Columbia Basin System Planning

SALMON and STEELHEAD PRODUCTION PLAN

METHOW AND OKANOGAN RIVERS SUBBASIN

September 1, 1990

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Columbia Basin System Planning

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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 drainages in the Columbia Basin. The main goal of this planning process was to develop options or strategies for doubling salmon and steelhead production in the Columbia River. The strategies in the subbasin plans were to follow seven policies listed in the council's Columbia River Basin Fish and Wildlife Program (Appendix A), as well as several guidelines or policies developed by the basin's fisheries agencies and tribes.

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

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

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

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

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PART I. DESCRIPTION OF SUBBASIN

__Location and General Environment__

The Methow and Okanogan subbasins represent the upper limit of anadromous salmonids in the Columbia River Basin and enter the Columbia between Wells and Chief Joseph dams. The Methow Subbasin encompasses about 1,800 square miles, is located in north central Washington with its source on the eastern slopes of the Cascade Mountains, and flows southeasterly to enter the Columbia River at River Mile (RM) 524 near the town of Pateros. The Okanogan Subbasin straddles British Columbia and Washington, begins near Armstrong, British Columbia, and flows south through a chain of ribbon lakes. The first and largest of these is Lake Okanogan, followed by Lakes Skaha, Vaseau and Osoyoos. The International Boundary divides Lake Osoyoos into two, nearly equal parts. From Lake Osoyoos, the Okanogan River flows about 80 miles south where it enters the Columbia River near Brewster at RM 533.

The Similkameen River enters the Okanogan River from the northwest approximately 75 miles above the mouth, approximately two miles below Lake Osoyoos near Oroville. It is the main tributary to the Okanogan and is primarily in Canada. At the confluence, the Similkameen has about four times greater volume than the Okanogan. Collectively, the Okanogan-Similkameen subbasin encompasses approximately 8,200 square miles with 2,500 square miles in the United States.

The Methow and Okanogan subbasins contain a wide variety of landscape and geological formations. The western part of the Methow and Similkameen basins are characterized by deep U-shaped valleys carved between steep, highly dissected Alp-like ridges and peaks. Most ridges and peaks have typical alpine glacial features such as cirques, cirque lakes, knife-edge ridges, and steep, pointed peaks. Avalanche chutes are common along valley side-slopes near the Cascade Crest.

Nearly all the Okanogan Subbasin, excluding the Similkameen, experienced continental glaciation and is characterized by moderate slopes and broad, rounded summits. The grinding action of glacial ice left deep deposits of drift in many areas and bare bedrock in others. The lower 82 miles of the Okanogan are characterized by a sinuous, broad, low gradient channel with the river only falling 165 feet, making it subject to accumulated sediments and thermal heating.

Soil fertility is low in both subbasins, containing only small amounts of necessary nutrients. The dry climate generates little vegetative growth, incorporating little organic matter of which most is located in the top several inches. Both subbasins contain coarse textured soils that are composed of glacial till but little ash. Granitic, volcanic, and sedimentary are the primary soil parent materials. Unconsolidated materials are also present such as glacial drift, pumice and ash deposits, alluvial plain and fan deposits. These constitute most subbasin stream channels and banks and are somewhat unstable. Alluvial plain and alluvial fan deposits are so deep in portions of the Methow that late summer flows are often subsurface, preventing or delaying adult passage, and stranding juvenile fish. In the Methow Basin these areas include 1) between Mazama and Weeman Bridge (RM 60.7-62.2); 2) between Early Winters Creek and Lost River (RM 67.5-73) and 3) between the confluence of Lost River and Robinson Creek (RM 73 and RM 74). Intermittent flows also occur in the Lost River between Eureka Creek and Drake Creek.

Generally, soils in the Methow have low to moderate erosion hazards. Rapid soil infiltration rates cause mass failures or rills and gullies, increasing the potential for both on-site and off-site resource development impacts.

Some soils in the Similkameen Basin have high potential for accelerated mass or surface erosion. These are shallow soils resting on hard, unweathered, unfractured bedrock on steep slopes. When water saturates the soil, the increased water content reduces cohesion between soil particles resulting in soil movement. Sediment from surface erosion or mass failure of this type is common in the lower reaches of the Similkameen River and the mainstem Okanogan River below its confluence with the Similkameen. Spawning gravel quality and rearing habitat in both the Similkameen and Okanogan have been degraded by sediments.

Climate in the subbasins is both maritime and continental due to the Cascade Mountains intercepting prevailing westerly winds and disrupting Pacific storm systems. Average precipitation near the Cascade Crest ranges from 80 to 100 inches and drops off rapidly eastward to about 10 inches in the Omak and Okanogan area. Snowfall ranges from 10 to 20 inches at lower elevations up to 500 inches near the Cascade crest. Snow usually covers the ground from December until late February in the lower elevations while from October to June at high elevations. Normal eastward moving air masses are frequently interrupted by outbreaks of cold air from Canada. The outbreaks are usually of short duration, but sometimes last for two to three weeks. In the Methow and Similkameen basins, substantial juvenile fish mortalities may occur due to severe winter icing (K. Williams, WDW, pers. commun.). In the Okanogan Basin, winter icing mortalities are probably minimal due to the temperature buffering effect of Lake Osoyoos. Average maximum winter temperatures range from 25 degrees Fahrenheit to 35 F, but temperatures of minus 15 F to minus 25 F occur.

From spring through fall, prevailing air flow is from the northwest and west. Warmer and dryer air generally enters the area in May, peaks in July and August, and continues until early September. Intense thunderstorms with localized flooding can occur. Average maximum temperatures are in the 60s and 70s with occasional 80+ F at higher elevations. At lower elevations, temperatures range from 80 F to 95 F and can exceed 100 F.

Six major vegetation zones are found in the subbasins:

1) Grass and Shrub Zone. This area is found in the lowest and most arid part of the subbasins, in the lower reaches of the Methow and Similkameen rivers, and the lowland areas of the Okanogan River into Canada. Irrigated agriculture and livestock grazing dominate. Plant types are big sagebrush, three-tip sagebrush, bitterbrush, grey rabbit brush, bluebunch wheatgrass, Idaho fescue and Sandberg bluegrass, arrowleaf balsamroot, lupine and western yarrow.

2) Ponderosa Pine Zone. This higher elevation zone occurs in a semiarid climate characterized by warm to hot, dry summers and cold winters. The modal plant community consists of a ponderosa pine overstory dominated by bitterbrush understory and an Idaho fescue, pinegrass, bluebunch wheatgrass, elk sedge, arrowleaf balsamroot ground cover. Ceanothus can occur in the understory as a result of past fires. Groves of quaking aspen are found in moist areas and streambanks are lined with quaking aspen, alder and Rocky Mountain maple. The middle to lower reaches of both the Methow and Similkameen rivers are in this zone. Grazing and agriculture dominate land use.

3) Lodgepole Pine Forest. This zone consists of nearly pure lodgepole stands, created by fire, which will eventually return to a climax species. The lodgepole zone is broad in elevations and climates and is found in all zones except the ponderosa pine. This zone is found in various areas in the middle to upper Methow and Similkameen basins.

4) Douglas Fir Zone. This area occurs between the Subalpine Fir Zone and the Ponderosa Pine Zone and is found in temperate climates at 3,000 to 5,000 feet. Primary tree species include Douglas fir, ponderosa pine and western larch. Other species include Engelmann spruce, Pacific silver fir, and western red cedar and quaking aspen in the stream bottoms.

5) Subalpine Fir Zone. Typical trees associated with this zone include subalpine fir, Engelmann spruce, Douglas fir and lodgepole pine. Whitebark pine and subalpine larch occur in the upper reaches. Mountain hemlock and Pacific silver fir are secondary associates. Understory is typically dominated by grouse whortleberry, pine mat manzanita, pinegrass and dryland sedge. Meadow openings have a plant community consisting of green fescue, lupine sedge and subalpine big sagebrush. Elevation is 5,000 to 7,400 feet.

6) Alpine Zone. Tree species are subalpine fir, whitebark pine and subalpine larch. Rarely, lodgepole pine and Engelmann spruce are found at the lower margins. Elevation generally exceeds 7,000 feet.

Riparian vegetation in the Methow Subbasin is dominated by cottonwood, quaking aspen, alder, western red cedar and Rocky Mountain maple. The riparian zone in the upper Methow is fairly wide and relatively undisturbed. The mid to lower reaches have experienced extensive livestock grazing and agricultural development. The low precipitation and variable climate have evolved a plant community susceptible to development and overuse. Livestock grazing in the mid to lower stream reaches has greatly reduced understory vegetation along the stream channel. This vegetative cover is important for juvenile fish, bank stability and erosion control. Agricultural developments and diversions also have modified the riparian zone by chemical and mechanical vegetation removal.

Riparian areas in the Okanogan are narrow due to extensive agricultural development. Reclamation of wetlands, vegetation removal for crop production and weed control, and poor grazing practices have eliminated bank vegetation in some areas. The result has been accelerated erosion, with most river reaches possessing vertical cutbanks. Additionally, reduction in bank vegetation has increased solar heating of the stream.

Fisheries Resources

The Okanogan-Similkameen Subbasin contains summer steelhead, summer chinook, and sockeye salmon along with resident game fish. Spring chinook were once present, but are now extinct. The Methow Subbasin contains summer steelhead, spring chinook and summer chinook along with resident game fish.

All natural fish in the subbasins are presently depressed due to overharvest, Columbia River dam related mortality, and subbasin habitat degradation and water diversions. A substantial fishery currently exists for summer steelhead in the Methow

Subbasin. Recreational fisheries for spring or summer chinook are not allowed within the mid to upper Columbia River or tributaries therein, although a Colville tribal fishery exists at the base of Chief Joseph Dam.

Prior to the 1941 completion of Grand Coulee Dam, anadromous salmonids destined for the upper Columbia were intercepted at Rock Island Dam (1939-1941) and transplanted into the Wenatchee, Entiat, Methow and Okanogan rivers. This probably reduced the genetic identity of individual stocks.

The Wells Salmon and Steelhead Hatchery facility is located immediately downstream of both subbasins at the Douglas County Public Utility District's Wells Dam on the right bank of the Columbia River. Douglas County PUD constructed the hatchery in 1967 to rear summer steelhead, and for planting steelhead into the Okanogan and Methow subbasins, and summer chinook in the Methow River. In addition, Winthrop Hatchery on the Methow River rears spring chinook for the Methow River.

A Wells Dam settlement agreement is being implemented in four phases involving spring and summer chinook, summer steelhead and sockeye salmon. Details of the agreement are discussed in Part IV.

Water Resources

Most subbasin water originates from the winter snowpack; stream levels are characterized by low summer, fall and winter flows with peak flows in spring (Table 1). Many small streams dry up in August and September. During extended dry summers, portions of the upper Methow and its tributaries have no surface flow. Approximately 50 percent to 70 percent of the annual flow occurs in May and June, although summer thundershowers or winter rain-on-snow events can create short-term peak flows.

The Methow and Okanogan basins exhibit diverse water qualities (Tables 2-6). The Methow, with its heavily forested headwaters, steep gradient and limited streamside developments, has relatively pure water although cold temperatures in the upper tributaries limit fish growth.

Table 1. Mean monthly discharges (cfs) for the Methow/Okanogan subbasins (USGS 1984).

Month	Discharge	Month	Discharge
Methow Subbasin at Pateros, Washington. (1959 - 1979) (Station # 12449950)			
Jan	416.6	Jul	2268.0
Feb	428.9	Aug	729.3
Mar	558.6	Sep	491.1
Apr	1366.1	Oct	530.7
May	4872.5	Nov	527.6
Jun	6611.7	Dec	485.7
Okanogan Subbasin at Oroville, Washington. (1943 - 1979) (Station # 12439500)			
Jan	511.6	Jul	699.7
Feb	571.1	Aug	539.9
Mar	610.5	Sep	529.5
Apr	736.2	Oct	554.1
May	1086.7	Nov	535.9
Jun	1080.3	Dec	520.3
Similkameen Subbasin at Nighthawk, Washington. (1929 -1979) (Station # 12442500)			
Jan	603.6	Jul	3038.6
Feb	661.4	Aug	920.6
Mar	685.0	Sep	616.3
Apr	1929.9	Oct	725.6
May	8027.8	Nov	883.6
Jun	9169.0	Dec	746.6
Okanogan Subbasin at Mallot, Washington. (1966 -1979) (Station # 12447200)			
Jan	1113.4	Jul	4149.5
Feb	1363.1	Aug	1427.0
Mar	1555.8	Sep	1045.2
Apr	2239.5	Oct	1152.5
May	8367.4	Nov	1307.1
Jun	11496.3	Dec	1168.3

Table 2. Physical and chemical characteristics of the Methow at Twisp, 1970-1980, Station 12449510 (STORRETT, EPA, R-10, Seattle, Wash.).

Parameter	Mean
pH	7.70
Temp (F)	43.14
Dissolved Oxygen (mg/l)	11.84
Specific Cond. (micromho)	124.59
Turbidity (NTU)	2.78
Ammonia T NH3-N (mg/l)	0.04
Nitrite T NO2-N (mg/l)	0.01
Nitrate T NO3-N (mg/l)	0.11
Total Phosphorus (mg/l) P	0.02

Table 3. Physical and chemical characteristics of the Methow at Pateros, 1970-1982, Station 12449954 (STORRETT, EPA, R-10, Seattle, Wash.).

Parameter	Mean
pH	7.87
Temp (F)	47.21
Dissolved Oxygen (mg/l)	12.03
Specific Cond. (micromho)	149.24
Turbidity (NTU)	5.14
Ammonia T NH3-N (mg/l)	0.04
Nitrite T NO2-N (mg/l)	0.01
Nitrate T NO3-N (mg/l)	0.19
Total Phosphorus (mg/l) P	0.02

Table 4. Physical and chemical characteristics of the Okanogan at Oroville, 1960-1978, Station 12439150 (STORRETT, EPA, R-10, Seattle, Wash.).

Parameter	Mean
pH	8.09
Temp (F)	52.10
Dissolved Oxygen (mg/l)	11.69
Specific Cond. (micromho)	267.81
Turbidity (NTU)	2.07
Ammonia T NH3-N (mg/l)	0.05
Nitrate T NO3-N (mg/l)	0.28
Total Phosphorus (mg/l) P	0.02

Table 5. Physical and chemical characteristics of the Similkameen at Oroville, 1960-1978, Station 12443600 (STORRETT, EPA, R-10, Seattle, Wash.).

Parameter	Mean
pH	7.78
Temp (F)	48.79
Dissolved Oxygen (mg/l)	12.09
Specific Cond. (micromho)	160.87
Turbidity (NTU)	6.11
Ammonia T NH3-N (mg/l)	0.05
Nitrate T NO3-N (mg/l)	0.03
Total Phosphorus (mg/l) P	0.02

Table 6. Physical and chemical characteristics of the Okanogan at Malott, 1966-1977, Station 12447200 (STORRETT, EPA, R-10, Seattle, Wash.).

