12,000 fish annually to the Deschutes River.

Planners recommend Strategy 5. This strategy is a combination of natural production enhancement in Shitike Creek and Warm Springs River, expansion of natural production into the White River drainage above White River Falls, and production increases at Round Butte and Warm Springs hatcheries.

Proposed natural production enhancement projects should increase juvenile rearing habitat and adult holding areas in the subbasin, and decrease juvenile losses at a diversion. The net effects will be increases in egg-to-smolt survival, smolt-to-smolt survival, smolt capacity, and pre-spawning survival. Proposed hatchery production projects will increase hatchery smolt capacity and smolt-to-adult survival.

The System Planning Model estimates the Deschutes River Subbasin would have a spring chinook run size of 9,082 and provide a maximum sustainable harvest rate of 0.63, 5,722 fish available for harvest, and 2,652 spawners following implementation of the recommended strategy.

The estimated cost of the natural production enhancement portion of this strategy-is $7,684,000 based on cost estimation methods provided by the System Planning Group. These natural production enhancement projects are included in the recommended strategy for summer steelhead enhancement. Planners have not estimated costs for the proposed hatchery production projects at this time.

Fall Chinook

The objective for fall chinook calls for making 4,000 to 5,000 fall chinook salmon (jacks and adults) available for harvest in recreational and Warm Springs tribal fisheries in the Deschutes River. It also calls for a spawning escapement of 6,000 to 7,000 wild fall chinook salmon through the return of 10,000 to 12,000 fish annually to the Deschutes River.

Planners recommend Strategy 2, natural production, Level II. This strategy enhances the riparian areas along the Deschutes

River to 60 percent of the 'vegetative potential, and enhances the spawning gravel in the upper three miles of the mainstem.

Proposed natural production enhancement projects should increase juvenile habitat and enhance spawning habitat. The net effect will be an increase in egg-to-smolt survival and smolt capacity.

The System Planning Model" estimates fall chinook salmon in the Deschutes River Subbasin would have a run size of 12,397 fish' and provide a maximum sustainable harvest rate-of 0.52, 6,446 fish available for harvest, and 5,653 spawners following implementation of the recommended strategy.

The estimated cost of this strategy is $2,329,500 based on cost estimation methods provided by the System Planning Group.

Summer Steelhead

The summer steelhead objective is to provide 5,000 to 11,000 summer steelhead available for harvest in recreational and Warm Springs tribal fisheries in the Deschutes River. It also calls for a spawning escapement of 10,000 natural spawners and 600 to 1,000 hatchery brood stock through the return of 16,000 to 22,000 summer steelhead annually to the Deschutes River.

Planners recommend Strategy 3, which enhances natural production in Trout, Shitike, Bakeoven and Buck Hollow creeks and Warm Springs River, and expands natural production into the White River drainage above White River Falls. Current natural production levels would be maintained in all other areas of the subbasin. Current hatchery production levels at Round Butte Hatchery would be maintained.

Proposed natural production enhancement projects should increase juvenile rearing habitat and adult holding areas in the subbasin, and decrease juvenile losses at irrigation diversions. The net effects will be increases in egg-to-smolt survival, smolt-to-smolt survival, smolt capacity, and pre-spawning survival.

According to the System Planning Model, implementing Strategy 3 would increase summer steelhead production in the Deschutes River Subbasin to 19,444 fish and provide a maximum sustainable harvest rate of 0.52, 10,111 fish for harvest and 8,042 spawners. While the System Planning Model indicates the spawner escapement goal is unattainable, the Fish Management Committee felt there was enough information available to indicate that the spawner escapement goal is achievable.

The estimated cost of this strategy is $13,286,000 based on cost estimation methods provided by the System Planning Group.

All of the natural production enhancement projects identified in the recommended strategy for spring chinook salmon are included in this strategy. .

Sockeye

Planners call for developing and maintaining a self-sustaining run of anadromous sockeye salmon returning to the subbasin that will provide recreational and tribal harvest opportunities in the Columbia and lower Deschutes rivers.

Planners currently estimate that the Deschutes River Subbasin may be able to support an average annual run size of approximately 5,000 fish returning to the mouth of the subbasin and an average annual harvest of 1,500 sockeye salmon in the Deschutes Subbasin. These are interim numbers that will be dependent on the ability to achieve the stated biological objective and for the system to be able to sustain a 25 percent harvest rate. The utilization objective may change as more data becomes available.