Parameter	Mean
pH	7.83
Temp (F)	49.87
Dissolved Oxygen (mg/l)	11.24
Specific Cond. (micromho)	221.49
Turbidity (NTU)	9.82
Ammonia T NH3-N (mg/l)	0.07
Nitrite T NO2-N (mg/l)	0.01
Nitrate T NO3-N (mg/l)	0.22
Total Phosphorus (mg/l) P	0.04

Water quality in the Okanogan is influenced by the basin geomorphology and extensive agricultural development. Significant amounts of silt enter the Okanogan, much of it from agricultural practices. Scouring and sloughing of stream channels add to downstream sediment problems. Sediment has greatly reduced the quality of spawning and rearing habitat throughout the basin. Thermal pollution resulting from tributary irrigation return flows, overappropriated streamflows and physical characteristics of the river create a thermal barrier to migrating fish in late summer and early fall. High water temperatures also limit rearing habitat available for juvenile salmonids.

Spawning gravel quantity and quality in the Okanogan and Similkameen basins have been compromised by sand and sediments originating in the upper Similkameen, and from systemwide range practices and agricultural sources. Substrate of the Ellisford to Riverside reach is sand and silt. Substrates in the lower reaches of the Okanogan are essentially unusable, but mainstem conditions improve somewhat upstream of Omak-Okanogan. Substrates between the head of Lake Osoyoos to Oliver, British Columbia, are fair to poor as the result of flood control measures. The Oliver to Vaseaux Dam reaches generally have good spawning gravels. The spawning substrate in the 8.8 miles of the Similkameen below Enloe Dam is reduced by sand and silt originating in the upper Similkameen River.

Upstream migration barriers, natural and man-made, occur in the Methow, preventing fish from ascending some stream reaches. Beaver dams are common in the lower reaches of several tributaries and some are passage barriers. Additionally, several miles of the upper Methow and tributaries are dewatered during drought periods. Upstream passage difficulty occurs at some irrigation diversions during low flows (K. Williams, WDW, pers. commun.). The high gradient, boulder zones of many Methow tributaries are exploited by steelhead, with spring and summer chinook utilizing the mid to upper mainstem and tributaries, and lower mainstem, respectively.

The Okanogan and Similkameen rivers each have upstream passage problems unique to their respective systems. The lower Okanogan River has the aforementioned thermal barrier that delays summer chinook and sockeye migration. A diversion dam located about eight miles above Oliver, British Columbia, is presently the upper terminus to migratory fish. Historically, sockeye and possibly other species spawned above Lake Okanogan. The Similkameen River is currently impassable at Enloe Dam, an abandoned power generation facility located 8.8 miles above the confluence with the Okanogan River. It is unclear whether anadromous salmonids historically negotiated Enloe Falls, directly below the dam.

Water in the subbasins has been used for hydroelectric power generation, municipal purposes and irrigated agriculture. Irrigated agriculture is the primary consumer of water. With dam construction on the Columbia River, the small hydroelectric projects on the Methow and Okanogan rivers were abandoned. In recent years, there has been activity toward relicensing the abandoned Enloe Dam project by Okanogan Public Utility District and licensing of a project utilizing the Twisp River canal of the Methow Valley Irrigation District. Most other hydroelectric projects utilize small tributary streams in remote locations.

The Northwest Power Planning Council has identified fish passage at Enloe Dam as an enhancement project in its Columbia River Basin Fish and Wildlife Program. To date, the council has completed a reconnaissance inventory of potential fish passage alternatives at the dam. Passage at Enloe Dam would almost double anadromous salmonid habitat, excluding sockeye salmon, above Wells Dam.

The amount of irrigated land has increased in the subbasins, but the amount of water used has not increased proportionately. Canals, ditches and surface irrigation systems have given way to closed-pipe conveyance of water with sprinkler application (B. Barwin, Washington Department of Ecology, pers. commun.). Due to maintenance costs and the increased availability of electric power, many ditch systems have been replaced with pumps drawing directly from rivers or adjacent wells. Municipal water supplies in the Methow and Okanogan basins are derived exclusively from groundwater sources. These wells draw water from aquifers often in hydraulic continuity with the rivers.

A number of streams in the subbasins have been adjudicated by the 1917 Surface Water Code process. In the Methow Basin, Beaver, Black Canyon, Gold, Libby and McFarland creeks have been adjudicated. In the Okanogan Basin, Bonaparte, Chiliwist and Salmon creeks, and the Similkameen River have been adjudicated. In 1976, the Washington Department of Ecology adopted WAC 173-548 for the Methow River and WAC 173-549 for the Okanogan River. These two regulations (known as the Methow River and Okanogan River Basin Plans) established minimum instream flows for the mainstem and major tributaries of each river to provide base flows necessary for fish and other values. Additionally, many smaller tributary streams were closed to further consumptive appropriations.

Land Use

In the Methow Subbasin, forestry is the principal land use (Table 7). The U.S. Forest Service is the largest forest land owner with 94 percent (Table 8). Approximately 340,000 acres of Forest Service subbasin land is in either the Sawtooth Wilderness or Pasayten Wilderness. The remaining acreage is mostly private with small parcels of state forest land. Livestock grazing is the second largest land use. Agriculture uses 22,000 acres of which approximately 64 percent is irrigated. Municipalities in the subbasin include Pateros, Twisp and Winthrop.

Okanogan-Similkameen Subbasin land use is about equally dominated by forest and rangelands. The largest landowners in the Okanogan Basin are the Colville Indian Tribe and the U.S. Forest Service of which approximately 210,000 acres are in the Pasayten Wilderness. Agricultural cropland uses 89,000 acres with about 36 percent irrigated. Principal municipalities in the Okanogan Subbasin include, Omak-Okanogan, Tonasket and Oroville. Growth in both subbasin municipalities has been slow.

Table 7. Land ownership in the Methow and Okanogan basins (PNWRBC 1977a, 1977b).

Administering Agencies	Methow Basin (acres)	Okanogan Basin (acres)
FEDERAL		
Forest Service	1,138,800	450,000
BLM	9,900	47,400
USFWS	3,100	2,800
BOR	-	800
Defense Dept.	-	1,000
PUBLIC		
State	34,700	214,100
County	300	300
Municipal	100	2,900
PRIVATE		
Tribal	-	412,200
Private	209,900	239,000
LARGE WATER AREAS	3,000	20,000
BASIN TOTALS	1,399,800	1,500,200

Table 8. Cover and land use in the Methow and Okanogan basins (PNWRBC 1977a, 1977b).

Use	Methow Basin (Acres)	Okanogan Basin (Acres)
Cropland	22,000	89,000
Rangeland	134,000	689,000
Forest Land	1,208,000	648,000
Other Land	32,800 1/	74,200 1/
BASIN TOTALS	1,396,800	1,500,200

1/ Includes small amounts of urban areas and large water bodies.

PART II. HABITAT PROTECTION NEEDS

History and Status of Habitat

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

Fishery managers can influence fish habitat through management of the water and management of the physical habitat including the riparian edge. Water flow management and water withdrawals in the subbasins and management of the physical habitat are of primary importance.

Physical modification of aquatic habitat is controlled by state and federal statutes. Regulations overlap and are designed to limit impacts to public stream and shoreline resources. Laws addressing developments that could degrade stream and shoreline resources follow.

Federal

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

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

State (Washington)

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

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

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

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

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

6. Minimum Flow Program, Department of Ecology.

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

8. Flood Control Statutes, local government.

9. Forest Practices Act, Department of Natural Resources.

On the Colville Indian Reservation, the Colville Tribes have sovereign jurisdiction over resource management, which includes; 1) Colville Forest Practices Water Quality Act of 1985; 2) Colville Water Code of 1974; 3) Colville Water Quality Standards Act of 1984; 4) Colville On-Site Wastewater Treatment and Disposal Act and 5) the Colville Mining Practices Water Quality Act.

Constraints and Opportunities for Protection

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

In some cases, important factors affecting the quantity and quality of stream habitat are outside the direct regulatory authority of the fisheries management agencies. Interagency cooperation is important to address this difficult management situation. Good interagency communication of goals and objectives within watersheds and cooperative administration and enforcement could improve habitat protection.

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

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

Federal

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

Canada

B.C. Ministry of Environment
Department of Lands, Forests and Water Resources

State

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

Tribal

Colville Indian Nation
Yakima Indian Nation (YIN)

Local

Okanogan County
Okanogan PUD
Douglas County
Douglas PUD

Currently, the U.S. Forest Service is developing a forest plan to identify future management options and direction. Fish resource needs and water quality will be addressed. The Okanogan National Forest will be looking to the Columbia River System Planning process to help set direction for management of anadromous fish habitat.

The Okanogan National Forest currently applies a "Best Management Practices" approach to silvicultural activities. Best Management Practices (BMPs) are defined as, "a practice or combination of practices, that is determined by a State (or designated area-wide planning agency) after problem assessment, examination of alternative practices, and appropriate public participation to be the most effective, practicable (including technological, economic and institutional considerations) means of preventing or reducing the amount of pollution generated by non-point sources to a level compatible with water quality goals." National forests are not regulated by the state Forest Practices Rules and Regulations as long as they can demonstrate that U.S. Forest Service silvicultural practices (BMPs) are equal to or exceed the state's. The U.S. Forest Service conducts an environmental analysis for timber sales and other resource developments on lands it administers. During this process, the U.S. Forest Service involves other agencies, groups and tribes in issue development and will often consult with them during the process.

The Colville Forest Practices Water Quality Act [Tribal Resolution No. 1985-20 (January 18, 1985)] regulates the forest practices within the boundaries of the Colville Indian Reservation. Tribal policy dictates that forestlands be managed on sound policies protecting natural resources and the tribal population, and will be compatible with practices protecting soils, water quality, fish and wildlife, recreational opportunities and aesthetics. The current Forest Practices Water Quality Act is a "Best Management Practices" approach.

Habitat Protection Objectives and Strategies

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

1) No net loss of existing habitat.

2) No degradation of water quality.

3) No decrease of surface water quantity.

4) Increased security for existing habitat.

5) Increased salmonid use of underutilized habitat.

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

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

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

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

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

2) Purchasing riparian property adjacent to critical habitat.

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

4) Publishing additional inventories of important habitat for specific stocks.

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

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

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

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

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

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

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

PART III. CONSTRAINTS AND OPPORTUNITIES FOR ESTABLISHING PRODUCTION OBJECTIVES

Systemwide Considerations

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

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

As an extension of these objectives, subbasin plans should:

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

2) Work toward harvest stability within subbasins.

3) Provide equitable opportunity to each user group.

4) Maintain habitat and improve where possible.

5) Manage for the consistent escapement of escapement allowances.

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

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

The Pacific Salmon Treaty, negotiated in 1985, has a large influence on ocean harvest. The major principles of the treaty attempt to 1) prevent overfishing and provide for optimum production, and 2) provide for each party to receive benefits equivalent to the production of salmon originating in its waters.

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

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

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

3) Annual variation in abundance of the stocks.

Local Considerations

Nine Columbia River dams and associated smolt and adult mortalities impact production from the subbasins. Overharvest of subbasin natural fish frequently occurs due to downstream mixed-stock fisheries, resulting in underseeded subbasin habitat.

Rangeland in the Methow and Okanogan subbasins is seasonally overgrazed in proximity of many mainstem and tributary reaches (PNWRBC 1977). Only about 30 percent of the subbasin rangeland has adequate conservation treatment, with about 60 percent having erosion control problems (PNWRBC 1977). Almost half of this land needs improved range management practices to properly protect from loss of streamside cover, bank trampling and accelerated bank erosion. Fish are impacted through reduced stream shading, increased siltation, reduced instream cover, and higher water temperatures.

Limited residential and commercial developments are present in the Methow Basin and United States portions of the Okanogan Basin, however, extensive recreational developments have been made in Lake Osoyoos. Impacts on the juvenile sockeye in Lake Osoyoos or the Okanogan River is unknown. However, shoreline development has degraded the lacustrine habitat from sewage effluent, vegetation manipulation, and pesticide use.

The proposed Early Winters Recreation Area development in the upper Methow has raised concerns over additional recreational and residential growth. Additional growth may be concentrated near streams and could reduce the quality of spawning and rearing habitat. Intermittent flows are common from natural phenomenon and may be exacerbated with future development.

Numerous irrigation diversion dams are found throughout the Methow and Okanogan subbasins. Most of these are passable to adult fish at usual flows, however, entrainment of juvenile fish occurs due to substandard screening at some sites.

Habitat management policies in the Canadian portion of the Okanogan Subbasin can affect the U.S. Okanogan Subbasin. Also, policies in the United States immediately below the border (such as Lake Osoyoos levels) could effect Canadian lands. When considering flooding, irrigation, fisheries enhancement and other problems in the Okanogan Subbasin, Canadian interests must be involved in the decision-making process. An International Joint Commission was set up by Canada and the United States to equitably allocate international water right claims and resolve disputes in river basins held in common. In 1980, the Washington Department of Ecology and the British Columbia Ministry of Environment and Parks developed the Cooperation Plan for Osoyoos Lake Levels and Trans-Border Flows for operation of Zosel Dam at the outlet of Lake Osoyoos. Trans-border minimum flows for drought years were established for the lower Okanogan River that range from 340 cfs in August to 300 cfs in October. Provisions for a second or subsequent drought year might necessitate reducing trans-border flows to as low as 100 cfs. In 1987, Washington departments of Ecology, Wildlife, and Fisheries, and the Colville Tribes entered into a memorandum of understanding regarding the operation of the Zosel Dam Osoyoos Lake level control structure, and identified important fishery considerations.

Due to chronic water shortages in the Okanogan Basin, additional storage facilities have been proposed. Currently, a dam on Palmer Lake in the Similkameen Basin is being considered to increase late season irrigation flows. Another considered site would require enlargement of Enloe Dam.

The Methow River and its major tributary, the Chewack, are included in the "nationwide inventory of wild and scenic rivers" (USDI 1982). Additionally, the Methow, Chewack, and Twisp rivers are considered "rivers of statewide significance". Under this classification, the state is to study these rivers for possible inclusion in the Washington Scenic River System (Washington State 1979). Portions of the Pasayten River, Lost River, Wolf, Canyon, Granite and Ruby creeks are eligible for inclusion in the national Wild and Scenic Rivers System.

The Northwest Power Planning Council's "protected areas" program (via the Columbia River Basin Fish and Wildlife Program and the Northwest Conservation and Electric Power Plan) recommends portions of the Methow and Okanogan subbasins be "protected" from further hydroelectric development.

With the Yakima Indian Treaty (1855) and the subsequent Executive Order of July 2, 1872, most original native Americans who inhabited Chelan, Kittitas, Yakima, Okanogan, and Douglas counties were resettled onto the Yakima and Colville reservations. As guaranteed by the Yakima Treaty of 1855, the Yakima Nation reserved the right to continue to hunt and fish outside of the established reservation without interference from states or federal government, absent express acts of Congress. The area of the Columbia River north from Priest Rapids Dam to Canada, including the tributaries, is part of the original territory of numerous Indian tribes and was used extensively for tribal hunting and fishing. There is a dispute between existing Indian nations as to the nature and extent of rights within the subbasins.

Among tribes who signed the Treaty at Walla and reserved rights to fish off reservation were the Yakima, Chelan, Wenatchee, Entiat and Columbia tribes. The Confederated Tribes and Bands of the Yakima Indian Nation and its members, as the legal successors in interest to those tribes, reserved those rights for itself and its members. As a result of the treaty, tribes retain substantial governmental authority over activities that affect hunting and fishing. Thus, treaty tribes have a right to co-manage and participate equally in fish management decisions affecting the Columbia River and its tributaries. Such co-management responsibilities include harvest management, habitat development or modification, fish culture and enhancement projects, as well as habitat utilization and restoration.

The Confederated Tribes of the Colville Reservation (Colville Tribes) is a confederation of 11 aboriginal tribes and bands. Six tribes (Wenatchi, Entiat, Chelan, Columbia, Palus, and Chief Joseph Band of Nez Perce) signed treaties in 1855 with the United States that contained language which reserved the right to continue to fish off reservation. As the successor government, the Colville Tribes sought to intervene in <u>United States vs. Oregon</u> for the purpose of allowing the Colville Tribes to assert the treaty-reserved rights of its six treaty-signing constituent tribes. The Colville Tribes are now recognized as an intervenor in the case; however, the treaty fishing rights issue will be determined in future proceedings.

The Wenatchi, Entiat, Chelan, and Columbia tribes were provided a separate executive order reservation that was originally adjacent and west of the Colville reservation. This reservation, known as the Columbia Reserve, was bordered by the Okanogan and Columbia rivers on the east, and the Cascade crest on the west. It ran from the Canadian border down to and including Lake Chelan. The Columbia Reserve was extinguished and the four tribes were removed to the Colville Reservation. The other tribes of the confederation, not party to any treaty, were residents of the original Colville Reservation. The original boundaries of the reservation extended up to the Canadian border. When the northern half of the reservation was released, fishing and hunting rights were retained by all tribes and bands of the confederation. The Columbia River and Okanogan River are boundary waters of the reservation, and as such, a limited on-reservation fishery for salmon and steelhead exists (Chief Joseph Dam Tailrace Fishery).

PART IV. ANADROMOUS FISH PRODUCTION PLANS

METHOW SUMMER STEELHEAD

Fisheries Resource

Natural Production

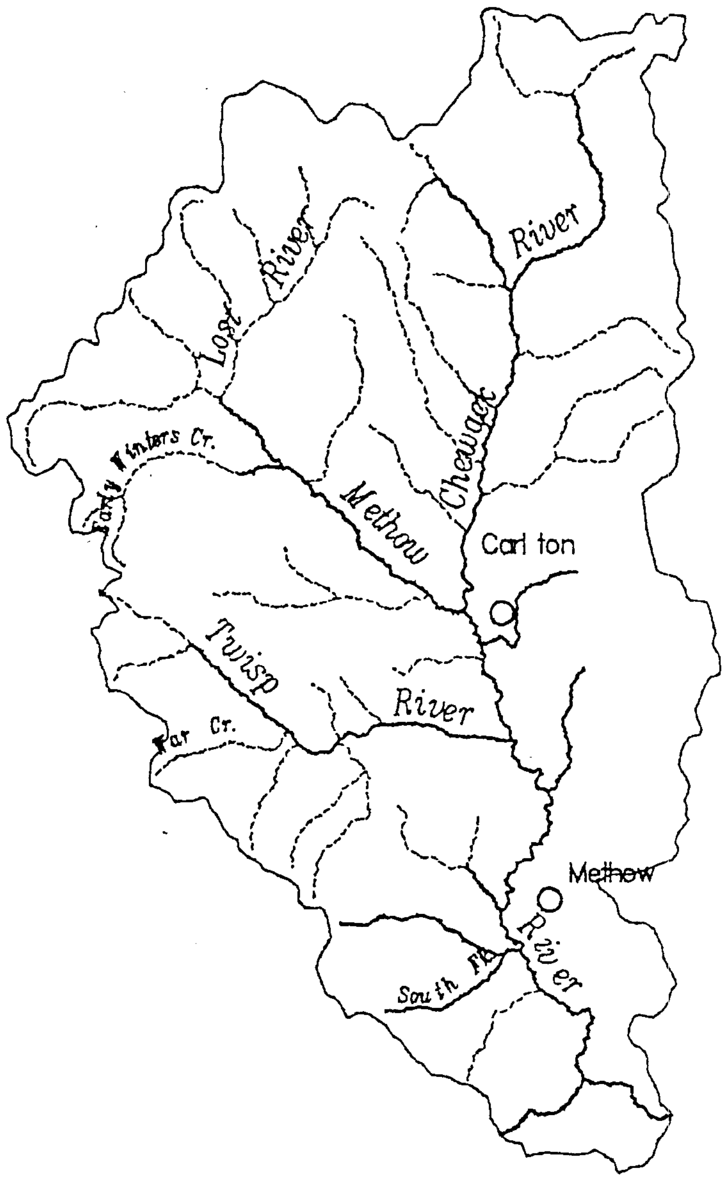
History and Status

Methow steelhead production has declined dramatically from historic levels. Mainstem Columbia dams, intensive commercial fishing and subbasin stream developments are probably responsible for the decline. In 1912, a hydro-irrigation dam was constructed across the Methow River at Pateros. Although removed in the 1930s, a coho run was destroyed and steelhead and chinook were impacted (Mullan 1983). Between 1939 and 1943, as part of the Grand Coulee Fish Maintenance Project, upper Columbia River steelhead were trapped at Rock Island Dam and released into the Methow, Entiat and Wenatchee rivers. Thus, Methow steelhead were mixed with other upper Columbia River stocks. Historical counts at Rock Island Dam, representing the Methow, Okanogan, Wenatchee, and Entiat rivers and the upper Columbia, averaged 2,780 fish for the 1930s, 2,605 fish for the 1940s, and 3,722 fish for the 1950s. Presently, only about 200 natural fish return to the Methow. Historically, steelhead were probably distributed throughout the subbasin, as they are now.

Life History and Population Characteristics

Due to lack of data on natural steelhead within the Methow Subbasin, population characteristics were derived from Wells Hatchery steelhead. Generally, Methow steelhead enter the lower Columbia between May and September with fish arriving at Wells Pool in early July. Fish enter the Methow in mid-July and peak between mid-September and October. During winter, fish generally return to the warmer Columbia River and re-enter the Methow to begin spawning in mid-March after ice-out. Spawning continues through May and many fish seek out the higher reaches (K. Williams, WDW, pers. commun.). Fry emergence occurs that summer and juveniles rear for two to four years prior to spring ocean emigration. Upper elevation reaches produce older smolts (Table 7); one fish was estimated at 7 years freshwater age (Williams 1988).

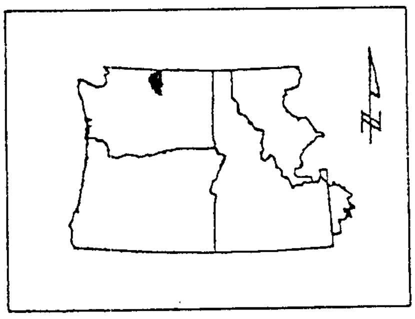
METHOW SUBBASIN



SUMMER STEELHEAD DISTRIBUTION*

———— PRESENT/POTENTIAL

- - - - - ABSENT



GIS GEOGRAPHIC INFORMATION SYSTEM

BONNEVILLE POWER ADMINISTRATION

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

Returning adults averaged 40.7 percent 1-salt and 58.1 percent 2-salt fish (Table 8). Sex ratios (female-to-male) for 1-salt and 2-salt fish were 1-to-0.66 and 1-to-0.22, respectively (Table 9). For adults (natural and hatchery) at Wells for 1983 through 1987, 1-salt fish averaged 24.1 inches and 5.7 pounds, and 2-salt fish averaged 29.1 inches and 10.2 pounds (Table 10). Average fecundity of 23.9-inch 1-salt and 28.6-inch 2-salt females was 5,082 and 6,368 eggs per female, respectively.

Based on the 1982 through 1986 Wells brood stock analysis where natural fish comprised 2.76 percent of the total (Williams 1988), estimated subbasin return averaged 201 natural fish for 1977 through 1986 (Table 11). Spawning escapement was estimated at 93 fish.

Egg-to-smolt and smolt-to-adult survival is not known for Methow natural steelhead.

The Northwest Power Planning Council's habitat carrying capacity model estimated that 169,610 smolts could be produced in the Methow Subbasin.

Table 7. Steelhead smolt age by subbasin area.

Area	Smolt Age
Mainstem Methow River to Early Winters Creek.	2
Lower mainstem of Twisp and Chewach rivers.	2
Methow River from Early Winters Creek to Lost River.	2-3
Lower Lost River.	2-3
Middle Chewach and Twisp rivers.	2-3
Small Tributaries and headwater streams	3-7

Table 8. Adult age structure of Wells Dam summer steelhead (includes freshwater ages) (Williams 1988).

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

Table 9. Sex ratio (F:M) of Wells Dam summer steelhead (Williams 1988).

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

Table 10. Length and weight and sex of Wells steelhead (Williams 1988).

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

Table 11. Run size of natural Methow summer steelhead. Natural production estimates are not available prior to 1982; 1977-1981 estimates are based on 1982-1986 average (0.0276).

Year	Total Return	Sport Catch	Tribal Catch	Escapement
1977	127	50	No Data	77
1978	36	18	" "	18
1979	48	32	" "	16
1980	49	41	1	7
1981	83	46	3	34
1982	482	226	10	246
1983	111	59	1	51
1984	396	210	4	182
1985	449	237	16	196
1986	227	109	14	104
AVE	201	103	5	93

Supplementation History

For 1981 through 1987, an average of 370,664 steelhead smolts were planted in the subbasin (Table 12). Prior to 1981, collection for upper Columbia River brood stock occurred primarily at Priest Rapids Dam. Currently, Wells Dam brood stock is used. Hatchery production provides a sport fishery and supplements natural fish when underescaped. Smolt release timing depends on Columbia River spill, which normally begins about April 20. Outplanting is generally concluded by mid-May. Smolt-to-adult survival rates for 1965 through 1979 and 1980 through 1987 averaged 1.20 percent and 3.90 percent, respectively. Currently, increased hatchery plants are not desired or anticipated.

Table 12. Releases of hatchery steelhead in the Methow Subbasin.

Release Year	Hatchery & Stock	Smolts Released	Release Location	Adult Brood Collection Site
1977	Wells	147,922	Methow	Priest Rapids
1978	Wells	79,589	Methow	Priest Rapids
1979	Wells	203,368	Methow	Priest Rapids
1980	Wells	179,544	Methow	Wells
1981	Wells	358,234	Methow	Wells
1982	Wells	324,418	Methow	Wells
		15,002	Twisp	Wells
		15,016	Chewuch	Wells
1983	Wells	348,703	Methow	Wells
		16,988	Twisp	Wells
		16,368	Chewuch	Wells
1984	Wells	356,134	Methow	Wells
		14,336	Twisp	Wells
		19,995	Chewuch	Wells
1985	Wells	326,687	Methow	Wells
1986	Wells	360,648	Methow	Wells
		21,300	Twisp	Wells
		19,912	Chewuch	Wells
1987	Wells	336,605	Methow	Wells
		28,210	Twisp	Wells
		16,090	Chewuch	Wells
	1981-1987 AVE	370,664		

Fish Production Constraints

The greatest steelhead production limitations in the subbasin is inadequate natural fish escapement resulting from overharvest in downstream fisheries and dam related mortality of smolts and adults. In-subbasin production constraints (Table 13) are secondary. Slow growth rates of juveniles within the subbasin and losses of juvenile fish resulting from winter icing conditions, spring runoff flooding, and lack of instream winter cover may limit production (K. Williams, WDW, pers. commun.). Juvenile and smolt losses occur at some unscreened irrigation diversions.

Table 13. Major habitat constraints in the Methow Subbasin.

Location	Species Present	Low Flow	Migration Barriers	Other Constraints
Methow R. (Lower)	Sp. Chinook	No	N/A	System Prod. Cover
	Sum. Chinook	-	-	System Prod.
	Steelhead	-	-	System Prod. Winter Cover
Methow R. (Lower tribs.)	Steelhead	Yes	Beaver Dams Steep Gradients	System Prod. Winter Cover Cold Water Temp
Methow R. (Upper)	Sp. Chinook	Yes	Intermittent Flow	System Prod. Cover
	Sum. Chinook	-	-	System Prod.
	Steelhead	-	- Steep Gradients	System Prod. Winter Cover Cold Water Temp
Twisp R.	Sp. Chinook	Yes	Intermittent Flow	System Prod. Cover
	Steelhead	-	- Steep Gradients	System Prod. Winter Cover Cold Water Temp
Chewack R.	Sp. Chinook	Yes	Intermittent Flow	System Prod. Cover
	Steelhead	-	-	System Prod. Winter Cover Cold Water Temp
Lost R.	Sp. Chinook	Yes	Intermittent Flow	System Prod. Cover
	Steelhead	-	- Steep Gradients	System Prod. Winter Cover Cold Water Temp

Hatchery Production

Description of Hatcheries

The Wells Salmon and Steelhead Hatchery is located immediately downstream of the Douglas County Public Utility District's Wells Dam on the right bank of the Columbia at RM 516. Wells County PUD constructed the hatchery in 1967. The PUD maintains the facility while the departments of Wildlife and Fisheries operate it. Columbia River water supplies the hatchery by a gravity flow syphon from Wells Dam (Wells Pool). The syphon capacity is estimated at 100 cfs to 130 cfs (M. Erho, Douglas PUD, pers. commun.). Columbia River water temperature ranges from 36 F in winter to 65 F in late summer. Columbia River water has ichthyophthirius, columinaris and furunculosis and could be a vector for infectious pancreatic necrosis (IPN) and IHN virus; IPN virus has been detected in Wells brood stock. Groundwater sources (25 cfs) have also been developed to alleviate potential disease problems associated with Columbia River water.

The hatchery shares 96 stacks of Heath incubators, 40 15'x 1' troughs and 10 10'x 100' raceways with the Washington Department of Fisheries and has four approximately 1.5-acre rearing ponds. Flows in the ponds are about 3 cfs each well water in summer (three ponds operated) and 6.5 cfs after November. Final rearing occurs in the ponds.

Wells Hatchery currently raises summer steelhead and chinook salmon. The hatchery plants about 550,000 (100,000 pounds) summer steelhead smolts into the Methow and Okanogan subbasins annually. Additionally, the hatchery produces 56,000 pounds of summer chinook (Table 14). The hatchery is near production limits and is restricted by available summer well water. Potential facility improvements include equipment and larger seasonal staff to improve outplanting efficiency.