Subbasin planners recommend conducting a study to determine the feasibility of providing passage for sockeye salmon adults and juveniles past the Pelton-Round Butte hydroelectric project. If passage is feasible, production from the area above the hydroelectric project could be used to reestablish the sockeye salmon run in the lower subbasin. The passage project would provide access to historic spawning and rearing habitat that is now unavailable because of blockage by the hydroelectric project. Pelton fish ladder would not be used for fish passage under this action. The estimated cost of this study is $500,000 according to the application for amendment to the Columbia River Basin Fish and Wildlife Program.

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: Deschutes River

STOCK: Spring Chinook

STRATEGY: 1

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1	6	0.6	20	I20	72
2	9	0.6	20	180	108
3	6	0.3	20	120	36
4	7	0.6	20	140	84
5-	7	0.6	20	140	84

TOTAL VALUE 700

DISCOUNT VALUE 384

CONFIDENCE VALUE 0.54857142

SUBBASIN: Deschutes River

STOCK: Spring Chinook

STRATEGY: 2

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1	5	0.6	20	100	60
2	9	0.6	20	180	108
3	7	0.3	20	140	42
4	7	0.6	20	140	84
5	7	0.6	20	140	84

TOTAL VALUE 700

DISCOUNT VALUE 378

CONFIDENCE VALUE 0.54

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SUBBASIN: Deschutes-River

STOCK: Spring Chinook

STRATEGY: 3

CRITERIA	RATING	CONFIDENCE	WE"IGHT	UTILITY	'DISCOUNT UTILITY
1	6	0.6	20	i2 0	72
2	5	0.6	20	100	60
3	6	0.3	20	120	36
4	7	0.6	20	140	84
5	6	0.6	20	120	72

TOTAL VALUE 600

DISCOUNT VALUE 324

CONFIDENCE VALUE 0.54

SUBBASIN: Deschutes River

STOCK: Spring Chinook

STRATEGY: 4

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1	5	0.6	20	100	60
2	8	0.6	20	160	96
3	8	0.6	20	160	96
4	7	0.6	20	140	84
5	8	0.6	20	160	96

TOTAL VALUE 720

DISCOUNT VALUE 432

CONFIDENCE VALUE 0.6

SUBBASIN: Deschutes River

STOCK: Spring Chinook

STRATEGY: 5

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1	7	0.6	20	140	84
2	9	0.6	20	180	108
3	6	0.3	20	120	36
4	7	0.6	20	140	84
5	7	0.6	20	140	84

TOTAL VALUE 720

DISCOUNT VALUE 396

CONFIDENCE VALUE 0.55

SUBBASIN: Deschutes River

STOCK: Summer Steelhead

STRATEGY: 1

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1	5	0.6	20	100	60
2	8	0.6	20	160	96
3	6	0.3	20	120	36
4	8	0.6	20	160	96
5-	8	0.6	20	160	96

TOTAL VALUE 700

DISCOUNT VALUE 384

CONFIDENCE VALUE 0.54857142

SUBBASIN: Deschutes River

STOCK: Summer Steelhead

STRATEGY: 2

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1	5	0.6	20	100	60
2	8	0.6	20	160	96
3	6	0.3	20	120	36
4	7	0.6	20	140	84
5	8	0.6	20	160	96

TOTAL VALUE 680

DISCOUNT VALUE 372

CONFIDENCE VALUE 0.54705882

SUBBASIN: Deschutes River

STOCK: Summer Steelhead

STRATEGY: 3

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1	6	0.6	20	120	72
2	8	0.6	20	160	96
3	6	0.3	20	120	36
4	7	0.6	20	140	84
5	7	0.6	20	140	84

TOTAL VALUE 680

DISCOUNT VALUE 372

CONFIDENCE VALUE 0.54705882

SUBBASIN: Deschutes River

STOCK: Summer Steelhead

STRATEGY: 4

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1	5	0.6	20	100	60
2	8	0.6	20	160	96
3	6	0.3	20	120	36
4	7	0.6	20	140	84
5	7	0.6	20	140	84

TOTAL VALUE 660

DISCOUNT VALUE 360

CONFIDENCE VALUE 0.54545454

SUBBASIN: Deschutes River

STOCK: Summer Steelhead

STRATEGY: 5

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1	6	0.6	20	120	72
2	8	0.6	20	160	96
3	6	0.3	20	120	36
4	8	0.6	20	160	96
5	7	0.6	20	140	84