Brood stock is collected at Wells Dam from August through November and most fish are captured in September. Wells stock adults migrate over Bonneville Dam from May through September, pass Priest Rapids Dam from early June through mid-October, and first arrive at Wells Dam in mid-July. Adults are collected at random in a fish trap on the right bank fishway and include natural and hatchery fish. Approximately 650 fish are required for brood stock.

Table 14. Wells Hatchery mitigation program.

Species	Production Goal *	Location Planted	Agreement
Summer Steelhead	50,000 lbs.@ 6/lb.	Methow/Okanogan	Program Adjusted, Original Agreement (1972).
	25,000 lbs. @ 6/lb.	" "	FERC Interim Fisheries Settlement (1980).
	30,000 lbs. @ 6/lb.	" "	USBR Mitigation Program Ends 1991 Smolt Release.
Summer Chinook	24,500 lbs.@ 10/lb.	Columbia R. Wells Dam	Program Adjusted, Original Agreement (1969).
	32,000 lbs. @ 40/lb.	"	" "
	4,444 lbs. @ 90/lb.	Methow	1984 Stipulation FERC Interim Fisheries Settlement.

Life History and Population Characteristics

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

Spawning begins in early January, peaks by early February, and is completed by early March. Generally, natural fish ripen later than hatchery fish. Egg-to-smolt survival is somewhat variable, but about 85 percent to 90 percent (S. Roberts, WDW, pers. commun.). Smolts are planted about 14 months later. Williams (1988) determined that 9.9 percent of hatchery smolts residualized at least one year in fresh water following their release.

Hatchery returns for 1977 through 1986 averaged 8,164 fish with a large increase after 1983 (Table 15). The reason for the increase includes increased smolt numbers, water spills over

Columbia River dams in spring, smolt transportation below McNary Dam, high natural flows and high ocean survival.

Spawning escapement was estimated at 4,051 fish for the same years. For hatchery fish spawning naturally in the lower mainstem, hatchery fish often precede natural fish in spawning (March 1 to May 15 versus March 15 to May 31). Higher elevation mainstem and tributary spawning begins a few weeks later with the hatchery fish again spawning earlier (March 15 to May 31) than natural fish (April 1 to May 31).

Table 15. Methow steelhead hatchery run size.

Year	Total Return/1	Sport Catch	Tribal Catch	Escapement
1977	4,960	1,724	No Data	3,236
1978	1,306	618	" "	688
1979	3,336	1,138	" "	2,198
1980	2,802	1,460	19	1,323
1981	3,756	1,628	126	2,002
1982	5,419	1,575	111	3,773
1983	19,372	10,454	205	8,714
1984	14,703	7,736	136	6,831
1985	15,587	8,136	553	6,898
1986	10,398	4,889	658	4,851
AVE	8,164	3,936	258	4,051

1/ Wells Dam Counts, Douglas County PUD. No natural production estimates are available prior to 1982, therefore, hatchery estimates from 1977-1982 are calculated by the average hatchery composition from 1982-1986 (97.24 percent).

Harvest

Sport effort for steelhead in the mid to upper Columbia River has increased in recent years. Angler trips increased from less than 4,000 prior to 1981 to over 20,000 trips by the mid-80s (Williams 1985). Collectively, the Wells Pool, Methow and Okanogan harvest averaged 5,018 fish from 1977 through 1986 (Table 16) and in 1983 through 1985, was highest in the state.

Within the Methow Subbasin, sport anglers caught an average of 3,936 fish for 1977 through 1986, while tribal harvest was estimated at 258 fish for 1980 through 1986. Combined sport and tribal harvest rate averaged about 55.5 percent on hatchery and natural fish for 1977 through 1986. A Colville tribal fishery exists at the base of Chief Joseph Dam and harvest in 1980 through 1987 averaged 298 fish (Table 17).

Table 16. Steelhead sport harvest, 1967-1986.

Year	Methow	Okanogan	Similkameen	Wells/1 Pool	Total	Run	Rate
1967	212	100	24	21	357	2028	0.18
1968	428	22	0	43	493	2213	0.22
1969	199	0	0	20	219	769	0.28
1970	358	29	7	36	430	1624	0.26
1971	764	70	27	76	937	3899	0.24
1972	588	14	8	59	669	1715	0.39
1973	565	4	14	57	640	1861	0.34
1974	62	2	0	6	70	530	0.13
1975	109	2	0	22	133	505	0.26
1976	1616	8	0	323	1947	4636	0.42
1977	1773	9	0	355	2137	5464	0.39
1978	636	4	0	125	765	1475	0.52
1979	1170	10	0	363	1543	3771	0.41
1980	1501	0	10	495	2006	3363	0.60
1981	1674	3	0	265	2/1942	4110	0.47
1982	1529	6	13	2124	3672	7805	0.47
1983	5824	34	17	4642	10517	19530	0.54
1984	4779	397	339	3578	9093	16663	0.55
1985	4423	1193	746	4972	11334	19712	0.57
1986	2891	1042	354	2887	7174	13252	0.54

1/ Columbia River sport harvest for Wells Pool is based on a five-year average (1979-1983) of Methow River harvest where Columbia harvest is 35.4 percent of above Wells Dam harvest.

2/ Columbia River (Wells Pool) punch-card data was not available until 1981.

Table 17. Colville tribal harvest, Chief Joseph Dam fishery (Colville Confederated Tribes and WDW).

Year	Chinook	Steelhead	Sockeye
1980	396	21	33
1981	272	130	230
1982	302	122	140
1983	391	207	228
1984	309	153	48
1985	480	694	44
1986	967	819	94
1987	540	238	68

Harvest regulations protect juveniles and natural adults. Protection of juveniles is restricted by 1) bait prohibition and a 12-inch minimum size limit; and 2) delayed general stream fishing opening date. Because natural fish have been underescaped, subbasin harvest has been closed via "wild steelhead release" regulations. The river is open from June 1 through March 31 with a two fish limit. Harvest monitoring and enforcement is conducted by Washington Department of Wildlife enforcement agents.

There is no formal agreement between the Colville Tribe and Washington Department of Wildlife regarding the tribal fishery at the base of Chief Joseph Dam. It is assumed that a formal agreement will be forthcoming.

Specific Considerations

The goal of steelhead management in the subbasin is to rebuild the natural run to meet spawning escapement goals. To protect the genetic integrity of natural fish, harvest is targeted on hatchery fish. Natural steelhead are managed for maximum sustainable population and escapement at that level is the minimum acceptable escapement. Spawning escapement requirements have been set with the best available information and is presently 3,200 adults.

The largest natural fish production limitation has been inadequate escapement reaching the subbasin as a result of dam mortalities and adult overharvest downstream of the subbasin. Natural fish destined for the Methow are subjected to non-selective mixed-stock fisheries in the Columbia River. Because large hatchery programs are present that need relatively little escapement, non-selective harvest can overharvest smaller natural populations that need a relatively large amount of escapement. As hatchery programs in other basins expand, the jeopardy of overharvest by non-selective fisheries in the Columbia increases. The natural run is now about 200 fish; unless out-of-basin harvest rates or techniques are altered, this run will be terminated. Selective harvest of hatchery fish at dams would allow natural fish to escape.

The subbasin is located above nine Columbia River dams and smolts and adults are subjected to mortalities at each dam and impoundment. The System Planning Model indicated 6,774 fish would return to spawn in the subbasin under existing conditions if the mainstem dams did not exist. Washington Department of Wildlife policy emphasizes natural fish. The genetic consequences of the current dependency on hatchery fish may be severe. Natural fish spawning escapement for 1977 through 1986 averaged only 93 adults. Subsequent "wild" fish release regulations are expected to increase subbasin spawning escapement of natural fish although returns will probably be inadequate unless downstream conditions are changed.

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

Wells Dam has the capability to monitor natural production of juveniles from the combined Okanogan and Methow rivers through collection facilities at the dam. This would allow carrying capacities to be defined.

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

Critical Data Gaps

Improved information is needed regarding potential carrying capacity to more accurately estimate spawning escapement needs. Egg-to-smolt and smolt-to-adult information is needed. The importance of winter habitat needs to be determined; severe winter mortalities may occur from icing conditions. Also, genetic impacts of hatchery fish on the natural stock needs to be determined. Research is needed to distinguish anadromous steelhead areas from resident rainbow zones.

Objectives

Stock: Methow Natural Summer Steelhead

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

Biological Objective: Maintain genetic integrity and biological characteristics such as run timing, age composition, and length frequency. The biological objective has priority within the subbasin for this stock. This population is managed for maximum sustainable population. Minimum spawning escapement required is 3,200 fish.

Stock: Methow Hatchery Summer Steelhead

Utilization Objective: 10,000 fish for sport and tribal anglers. The utilization objective has priority over the biological objective in the subbasin for this stock.

Biological Objective: Maintain biological characteristics of existing hatchery stock or the natural stock. Because objectives for hatchery steelhead have been met or nearly met in recent years, no strategies for this stock are offered.

Alternative Strategies

Strategies for summer steelhead in this report have specific themes. Means to obtain the objectives are first attempted using natural methods followed by less natural techniques and finally, hatchery production. Actions identified under each strategy are closely related to the theme. Strategies 1 and 2 have natural production themes seeking to improve the productivity of the existing natural stock. Strategy 3 is a "benign" supplementation strategy, emphasizing actions to develop a single supplemented run with yet higher productivity. Hatchery strategies would normally follow, however, because enhancement of the hatchery stock is not desired, no hatchery strategies are addressed. Note that the System Planning Model indicates that planned mainstem improvements will increase subbasin returns by about 60 percent.

Modeling results for each strategy are presented in Table 18 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 18. 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 18a.

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

This strategy provides for prudent stewardship of existing habitat and water quality in the historic distribution range through various existing laws and agreements. Streams in the subbasin need to be inventoried for summer temperature profiles; those exceeding temperature sensitivity criteria should be classified as such through the Department of Natural Resources so future impacts will be minimized. Water withdrawals should be reduced as possible. Riparian zones should be managed to provide a continuous recruitment of large organic debris. Stream typing should be reviewed and streams should be upgraded as needed.

Hypothesis: Existing habitat, if managed properly, should provide near capacity numbers of natural smolts if adequately seeded. Location of diversions on smaller tributaries is unknown and some diversions remain unscreened. Monitoring natural smolt production at Wells Dam would allow much needed information on smolt capacity and spawner-recruit data.

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

Numeric Fish Increases: The System Planning Model indicated an additional 65 fish will return to the subbasin under existing conditions. MSY after mainstem improvements would increase by 9,164 fish.

ACTIONS: 1-3

1. Maintain at least current level of stream habitat quality and quantity. Seek improved water quality via reduction of sedimentation. Seek legislation to eliminate additional or replacement water withdrawals. Inventory and map habitat.

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

3. Operate smolt collection facilities at Wells Dam to estimate natural production from the Okanogan and Methow rivers.

Cost Estimates: Estimated one FTE year to inventory diversion screening needs and inventory and map habitat ($40,000). New screen and refurbishing costs for existing structures (includes implementation and operation and maintenance costs) for the first 25 years is estimated at $536,470 (Standard Cost Estimate). Costs to operate the smolt collection facilities at Wells Dam are estimated to cost $40,000 per year for 10 years.

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

Hypothesis: Increasing streamflows will increase habitat, and improve winter cold water temperatures, thereby increasing smolt capacity. The Department of Ecology's river basin plans provide for minimum flows only and allow fish life at a subsistence level. Proposed recreational development (Early Winters Recreation Area) and associated residential growth are expected to further deplete current flows.

Assumptions: This strategy assumes additional water supplies can be developed through storage. State water law will need to be modified to allow saved or additional water to be dedicated to fisheries enhancement purposes and not other consumptive uses. This strategy assumes egg-to-smolt survival will be increased by a relative 15 percent in addition to Strategy 1.

Numeric Fish Increases: The System Planning Model indicated this strategy would add 77 natural fish to the subbasin under current conditions. MSY after mainstem improvements would increase by 9,178 fish.

ACTIONS: 1-5

1. -
2. -
3. -

4. Inventory potential water storage sites to identify possible sources of supplemental water. Some preliminary inventory work has been conducted in the Methow Basin by the U.S. Geological Survey (Appendix D).

5. Construct multiple upper basin flow augmentation reservoirs.

Cost Estimates: Inventory of potential sites will require a hydraulic engineering consulting firm and cost about $200,000. Cost of reservoirs will depend on the sites selected, but is here estimated at $50 million with O&M at $250,000 per year.

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

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

Assumptions: This strategy assumes the natural stock can be increased enough to allow removal of 650 fish for brood stock purposes. Action 6 assumes relative smolt survival of hatchery fish will increase from 0.67 to 0.71 and viability of naturally spawning hatchery-hatchery and hatchery-natural crosses will increase by a relative 10 percent.

Numeric Fish Increases: The System Planning Model indicated this strategy would add 846 fish to the subbasin under current conditions. MSY after mainstem improvements would increase by 10,351 fish.

ACTIONS: 1, 2, 3, 6

1. -
2. -
3. -

6. Utilize captured natural brood stock for existing hatchery programs.

Costs: Capital costs of Action 6 are estimated at $20,000 with O&M at $10,000 per year.

Recommended Strategy

The recommended strategy is Strategy 3. This strategy seeks to inventory, repair and aggressively guard habitat while using natural fish for hatchery brood stock. The subbasin emphasis is on natural fish although increased hatchery returns are expected from an improved hatchery stock. Use of natural brood stock for hatchery supplementation should reduce genetic impacts on natural fish. Monitoring natural smolt production at Wells Dam would be a useful tool in subbasin management. This strategy was also supported by the SMART analysis (Appendix B). The natural stock in this subbasin is so depressed it will probably be destroyed unless alternate out-of-basin harvest techniques are used in Columbia River pools.

Table 18. System Planning Model results for summer steelhead (A's) in the Methow Subbasin. Baseline value is for pre-mainstem implementation, all other values are post-implementation.

Utilization Objective:
Zero natural and 10,000 hatchery fish for sport and tribal harvest.

Biological Objective:
Maintain genetic integrity of natural fish. Minimum spawning goal of natural fish is 3,200 fish.

Strategy[1]	Maximum[2] Sustainable Yield (MSY)	Total[3] Spawning Return	Total[4] Return to Subbasin	Out of[5] Subbasin Harvest	Contribution[6] To Council's Goal (Index)
Baseline	11,469 -N	5,799	17,920	4,651	0(1.00)
All Nat	20,647 -N	7,215	28,676	7,442	24,362(1.60)
1	20,633 -N	7,211	28,656	7,438	24,318(1.60)
2	20,647 -N	7,215	28,676	7,442	24,362(1.60)
3*	21,820 -N	7,253	29,890	7,758	27,112(1.67)

*Recommended strategy.

[1]Strategy descriptions:

1. Aggressive habitat protection, upgrade diversions. Post Mainstem Implementation.
2. Strategy 1 plus improve mainstem and tributary streamflows through the use of flow augmentation reservoirs. Post Mainstem Implementation.
3. Strategy 1 plus use natural fish for hatchery brood stock. Post Mainstem Implementation.

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

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

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

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

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

Table 18a. Estimated costs of alternative strategies for Methow summer steelhead. Cost estimates represent new or additional costs to the 1987 Columbia River Basin Fish and Wildlife Program; they do not represent projects funded under other programs, such as the Lower Snake River Compensation Plan or a public utility district settlement agreement. (For itemized costs, see Appendix C.)

	Proposed Strategies		
	1	2	3*
Hatchery Costs			
Capital[1]	0	0	0
O&M/yr[2]	0	0	0
Other Costs			
Capital[3]	1,000,000	51,000,000	1,020,000
O&M/yr[4]	8,800	258,800	18,800
Total Costs			
Capital	1,000,000	51,000,000	1,020,000
O&M/yr	8,800	258,800	18,800

* Recommended strategy.

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

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

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

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

METHOW SPRING CHINOOK

Fisheries Resource

Natural Production

History and Status

Spring chinook were once abundant in the upper Columbia River (Mullan 1987). However, overfishing and habitat alterations depleted spring chinook numbers in the early 1900s. Also, in the Methow Basin, flood control dikes, roads, logging, housing developments, and irrigated agriculture have caused cumulative losses of habitat. A hydro-irrigation dam constructed in 1912 across the Methow at Pateros (Mullan 1983) harmed salmon runs. The extent of depletion of Methow fish is difficult to ascertain due to the lack of historical data. Columbia River dams with associated smolt and adult mortalities are thought to be current limiting factors. Prior to completion of Grand Coulee Dam, spring chinook destined for the upper Columbia were intercepted at Rock Island Dam (1939-1941) and released into the Wenatchee, Entiat and Methow rivers. Natural escapement in the Methow averaged 2,024 fish for 1977 through 1985 (Table 19).

Life History and Population Characteristics

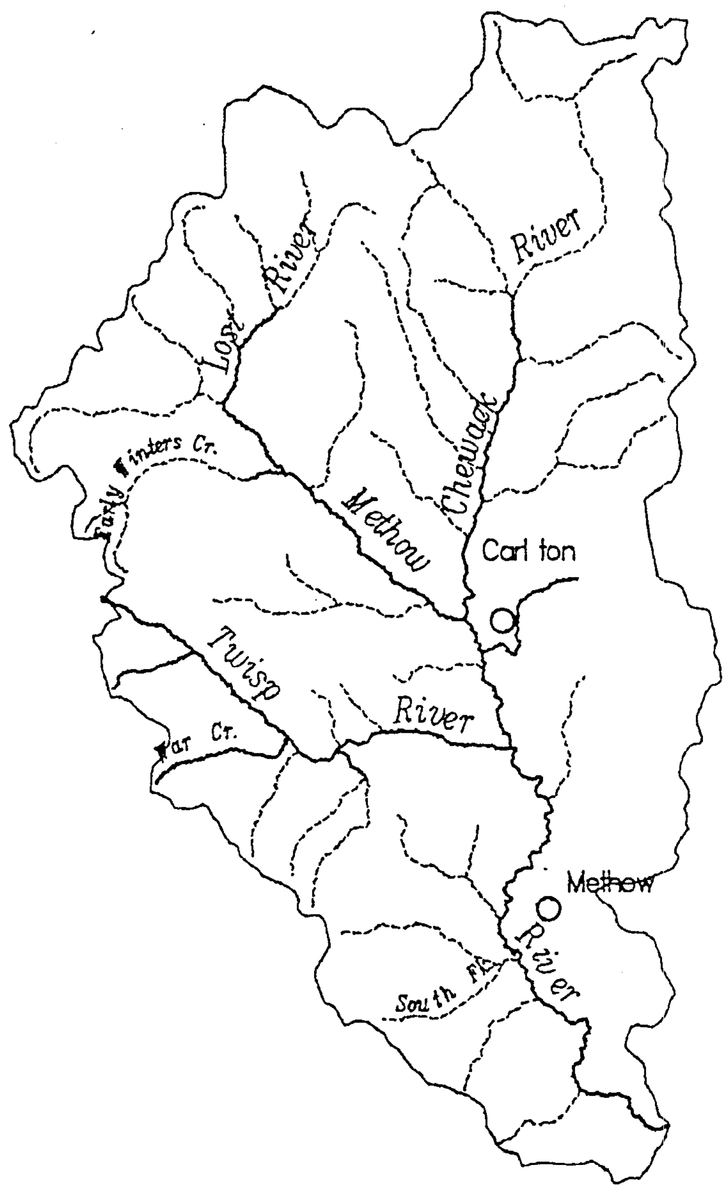
Methow spring chinook enter the Columbia River in mid-March with approximately 50 percent passing Priest Rapids Dam by mid-May. Fish enter the Methow from mid-May through July and primarily use the upper mainstem reaches of the Methow, Chewack, Lost and Twisp rivers. Spawning occurs from late July through mid-September; fry emerge in April and May. Juveniles spend the next year in fresh water prior to spring ocean migration.

Age of fish was 7.1 percent, 61.8 percent and 32.1 percent 1-, 2-, and 3-ocean years, respectively (Mullan 1984, 1985). Sex ratio (female-to-male) was 1-to-0.42. Fork length of males (n=49) and females (n=117) was 84.0 and 83.4 cm, respectively. Fecundity data was not available for Methow spring chinook, however, Leavenworth National Fish Hatchery stock may be representative. For ocean ages 2 and 3, average fecundity was 4,200 and 4,600 eggs per female, respectively (Howell et al. 1984).

Egg-to-smolt or smolt-to-adult survival data was not available for natural spring chinook in the subbasin.

Based on the Northwest Power Planning Council's habitat carrying capacity model, spring chinook production potential for the Methow is estimated at 826,359 smolts.

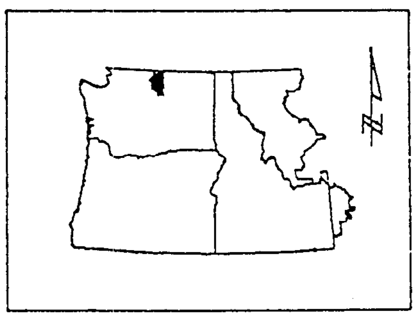
METHOW SUBBASIN



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 19. Methow natural spring chinook spawning escapement (WDF).

Year	Estimated Spawners 1/
1977	3,580
1978	3,041
1979	838
1980	884
1981	1,228
1982	1,521
1983	1,673
1984	2,016
1985	3,433
Average	2,024

1/ Includes an unknown contribution of Winthrop NFH spawners.

Fish Production Constraints

The greatest limitation of subbasin spring chinook production is loss of smolts and adults at nine Columbia River dams and impoundments. Within the subbasin, dewatering limits production in some reaches (Table 13) and low flows resulting from irrigation diversions reduce rearing habitat. Juvenile losses occur at substandard irrigation diversions. Loss of juveniles may also occur from winter icing conditions. Habitat losses from riparian developments have also reduced production potential, although unquantified. Impacts of bacterial kidney disease (BKD) on natural spring chinook is unknown.

Hatchery Production

Description of Hatcheries

Currently, Winthrop National Fish Hatchery, opened in 1942, is the only subbasin hatchery. Winthrop Hatchery originally cultured spring and summer chinook and sockeye eggs collected from adults trapped at Rock Island Dam. Steelhead and coho were also reared as part of the Grand Coulee Fish Maintenance Project. In 1951, the hatchery reared chinook, sockeye, coho, kokanee, steelhead, rainbow and brook trout. The facility stopped rearing sockeye in 1961, chinook in 1963, steelhead in 1966, and coho in 1969 and expanded trout production in 1967. The trout expansion was due to a cooperative agreement with the Confederated Tribes of the Colville Indian Reservation. The Colville agreement will terminate when the Colville Trout Hatchery is operational in 1989-1990. In 1974, part of Winthrop National Fish Hatchery was used for spring chinook production to rebuild upper Columbia spring chinook runs.

The current Winthrop National Fish Hatchery objective is to produce spring chinook annually and summer chinook as available (B. Kinnear, USFWS, pers. commun.). Potential production of existing facilities, including trout production, is about 1.1 million spring chinook smolts. United States vs. Oregon calls for production of 1.4 million smolts (after trout production ceases) annually. The Winthrop Station Development Plan indicates production could increase to about 2 million smolts when the Colville Trout Rearing Program is terminated and facilities are upgraded. For 1980 through 1987, an average of 986,187 smolts were planted.

Winthrop National Fish Hatchery has an infiltration gallery that can deliver 10 cfs. Additional surface water (30 cfs) is available from the river, but is impeded by icing conditions in winter. Surface water temperatures range from 32 F to 67 F in winter and summer, respectively. Groundwater is abundant in the area. Both groundwater and infiltration sources are a constant 49 F.

Spring chinook brood stock is taken from rack returns, however, returns are often insufficient. Brood stock source has previously included Cowlitz River, Entiat Hatchery, Little White Hatchery, Carson Hatchery and Leavenworth Hatchery (Table 20). Rack returns to Winthrop National Fish Hatchery averaged 567 adults for 1978 through 1986 (Table 21). It is unknown how many hatchery fish spawn naturally in the Methow.

As part of the Wells Settlement Agreement, Douglas County Public Utility District will fund a natural brood stock hatchery-based compensation program for the Methow. Production and acclimation facilities are intended to be consistent with Methow and Okanogan Subbasin planning efforts. Production of 450,000 smolts at 15 fish per pound will be planted in acclimation ponds in the Chewack and Methow rivers. As part of the Rock Island Settlement Agreement, 100,000 smolts at 10 fish per pound will be planted in an acclimation pond in the Twisp River near Newby Creek. Natural adults will be collected in tributaries near the acclimation ponds. Spring chinook smolt releases will be timed to coincide with Columbia River Dam spills and be provided with acclimation and imprinting before release. These programs will proceed in three phases (Table 22).

Table 20. Spring chinook releases in the Methow River from Winthrop Hatchery (Mullan 1987b).

Release Year	Number Released	#/lb	Release Location	Adult Brood Collection Site
1977	700,000	1250	Methow	Little Wht. Salmon
1978	365,000	15	Methow	Carson NFH
1979	427,000	15	Methow	Carson NFH
1980	60,000	17	Methow	Methow River
	1,147,000	17	Methow	Little Wht. Salmon
1981	78,000	18	Methow	Methow River
	268,000	18	Methow	Leavenworth NFH
	620,300	17	Methow	Carson NFH
1982	100,200	15	Methow	Methow River
	612,500	16	Methow	Leavenworth NFH
1983	785,100	18	Methow	Carson NFH
1984	601,500	16	Methow	Methow River
	281,300	197	Methow	Methow River
1985	1,167,600	17	Methow	Methow River
1986	570,200	16	Methow	Methow River
	528,500	16	Methow	Leavenworth NFH
1987	1,069,293	14	Methow	Methow River
AVE	986,187	(1980-1987)		

Table 21. Winthrop Hatchery spring chinook returns (Mullan 1987b).

Year		Rack Return
1978		38
1979		102
1980		137
1981		389
1982		601
1983		902
1984		900
1985		1,200
1986		836
	AVE	567

Table 22. Wells Dam Settlement Agreement, future plans.

Species	Production Goal	Location Planted	Comments
PHASE I Compensation Program			
Spring Chinook	30,000 lbs.@ 15/lb.	1/2 Chewack 1/2 Methow	
Sockeye	8,000 lbs.@ 25/lb.	Lk. Osoyoos or Palmer Lk.	Exp. net pen prog.
Summer Steelhead	30,000 lbs.@ 6/lb.	Methow and/or Okanogan R.	Replaces 25,000 lb. from 1980 agreement.
PHASE II Compensation Program			
Sockeye	7,000 lbs.@ 25/lb.	Lk. Osoyoos or Palmer Lk.	If sockeye net pen rearing successful, sp. chinook, summer chinook and steelhead the same as Phase I.
Summer Chinook	15,000 lbs.@ 10/lb. 6,500 lbs.@ 40/lb.	Methow Methow	If sockeye net pen rearing not successful, sp. chinook and steelhead the same as Phase I, sockeye discontinued.
PHASE III Compensation Program			
Sockeye	15,000 lbs.@15/lb		If successful @ Phase II.
Adjustment of Phase I and II Program After Project Mortality/Survival Study.			
PHASE IV Compensation Program			
Adjustment of Phase I and II Program for 110 percent Increase in Run Size.			

Life History and Population Characteristics

Freshwater adult migration begins in mid-March. Counts of upriver spring chinook peak at Bonneville Dam in April. An average of 50 percent of the Methow run generally passes Priest Rapids Dam by mid-May, arriving in the Methow in May to June.

Winthrop National Fish Hatchery spring chinook predominantly return at ocean age 2 (Table 23). Sex ratios are dominated by females at ocean age 2 and 3. Fecundity for ocean ages 2 and 3 averages 4,400 eggs per female (Howell et al. 1984). Fish are spawned in late August through mid-September. Fry swim up in late November. Hatchery egg-to-smolt survival is 94 percent (B. Wallien, USFWS, pers. commun.). Smolts are released in spring as yearlings. Smolt-to-adult survival ranged between 0.33 percent and 0.38 percent (Howell et al. 1984).

Table 23. Ocean age and length of Winthrop Hatchery spring chinook (Mullan 1984a and 1985).

	1 (<61 cm)	2 (61-81 cm)	3 (>81 cm)
Number of fish	21	712	279
Percent females	19.0	68.5	59.1

Constraints to Hatchery Production

Hatchery water quality is good although quantity has been a limiting factor. Bacterial kidney disease has been a major problem at the hatchery and furunculosis and redmouth have also caused losses occasionally. Infectious hematopoietic necrosis (IHN) was detected in the 1988 brood stock. Performance of the Winthrop National Fish Hatchery stock needs to be improved as it has consistently exhibited poor returns.

Harvest

Historically, a tribal fishery existed at the mouth of the Methow River, but has not fished for decades (Craig and Hacker 1940). A Colville tribal fishery is active at the base of Chief

Joseph Dam, but it is unlikely spring chinook comprise a part this harvest.

Currently, subbasin harvest of Methow spring chinook is not permitted. A directed fishery would need to be reconciled with the management intent and harvest equity set forth in the Columbia River Fish Management Plan. There is no formal agreement between the Colville tribes and Washington Department of Fisheries regarding a tribal fishery in this basin.

Specific Considerations

The subbasin is located above nine Columbia River dams, which subject juveniles and adults to high cumulative mortalities. Washington Department of Fisheries currently allows no Wells Pool or inbasin harvest of Methow spring chinook due to depressed run status. The subbasin is thought to be underescaped although escapement goals have not been quantified. New hatchery production will utilize natural brood stock.

United States vs. Oregon sets criteria for mainstem commercial fisheries. The management plan also establishes a mechanism for developing tributary fishing opportunities as run size exceeds spawning escapement objectives.

Natural spring chinook production potential in the subbasin is limited somewhat by low stream flows, irrigation diversions and instream and riparian habitat losses. Streamflow in portions of the Methow Basin is intermittent seasonally. Adult passage delays and stranding of juveniles is common in some reaches.