TOTAL VALUE 700

DISCOUNT VALUE 384

CONFIDENCE VALUE 0.54857142

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: Deschutes River
Stock: Spring Chinook

Action	Cost Categories*	Proposed Strategies 1	2	3	4	5**
Habitat Enhancement	Capital:	1,864,000	1,864,000		1,864,000	1,864,000
	O&M/yr:	30,400	30,400		30,400	30,400
	Life:	50	50		50	50
Screening	Capital:					
	O&M/yr:					
	Life:					
Barrier Removal	Capital:		2,984,000			2,984,000
	O&M/yr:		62,700			62,700
	Life:		50			50
Misc. Projects	Capital:					
	O&M/yr:					
	Life:					
Hatchery Production	Capital:	805,000		805,000		805,000
	O&M/yr:	87,500		87,500		87,500
	Life:	50		50		50
TOTAL COSTS	Capital:	2,669,000	4,848,000	805,000	1,864,000	5,653,000
	O&M/yr:	117,900	93,100	87,500	30,400	180,600
	Years:	50	50	50	50	50
Uater Acquisition		N	N	N	N	N
Fish to Stock	Number/yr:	350,000		350,000		350,000
	Size:	S, 10/lb.		S, 10/lb.		S, 10/lb.
	Years:	50		50		50

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

** Recommended strategy.

ESTIMATED COSTS FOR ALTERNATIVE STRATEGIES

Subbasin: Deschutes River
Stock: Fall Chinook

Action	Cost Categories*	Proposed Strategies 1	2**	3
Habitat Enhancement	Capital:	70,500	239,500	-408,500
	O&M/yr:	26,600	41,800	57,000
	Life:	50	50	50
Screening	Capital:			
	O&M/yr:			
	Life:			
Barrier Removal	Capital:			
	O&M/yr:			
	Life:			
Misc. Projects	Capital:			
	O&M/yr:			
	Life:			
Hatchery Production	Capital:			
	O&M/yr:			
	Life:			
TOTAL COSTS	Capital:	70,500	239,500	408,500
	O&M/yr:	26,600	41,800	57,000
	Years:	50	50	50
Uater Acquisition		N	N	N
Fish to Stock	Number/yr:			
	Size:			
	Years:			

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

- * Recommended strategy.

ESTIMATED COSTS FOR ALTERNATIVE STRATEGIES

Subbasin: Deschutes River
Stock: Summer Steelhead

Action	Cost Categories*	Proposed Strategies 1	2	3**	4	5
Habitat Enhancement	Capital:	1,864,000	3,066,000	3,066,000	1,864,000	1,864,000
	O&M/yr:	30,400	68,400	68,400	30,400	30,400
	Life:	50	50	50	50	50
Screening	Capital:					
	O&M/yr:					
	Life:					
Barrier Removal	Capital:			2,984,000	2,984,000	
	O&M/yr:			62,700	62,700	
	Life:			50	50	
Misc. Projects	Capital:					
	O&M/yr:					
	Life:					
Hatchery Production	Capital:					460,000
	O&M/yr:					50,000
	Life:					50
TOTAL COSTS	Capital:	1,864,000	3,066,000	6,050,000	4'848,000	2,324,000
	O&M/yr:	30,400	68,400	131,100	93,100	80,400
	Years:	50	50	50	50	50
Uater Acquisition		N	N	N	N	N
Fish to Stock	Number/yr:					100,000
	Size:					S, 5/lb.
	Years:					50

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

• * Recommended strategy.

ESTIMATED COSTS FOR ALTERNATIVE STRATEGIES

Subbasin: Deschutes River
Stock: Sockeye

Action	Cost Categories*	Proposed Strategies 1**
Habitat Enhancement	Capital:	
	O&M/yr:	
	Life:	
Screening	Capital:	
	O&M/yr:	
	Life:	
Barrier Removal	Capital:	
	O&M/yr:	
	Life:	
Misc. Projects	Capital:	100,000
	O&M/yr:	80,000
	Life:	5
Hatchery Production	Capital:	
	O&M/yr:	
	Life:	
TOTAL COSTS	Capital:	100,000
	O&M/yr:	8,000
	Years:	50
Water Acquisition		N
Fish to Stock	Number/yr:	
	Size:	
	Years:	

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

** Reccmnended strategy.