Critical Data Gaps

Egg-to-smolt survival needs to be identified to ensure spawning escapement goals are consistent with carrying capacity. A better understanding of winter habitat requirements is needed; winters losses may be substantial due to icing conditions (K. Williams, WDW, pers. commun.). The role of the Columbia River (Wells Pool) in juvenile production needs clarification. The various interactions between species and predator-prey relationships in the subbasin and the Columbia River (Wells Pool) need investigation.

Objectives

The objectives listed below represent an initial attempt to quantify harvest goals for the subbasin and describe the important biological goals for the stock.

Subbasin fishery needs are one part of a complex regime of existing fisheries management. The Columbia River Fish Management Plan, negotiated over several years by parties active in Columbia River fish management, describes a phased approach to initiating various fisheries as runs rebuild. This harvest management approach must be reflected in realistic subbasin fishery goals. Lower mainstem fisheries and terminal fisheries are planned under the existing Columbia River Fish Management Plan. How responsive individual subbasin stocks are in rebuilding relative to their lower river harvest management aggregate stock will influence the number of fish available for harvest in the terminal area.

The subbasin utilization or harvest objective reflects the biological goals, subbasin potential, and approximate level of fishery identified as desirable in open public meetings. It is expected that these objectives will be refined as additional information and more sophisticated modeling become available through the System Monitoring and Evaluation Program.

Utilization Objective

Harvest 2,000 fish, to be shared between Indian and recreational fisheries according to the United States vs. Oregon agreement. The biological objective has priority within the subbasin for this stock.

Biological Objective

Determine MSY escapement and manage escapement accordingly. Increase the productivity and maintain the unique characteristics of the stock, including the existing balance of spawners in tributaries of the subbasin.

Alternative Strategies

Strategies for spring chinook in this report have specific themes. Means to obtain the objectives are first attempted using natural methods followed by less natural techniques and finally, hatchery production. Actions identified under each strategy are closely related to the theme. Strategies 1 and 2 have natural production themes seeking to improve the productivity of the existing natural stock. Strategy 3 is a "benign" supplementation strategy, emphasizing actions to develop a single supplemented run with yet higher productivity. Strategy 4 is a hatchery strategy and only those actions needed to make the hatchery program work are addressed.

Modeling results for each strategy are presented in Table 24 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 24. 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 24a.

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

This strategy provides for prudent stewardship of existing habitat and water quality in the historic distribution range through various existing laws and agreements. Streams in the subbasin need to be inventoried for summer temperature profiles; those exceeding temperature sensitivity criteria should be classified as such through the Department of Natural Resources so future impacts will be minimized. Water withdrawals should be reduced as possible. Riparian zones should be managed to provide a continuous recruitment of large organic debris. Stream typing should be reviewed and streams should be upgraded as needed.

Hypothesis: Existing habitat, if managed properly, should provide near capacity numbers of natural smolts if adequately seeded. Some irrigation diversions are substandard. Diversion entrainment losses of juvenile fish is thought to be substantial. Location of diversions on smaller tributaries is unknown.

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

Numeric Fish Increases: Total production increase would be 2,515 fish at MSY.

ACTIONS: 1-2

1. Maintain at least current level of stream habitat quality and quantity. Seek improved water quality via reduction of sedimentation. Seek legislation to eliminate additional or replacement water withdrawals. Inventory and map habitat.

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

Cost Estimates: Estimated one FTE year to inventory diversion screening needs and inventory and map habitat ($40,000). New screen and refurbishing costs for existing structures (includes implementation and O&M costs) for the first 25 years is estimated at $536,470 (Standard Cost Estimate).

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

Hypothesis: Increasing streamflows will increase habitat, and improve winter cold water temperatures, thereby increasing smolt capacity. Proposed recreational development (Early Winters Recreation Area) and associated residential growth are expected to further deplete current flows.

Currently the Methow Valley Irrigation District is reorganizing and petitioning the Department of Ecology to convert from an open ditch delivery system to individual pump stations for its water right holders. The irrigation district withdraws water near Winthrop, Wash. (RM 46). The district's water delivery system currently consists of open unlined, or broken concrete lined canals and wooden flumes and estimated delivery loss is 45 percent. Methow Valley Irrigation District has permit capacity of 270 cfs, however, only uses 95 cfs. Conversion to individual pumps would realize a water savings of approximately 43 cfs, which could realize a 20 percent to 30 percent increase in late summer through fall streamflow below Winthrop in the Methow mainstem. Preliminary discussions with Methow Valley indicate it is agreeable to sharing surplus water with fisheries interests. Unfortunately, under current state water law, if the irrigation district were to convert to individual pumps, water savings could be appropriated by junior water right holders. It is recommended that if the water rights issues can be adequately addressed, that funding this project be shared.

Assumptions: State water law will need to be modified to allow saved or additional water to be dedicated to fisheries enhancement purposes and not other consumptive uses. Action 3 assumes smolt capacity will be increased by 5 percent. Action 4 assumes smolt capacity will be increased by 5,000 smolts per channel and subbasin egg-to-smolt survival will be increased by a relative 2 percent per channel.

Numeric Fish Increases: Total production increase would be 3,743 fish at MSY.

ACTIONS: 1-4

1. -
2. -

3. Implement water conservation and acquisition measures. These include conversion to sprinkler irrigation systems, lining of earthen irrigation ditches and/or conversion to pump irrigation systems versus ditch conveyance.

4. Construct and evaluate use of 10 groundwater channels in the upper Methow River. Several floodplain areas exist where this habitat enhancement technique should work well. One such area where a similar project was completed on private property was colonized rapidly by adults for spawning and juveniles for rearing. Such habitat would have relatively stable water temperatures and physical configuration.

Cost Estimates: Costs of drilling 120-foot wells for the approximately 230 landowners served by Methow Valley Irrigation District is estimated at $908,500 ($3,950 per well). Well drilling costs are based on averaged cost estimates provided by three drillers. .Pump costs (10 hp installed) are $874,000 ($3,800 per pump). Pump installation costs are based on averaged cost estimates provided by Bill Lindsey of Winthrop Pump and by T.J. Reid of Reid Pump and Supply (Wenatchee). Costs of groundwater channels are estimated at $30,000 each with an annual O&M cost of $1,000 each, for a total of $300,000 in capital costs and $10,000 in O&M.

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

Hypothesis: The proposed Douglas PUD Winthrop Spring Chinook Hatchery will attempt to minimize adverse genetic impacts on natural stocks and improve smolt-to-adult survival by using natural brood stock collected and acclimated in the tributaries where they originated.

Assumptions: This strategy assumes the relative survival of the increased hatchery production will increase from 0.5 to 0.75.

Numeric Fish Increases: Total production increase would be 3,739 fish at MSY.

ACTIONS: 1-5

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

5. Construct spring chinook hatchery facilities and acclimation ponds as needed in the Rock Island and Wells Dam settlement agreements. This will add 550,000 smolts from natural brood stock.

Cost Estimates: The proposed Douglas PUD Winthrop Spring Chinook Hatchery and satellite facilities are estimated to cost $5 million to $7.5 million (M. Erho, Douglas PUD, pers. commun.).

STRATEGY 4: Hatchery. This strategy seeks to achieve the objectives solely through improved hatchery production and practices. Increase the number and quality of Winthrop National Fish Hatchery spring chinook smolts.

Hypothesis: Poor returns of hatchery fish to Winthrop National Fish Hatchery are suspected to be partially the result of untenable cultural facilities and use of maladapted stocks from lower Columbia River hatcheries. The United States vs. Oregon agreement identifies the potential for Winthrop National Fish Hatchery to increase spring chinook production to 1.4 million smolts after trout production for the Colville Tribes ceases.

Assumptions: Increased smolt production will result in commensurate adult returns. Improved brood stock will increase relative survival of hatchery smolts by 10 percent.

Numeric Fish Increases: Total production increase would be 2,276 fish at MSY.

ACTIONS: 7, 8

7. Increase Winthrop Hatchery spring chinook smolt plants from 986,187 to 1.4 million fish (413,813 fish needed).

8. Improve the smolt-to-adult survival of the hatchery stock by evaluating and using other stocks and improving hatchery facilities.

Cost Estimates: Cost of this strategy is the cost of increased hatchery production; facilities are already present. Cost of improving smolt-to-adult returns at the hatchery are subjectively estimated at $200,000 per year for evaluation of improved brood stock and cultural practices.

STRATEGY 5: Combination of actions. This strategy uses all the above actions.

Hypothesis and Assumptions: See above strategies.

Numeric Fish Increases: Total production increase would be 5,132 fish at MSY.

ACTIONS: 1-8 (see above)

Costs: See above strategies.

Recommended Strategy

The recommended strategy is Strategy 5, the combination of actions. This strategy seeks to inventory, repair and aggressively guard habitat while improving summer flows, supplementing natural fish and improving the hatchery brood stock. The supplementation component is being implemented through the mid-Columbia PUD settlement agreements. The supplementation actions should reduce genetic impacts on natural fish. This strategy was also supported by the SMART analysis (Appendix B).

Table 24. System Planning Model results for spring chinook in the Methow Subbasin. Baseline value is for pre-mainstem implementation, all other values are post-implementation.

Utilization Objective:
Harvest 2,000 fish for sport and tribal anglers to be shared as per United States vs. Oregon.

Biological Objective:
Determine MSY escapement and manage escapement accordingly. Increase the productivity and maintain the unique characteristics of the stock, including the existing balance of spawners in tributaries of the subbasin.

Strategy[1]	Maximum[2] Sustainable Yield (MSY)	Total[3] Spawning Return	Total[4] Return to Subbasin	Out of[5] Subbasin Harvest	Contribution[6] To Council's Goal (Index)
Baseline	195 -N	1,874	2,442	765	0(1.00)
All Nat	3,938 -C	6,132	10,939	3,386	19,534(4.47)
1	2,710 -C	5,247	8,743	2,710	14,488(3.58)
2	3,938 -C	6,132	10,939	3,386	19,534(4.47)
3	4,734 -C	6,099	11,835	3,679	21,611(4.84)
4	2,471 -C	4,807	7,969	2,484	12,722(3.26)
5*	5,327 -C	6,433	12,684	3,954	23,575(5.19)

*Recommended strategy.

[1]Strategy descriptions:

1. Aggressive habitat protection, improve diversions, etc. Post Mainstem Implementation.
2. Strategy 1 plus water conservation and groundwater channels. Post Mainstem Implementation.
3. Strategy 2 plus construct hatchery facilities and rearing ponds, plant 550,000 smolts. Post Mainstem Implementation.
4. From baseline add 413,813 hatchery smolts. Post Mainstem Implementation.
5. Strategy 3 plus 413,813 hatchery smolts. Post Mainstem Implementation.

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

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

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

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

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

Table 24a. Estimated costs of alternative strategies for Methow spring chinook. Cost estimates represent new or additional costs to the 1987 Columbia River Basin Fish and Wildlife Program; they do not represent projects funded under other programs, such as the Lower Snake River Compensation Plan or a public utility district settlement agreement. (For itemized costs, see Appendix C.)

	Proposed Strategies				
	1	2	3	4	5*
Hatchery Costs					
Capital[1]	0	0	0	1,909,000	1,909,000
O&M/yr[2]	0	0	0	207,500	207,500
Other Costs					
Capital[3]	1,000,000	3,300,000	3,300,000	0	3,300,000
O&M/yr[4]	800	60,800	60,800	200,000	260,800
Total Costs					
Capital	1,000,000	3,300,000	3,300,000	1,909,000	5,209,000
O&M/yr	800	60,800	60,800	407,500	468,300

* Recommended strategy.

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

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

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

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

METHOW SUMMER CHINOOK

Fisheries Resource

Natural Production

History and Status

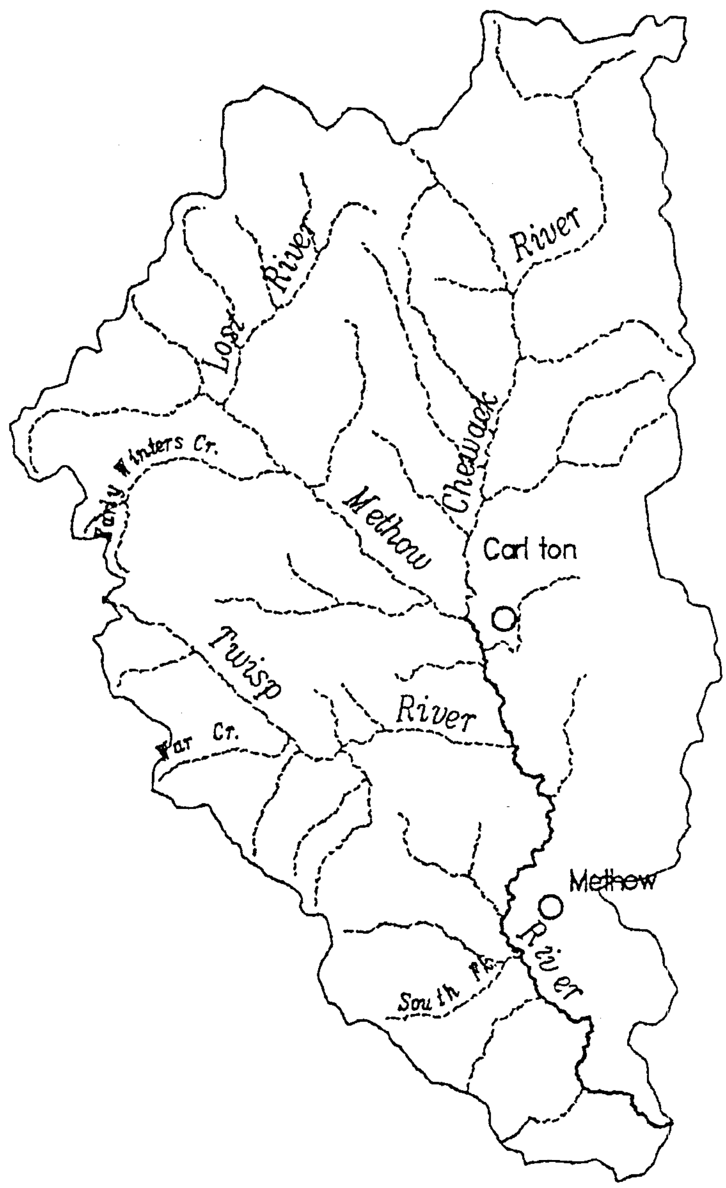
Historically, summer chinook were abundant in the middle to upper Columbia River and may have been the most plentiful of the chinook races. Prior to hydroelectric dam development, summer chinook migrated as far as Windermere Lake in British Columbia (Fulton 1968). Before completion of Grand Coulee Dam, summer chinook destined for the upper Columbia were intercepted at Rock Island Dam (1939-1941) and transplanted into the Wenatchee, Entiat, Methow and Okanogan rivers.

Tributary developments contributed to the decline of these fish. Developments included 1) obstructions to upstream migrants such as the 1912 through 1930 hydro-irrigation dam at Pateros or irrigation dams that impede access to spawning and rearing areas; 2) diversion structures in which fingerlings and smolts become entrained; 3) habitat losses in the rearing and spawning streams, resulting from streamside and riparian developments; and 4) poor instream flows resulting from agricultural diversions.

Life History and Population Characteristics

Methow summer chinook use the lower mainstem reaches of the Methow River and are managed for natural production. Summer chinook are released from Wells Dam Hatchery into the Columbia and have been released intermittently from Winthrop National Fish Hatchery. Natural production run size for 1977 through 1985 averaged 1,018 adults (Table 25). Contribution of hatchery fish to the subbasin is unknown.

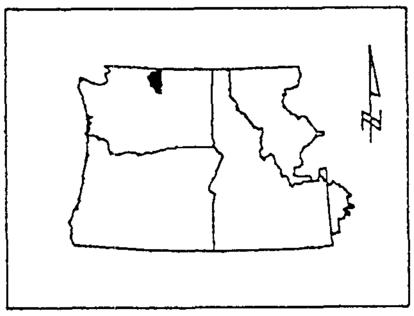
METHOW SUBBASIN



SUMMER 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 25. Methow summer chinook spawning escapement as determined from redd counts (Mullan 1987b, WDF).

Year	Number of fish
1977	1,069
1978	1,283
1979	2,433
1980	1,002
1981	679
1982	939
1983	458
1984	670
1985	630
AVE	1,018

Summer chinook migration begins in late May or early June with peak counts at Bonneville Dam during early July. The run peaks at Priest Rapids Dam in mid-July and passes Wells Dam in late July. Entry into the Methow occurs in late August. Spawning generally occurs during late September through early November with peak redd counts observed during the last two weeks of October (Meekin 1966 and 1967). Age-specific mean fecundity data is unavailable for Methow summer chinook. Mathews and Meekin (1971) determined a length-fecundity relationship for summer chinook where eggs = 214 x (fork length in inches) - 2,234. The corresponding fecundities are 2,284 (ocean age-2 fish), 4,306 (ocean age-3 fish) and 4,980 (ocean age-4 fish) eggs per female.

Age and length data is not available for natural subbasin summer chinook, however, some data is available from returns to Wells Dam. Age composition for Wells Dam summer chinook are limited to returns of coded-wire tagged fish for 1974 through 1977. An average of 4 percent of fish returned after one year in the ocean, 16 percent age 2, 48 percent age 3, 30 percent age 4 and 2 percent age 5 (Table 26). Sex ratios are unknown for subbasin summer chinook, but were assumed similar to Yakima River summer chinook as reported in Howell et. al. (1984). Length (fork length) from Wells brood stock for ocean ages 2, 3 and 4 was 56 cm, 80 cm, and 88 cm, respectively.

Table 26. Wells Dam Hatchery summer chinook age, sex ratio (F:M) and length (Howell et al. 1985).

	Ocean Age 1	2	3	4	5
Percent	4.0	16.0	48.0	30.0	2.0
F:M 1/	0:1.00	1:0.21	1:0.61	1:0.41	(?)
Length (cm)	41	56	80	88	92

1/ Sex ratio data from Yakima River summer chinook.

Emergence timing is not known for natural populations. Fry emerged from the Wells Hatchery spawning channel for 1968 through 1971 from January through April (Allen et al. 1968, 1969, 1971; Allen 1970). Methow River emergence may be delayed due to colder water temperatures.

Summer chinook generally rear in fresh water until age 0+ to age 1. Significant rearing occurs in mainstem Columbia River impoundments. No egg-to-smolt or smolt-to-adult survival data are available. Smolt-to-adult survival averaged 0.3 percent for tagged subyearlings from Wells Dam Hatchery (WDF 1984).

Based on the Northwest Power Planning Council's habitat carrying capacity model, potential summer chinook production is estimated at 1,470,822 smolts. This estimate may be misleading as summer chinook depend on downstream rearing habitat, which is provided by Columbia River reservoirs. It is not known whether other habitat features limit production earlier in the tributary of origin.

Fish Production Constraints

The greatest limitation regarding summer chinook production in the Methow Subbasin is the smolt and adult mortalities encountered at Columbia River dams and impoundments. Summer chinook outmigration occurs from late spring through midfall with the greatest number moving through the system in mid to late summer when Columbia River flows are low. Outmigrant mortalities are suspected to be severe from turbine mortality, predation, and loss of physiological fitness regarding freshwater-saltwater transition.

Hatchery Production

Initial propagation of summer chinook began in the early 1940s at Leavenworth, Entiat and Winthrop hatcheries (Howell et al. 1984). The earliest releases in the Methow was from Winthrop Hatchery, which has intermittently planted summer chinook (Table 27). Brood stock for Winthrop Hatchery after 1946 originated from fish collected at Wells Dam or from rack returns to Wells Hatchery.

In 1967, an artificial propagation facility began at the Wells spawning channel. Brood stock originated from rack returns and trapped adults. Conventional hatchery rearing began in 1978; the spawning channel was discontinued. Most fish produced at the previously described Wells Hatchery were planted in the Columbia River, an average of 319,011 yearlings and 1,565,838 fingerlings in recent years (Table 28). Under the current mitigation program, Wells Hatchery rears 4,444 pounds of summer chinook at 90 fish per pound, which are released into the Methow River in May and June. However, this happened only in 1987 when 212,732 fingerlings were planted at 45 per pound. Brood stock is collected at Wells Dam fishway. Hatchery egg-to-smolt survival is between 80 percent and 90 percent. Smolt-to-adult survival averaged 0.3 percent for tagged subyearlings from Wells Dam Hatchery (WDF 1984).

As part of the Rock Island Dam Settlement Agreement (Chelan County PUD), additional hatchery production of summer chinook is planned for the Methow Basin using acclimation ponds (Table 29). Additional production of summer chinook may result as part of the Wells Dam Settlement Agreement (Douglas County PUD), depending on the success of an experimental sockeye net pen rearing project. Brood stock will likely be collected at Wells Dam. Smolt releases will be timed to coincide with Columbia River dam spills and be acclimated and imprinted before outmigration. Acclimation ponds will be constructed between Carlton and Winthrop. The objectives of increased production is to offset dam mortalities by augmenting natural production.

Table 27. Releases of Winthrop Hatchery summer chinook into the Methow Subbasin (Mullan 1987b).

Release Year	Hatchery & Stock	Number Released	#/lb	Release Location	Adult Brood Collection Site
1943	Winthrop	66600	84	Methow	Leavenworth NFH
1944	Winthrop	10600	22	Methow	Leavenworth NFH
1946	Winthrop	480600	589	Methow	Entiat River
1977	Winthrop	213300	11	Methow	Wells Dam
	Winthrop	97900	11	Columbia	Wells Dam
1978	Winthrop	501700	15	Methow	Wells Dam
	Winthrop	94400	14	Columbia	Wells Dam
1979	Winthrop	169600	13	Methow	Wells Dam
	Winthrop	67200	14	Columbia	Wells Dam
1980	Winthrop	268100	21	Methow	Wells Dam
1981	Winthrop	170500	13	Methow	Wells Dam

Table 28. Wells Hatchery releases of summer chinook, 1983-1989.

Release Year	Fingerlings	Yearlings
1983	1,432,900	0
1984	1,240,865	0
1985	1,549,000	186,000
1986	1,791,617	200,440
1987	1,018,709	394,360
1988	1,759,720	385,213
1989	2,168,057	429,042
AVE	1,565,838	319,011 (1985-1989)

Table 29. Rock Island Dam Settlement Agreement, Eastbank Hatchery Production.

Species	Production Goal	Location Planted
Summer Chinook	57,600 lbs.@ 10/lb. 40,000 lbs.@ 10/lb.	Okanogan River Methow River
Sockeye	10,000	Lake Wenatchee or Lake Osoyoos (Net Pens) ?
Spring Chinook	10,000 lbs @ 10/lb	Twisp/Methow

Winthrop Hatchery only rears summer chinook when surplus eggs are available or when spring chinook egg sources are insufficient.

Diseases at Wells Hatchery are usually not severe. Bacterial diseases encountered at Wells Hatchery include columinaris and clubbed gills. Parasites include eye fluke, costia and ichthyophthirius. Columbia River water supplies are subject to temperature related diseases such as ichthyophthirius, columinaris and furunculosis. IHN virus is also suspected in Columbia River supplies at the facility.

Actions to increase hatchery summer chinook production for the Methow Subbasin should primarily revolve around reducing Columbia River Dam and impoundment related mortalities. As part of the Wells Settlement Agreement and the Rock Island Agreement efforts will being taken by both Douglas and Chelan County PUDs to investigate and minimize the hydroelectric project related mortalities.

Preliminary data from Douglas PUD indicates that survival rates are approximately equivalent for both summer chinook fingerling and yearling releases.

Harvest

Historically, a tribal fishery existed at the mouth of the Methow River, but has not been fished for decades (Craig and Hacker 1940). A Colville tribal fishery is active at the base of Chief Joseph Dam and average harvest for 1980 through 1987 was

457 fish (Table 30). It is unknown if this harvest included Methow summer chinook.

Currently, sport harvest of Methow summer chinook is not allowed. A directed fishery would need to be reconciled with the management intent and harvest equity set forth in the Columbia River Fish Management Plan. There is no formal agreement between the Colville tribe and Washington Department of Fisheries regarding a tribal fishery in this basin. If the profile of this fishery changes, it may be necessary to develop a formal state and tribal management agreement, identifying acceptable harvest levels.

Table 30. Tribal summer chinook harvest, Chief Joseph Dam.

Year	Number of Fish
1980	396
1981	272
1982	302
1983	391
1984	309
1985	480
1986	967
1987	540
AVE	457

Specific Considerations

Methow summer chinook are located above nine Columbia River dams and suffer high juvenile and adult mortalities at each dam and impoundment. Subbasin harvest has not been allowed due to depressed runs. Spawning escapement goals have not been quantified although the system is thought to be underescaped. New hatchery production of summer chinook will utilize natural origin brood stock.

Natural summer chinook production potential has been impacted somewhat by low streamflows, irrigation diversions and instream and riparian habitat losses.

Currently, all subbasin spawning escapement is considered to be natural fish. Hatchery and natural run composition needs to be determined.

Little life history survival data exists for natural mid to upper Columbia River summer chinook. Egg-to-smolt survival needs to be determined for the subbasin to assure spawning escapement goals are consistent with carrying capacity. Increased data on fecundity is also needed.

The importance of the Columbia River (Wells Pool) regarding the juvenile rearing and sources of mortality needs to be determined.

Objectives

The objectives listed below represent an initial attempt to quantify harvest goals for the subbasin and describe the important biological goals for the stock.

Subbasin fishery needs are one part of a complex regime of existing fisheries management. The Columbia River Fish Management Plan (CRFMP), negotiated over several years, by parties active in Columbia River fish management, describes a phased approach to initiating various fisheries as runs rebuild. This harvest management approach, must be reflected in realistic subbasin fishery goals. Lower mainstem fisheries and terminal fisheries are planned under the existing CRFMP. How responsive individual subbasin stocks are in rebuilding relative to their lower river harvest management aggregate stock, will influence the number of fish available for harvest in the terminal area.

The subbasin utilization or harvest objective reflects the biological goals, subbasin potential, and approximate level of fishery identified as desirable in open public meetings. It is expected that these objectives will be refined as additional information and more sophisticated modeling become available through the System Monitoring and Evaluation Program.

Utilization Objective:

Harvest 3,000 fish, to be shared between Indian and recreational fisheries according to the United States vs. Oregon agreement.

Biological Objective:

Determine MSY escapement and manage escapement accordingly. Increase the productivity and maintain the unique characteristics of the stock, including the existing balance of spawners in tributaries of the subbasin.

Alternative Strategies

Strategies for summer chinook in this report have specific themes. Means to obtain the objectives are first attempted using natural methods followed by less natural techniques and finally, hatchery production. Actions identified under each strategy are closely related to the theme. Strategies 1 and 2 have natural production themes seeking to improve the productivity of the existing natural stock. Strategy 3 is a "benign" supplementation strategy, emphasizing actions to develop a single supplemented run with yet higher productivity. Strategy 4 is a combination strategy and includes actions common to preceding strategies.

Modeling results for each strategy are presented in Table 31 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 31. 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 31a.

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

This strategy provides for prudent stewardship of existing habitat and water quality in the historic distribution range through various existing laws and agreements. Water withdrawals should be reduced as possible.

Hypothesis: Existing habitat, if managed properly, will continue to support substantial natural production. Some irrigation diversions are substandard. Diversion entrainment losses of juvenile fish may be substantial.

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

Numeric Fish Increases: Total production increase would be 671 fish at MSY.

ACTIONS: 1-2

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

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

Cost Estimates: Estimated one FTE year to inventory diversion screening needs and inventory and map habitat ($40,000). New screen and refurbishing costs for existing structures (includes implementation and O&M costs) for the first 25 years is estimated at $536,470 (Standard Cost Estimate).

STRATEGY 2: Supplementation. This strategy seeks to achieve the objectives by supplementing natural production with natural fish. Actions identified in Strategy 1 necessary for the success of the supplementation program are also required.

Hypothesis: The proposed Rock Island Dam and Wells Dam agreements call for 400,000 smolts at 10 fish per pound with an additional 150,000 at 10 per pound and 260,000 at 40 fish per pound (subyearlings) possible, depending on success of the sockeye program.

Assumptions: This strategy assumes the relative survival of the hatchery production will increase from 0.5 to 0.75.

Numeric Fish Increases: Total production increase would be 1,214 fish at MSY.

ACTIONS: 3

3. Construct summer chinook hatchery facilities and acclimation ponds as needed in the Rock Island and Wells Dam settlement agreements. This will add 400,000 yearlings.

Cost Estimates: The proposed Chelan County PUD Eastbank Hatchery and Winthrop acclimation ponds will cost $3.4 million and $1.5 million, respectively (S. Hays, Chelan Co. PUD, pers. commun.).

STRATEGY 3: Combination of Actions. This strategy selects actions from the above strategies that are deemed most effective in increasing returns.

Hypothesis and Assumptions: See above strategies.

Numeric Fish Increases: Total production increase would be 1,380 fish at MSY.

ACTIONS: 1-3 (see above)

Costs: See above strategies.

Recommended Strategy

The recommended strategy is Strategy 3, the combination of actions. This strategy seeks to inventory, repair and aggressively guard habitat while supplementing natural production. The supplementation component is being implemented through the mid-Columbia PUD settlement agreements. This strategy was also supported by the SMART analysis.

Table 31. System Planning Model results for summer chinook in the Methow Subbasin. Baseline value is for pre-mainstem implementation, all other values are post-implementation.

Utilization Objective:
Harvest 3,000 fish to be shared between sport and tribal anglers as per United States vs. Oregon.

Biological Objective:
Determine MSY escapement and manage escapement accordingly. Increase the productivity and maintain the unique characteristics of the stock, including the existing balance of spawners in tributaries of the subbasin.

Strategy[1]	Maximum[2] Sustainable Yield (MSY)	Total[3] Spawning Return	Total[4] Return to Subbasin	Out of[5] Subbasin Harvest	Contribution[6] To Council's Goal (Index)
Baseline	123 -C	580	768	361	0(1.00)
All Nat	794 -C	1,285	2,147	1,009	3,371(2.79)
1	794 -C	1,285	2,147	1,009	3,371(2.79)
2	1,337 -C	1,357	2,844	1,337	5,077(3.70)
3*	1,503 -C	1,458	3,067	1,441	5,620(3.99)

*Recommended strategy.

[1]Strategy descriptions:

1. Aggressive habitat protection, upgrade diversions, etc. Post Mainstem Implementation.
2. From baseline, add 400,000 hatchery smolts. Post Mainstem Implementation.
3. Strategies 1 and 2 combined. Post Mainstem Implementation.

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

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

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

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

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

Table 31a. Estimated costs of alternative strategies for Methow summer 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]	1,000,000	0	1,000,000
O&M/yr[4]	800	0	800
Total Costs			
Capital	1,000,000	0	1,000,000
O&M/yr	800	0	800

* Recommended strategy.

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

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

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

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

METHOW FALL CHINOOK

As evidenced by dam counts (Table 32), a small but persistent run of fall chinook has always returned to the upper Columbia River. Little quantitative information exists on these fish except the dam counts. Timing has also cast some doubt on the classification of these fish, some observers feeling that a number of summer chinook might have been included. Spawning locations, except for an area near the mouths of the Wenatchee and Chelan Rivers went unnoticed until recently.

Table 32. Adult fall chinook (upriver brights) interdam counts, upper mainstem, 1977-1987[a].

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

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

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

[c] Used Wells Dam counts.

Upriver bright fall chinook run sizes to the Columbia River have increased dramatically since 1984. These increases have been reflected in sharply higher spawning escapements in the Hanford Reach, the free-flowing stretch of the Columbia between Priest Rapids and McNary dams. Coincident with these observations and the cessation of trapping for fall chinook at Priest Rapids Dam, scattered concentrations of spawners began to show up in locations like Sand Hollow Creek, a tributary of Wanapum Reservoir; selected locations in Wanapum and Priest Rapids Reservoirs; in the tailrace of Wells Dam; and the lower end of the Okanogan, Methow, Chelan, Entiat and Wenatchee Rivers. These isolated concentrations were either a direct result of increased production in the Hanford Reach ("over runs" that actually originated from the Hanford Reach) or are just indications of improved production conditions for existing populations that may have benefitted from the same conditions that the Hanford Reach has. Either way, it remains to be seen if these production units persist past the current high levels of returns to the Hanford Reach.

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

With the limited information available at this time it does not seem reasonable to propose production strategies for this stock. However, the status of fall chinook should be evaluated and monitored annually. This will require the continuation of the detailed spawning ground surveys conducted since 1987 by the Yakima Tribe and funded by Chelan County PUD. These surveys have identified that there is a spatial and temporal separation between summer and fall chinook spawning in the Methow River (Kohn 1987). Since fall chinook were not a part of this contract work, the redd counts are incomplete. In 1987, however, 160 redds were counted on November 13 with a large number of live and spawning fish. These redds were scattered throughout the lower river to the area around Methow. No final counts were attempted. In 1988 an incomplete survey recorded 71 redds in the same reach.

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

OKANOGAN SUMMER STEELHEAD

Fisheries Resource

Natural Production

History and Status

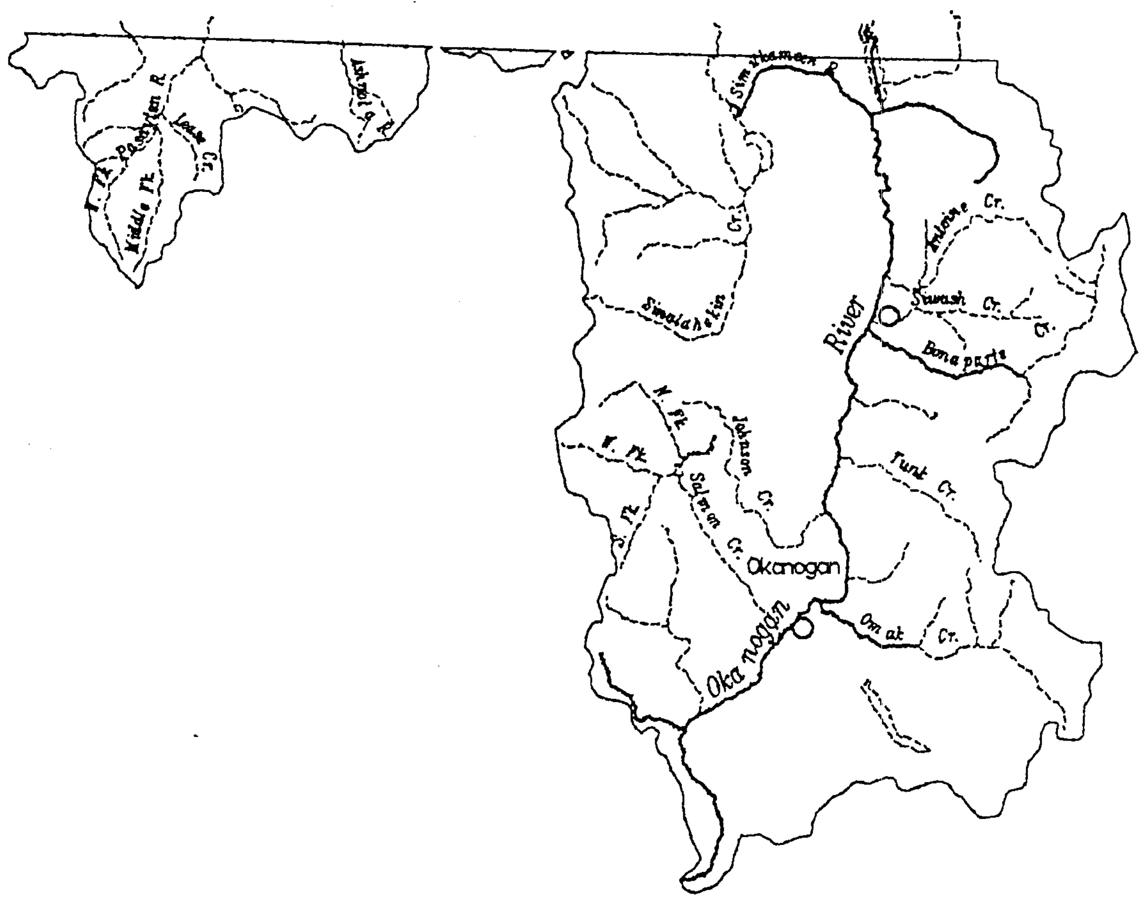
Historically, the Okanogan and Similkameen basins were significantly productive steelhead systems. Most production took place in tributaries that are presently inaccessible to migratory fish. The extent of subbasin decline is difficult to assess; for 1977 through 1986 an average of 14 natural fish returned. Spawning escapement averaged only four fish. Mainstem Columbia dams, intensive commercial fishing, and subbasin stream developments are probably responsible for the decline. The Okanogan is currently impassable below Lake Vaseaux, although it is uncertain if steelhead used areas above the lake (C. Bull, Ministry of Environment, British Columbia, pers. commun.). The Similkameen is blocked to passage at Enloe Dam, about nine miles above the confluence with the Okanogan, although few steelhead would pass the site due to a natural falls.

Between 1939 and 1943 as part of the Grand Coulee Fish Maintenance Project, upper Columbia River steelhead were trapped at Rock Island Dam and released into the Methow, Entiat and Wenatchee rivers. Thus, Okanogan steelhead were mixed with other upper Columbia River stocks. Historical counts at Rock Island Dam, representing the Methow, Okanogan, Wenatchee, and Entiat rivers, and upper Columbia River averaged 2,780 fish per year for the 1930s, 2,605 fish for the 1940s, and 3,722 fish for the 1950s.

The Northwest Power Planning Council has identified Enloe Dam fish passage in the Similkameen Basin as a possible enhancement project in its Columbia River Basin Fish and Wildlife Program. If implemented, this would almost double available habitat above Wells Dam.

The Northwest Power Planning Council's habitat carrying capacity model estimated potential steelhead production for the subbasin at 12,132 smolts in the Okanogan River and 45,972 smolts in the Similkameen River, a total of 58,104 fish.

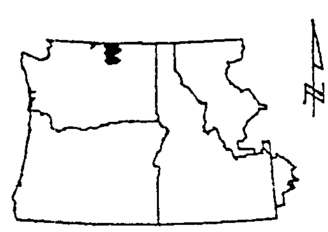
OKANOGAN SUBBASIN



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.

Life History and Population Characteristics

Due to warm summer water temperatures (up to 80 F), steelhead enter the subbasin after mid-September through April. Winter "drop-back" to the Columbia, as occurs in the Methow, may not occur, due to the temperature buffering of the Okanogan River by Lake Osoyoos. Most fish spawn between March 15 and May 31 in the mainstem Okanogan from Tonasket to Lake Osoyoos and in the Similkameen between Oroville and Enloe Dam. Limited tributary spawning occurs due to insufficient flows and irrigation diversions. Incubation and emergence timing vary on location within the watershed and are generally assumed to be earlier than the Methow. No data is available regarding egg-to-smolt survival rates, however, survival is probably poor due to habitat limitation and predation or competition from other fish. Juveniles rear for about two years prior to spring ocean migration.

Due to lack of in-subbasin data on Okanogan natural steelhead, population characteristics were derived from Wells Hatchery brood stock. This data was previously presented under Methow summer steelhead.

Based on the 1982 through 1986 Wells brood stock analysis where natural fish comprised 2.76 percent of the total (Williams 1988), estimated subbasin return averaged 17 natural fish for 1977 through 1988 (Table 33). Spawning escapement was estimated at eight fish.

Fish Production Constraints

Limiting natural production factors in the subbasin include the extensive riparian and instream habitat degradation and warm water temperatures (Table 34). Loss of tributary reaches such as Salmon, Bonaparte and Chiliwist creeks to irrigation have devastated natural production. The Okanogan is currently impassable below Lake Vaseaux; the Similkameen is blocked at Enloe Dam.

Table 33. Okanogan Subbasin natural summer steelhead run size.

Year	Total Return[1]	Sport Catch	Tribal Catch	Escapement
1977	13	9	No Data	4
1978	5	4	" "	1
1979	14	10	" "	4
1980	12	10	<1	2
1981	4	3	<1	1
1982	25	12	1	12
1983	6	3	<1	3
1984	21	15	<1	6
1985	24	19	1	4
1986	12	10	1	1
1987	34	0	1	33
1988	24	0	1	23

[1] Williams, K. (1988). Natural escapement is estimated to be 5 percent of natural production above Wells Dam. Estimates are from 1982-1986. Prior to 1982, natural production was estimated using the mean natural component percentage above Wells Dam for 1986-1987 (0.0276). Since no hatchery fish were expected (planted) from 1977 to 1983, it is assumed all harvest was natural fish, although hatchery strays are a possibility.

Table 34. Major habitat constraints in the Okanogan Subbasin.

Location	Species Present	Low Flow	Water Quality	Migration Barriers	Other Constraints
Okanogan R. (Lower Mainstem)	Sum. Chinook	Yes	Poor	Thermal Irrig. Div.	Sediment Cover High Temp
	Sockeye	-	-	Thermal Irrig. Div.	High Temp
	Steelhead	-	-	Thermal Irrig. Div.	Sediment Cover High Temp Flow Low velocity
Okanogan R. (lower Tribs.)	Steelhead Sum. Chinook	-	Good	Irrig. Div.	Cover Flow Access
Okanogan R. (Upper Mainstem)	Sum. Chinook	Yes	Fair	Thermal Irrig. Div.	Sediment Cover High Temp Gravel Qual Gravel Quan
	Sockeye	-	-	Thermal Irrig. Div.	
	Steelhead	-	-	Thermal Irrig. Div.	Sediment Cover High Temp Gravel Qual Low velocity
Okanogan R. (Upper Tribs.)	Steelhead	Yes	Fair	Irrig. Div.	Sediment Cover High Temp Gravel Quan
Similkameen R. (Mainstem)	Sum. Chinook	Yes	Fair-Good		Sediment Gravel Quan
	Steelhead	-	-	Hydro.Dam	Sediment Gravel Quan Cover/Habitat

Hatchery Production

The previously described Wells Salmon and Steelhead Hatchery produces the steelhead planted in the Okanogan Subbasin. A profile of the Wells Hatchery stock was detailed under Methow summer steelhead; the Okanogan is identical. Managers planted an average of 118,684 smolts (Table 35) in the Okanogan Subbasin in 1983 through 1989; plants were discontinued between 1973 and 1982. Smolt-to-adult survival for 1965 through 1979 and 1980 through 1987 averaged 1.20 percent and 3.90 percent, respectively. Currently, increased hatchery plants are not anticipated.

Smolt plants starting in 1983 produced an average return of 1,742 steelhead for 1984 through 1988 (Table 36). Factors such as mandatory dam spills during the spring smolt outmigration, partial smolt transportation below McNary Dam, high natural flows and high ocean survival aided returns. Due to the relatively low numbers of natural fish present, hatchery fish have probably exerted genetic influence on the natural population.

Spawning escapement of naturally spawning hatchery fish was estimated at 386 fish for 1984 through 1988. Hatchery fish often precede natural fish in spawning (March 1 to May 15 versus March 15 to May 31).

Table 35. Hatchery steelhead planted in the Okanogan Subbasin.

Year*	Hatchery & Stock	Number Released	Release Location
1983	Wells	99,639	Similkameen
1984	Wells	76,080	Similkameen
1985	Wells	55,554	Similkameen
1986	Wells	50,984	Similkameen
1987	Wells	88,410	Similkameen
	Wells	95,000	Okanogan
1988	Wells	81,528	Similkameen
	Wells	91,620	Okanogan
1989	Wells	89,674	Similkameen
	Wells	102,300	Okanogan
	AVE	118,684	

* no plants from 1974-1982

Table 36. Okanogan Subbasin hatchery steelhead run size (Williams 1988).

Year	Total Return	Sport Catch	Tribal Catch	Escapement
1977	23	9	No Data	14
1978	8	4	" "	4
1979	24	10	" "	14
1980	17	10	1	6
1981	6	3	1	2
1982	15	7	<1	8
1983	89	48	1	40
1984	1,440	1,029	13	398
1985	3,506	2,796	124	586
1986	2,306	1,857	146	303
1987	467	331	29	107
1988	993	416	41	536

Harvest

Within the Okanogan Subbasin, sport anglers caught an average of 328 fish from the Similkameen and 585 fish from the Okanogan for 1984 through 1988 (Table 37), while tribal harvest was estimated at 262 fish for 1980 through 1989 (Table 38). Combined sport and tribal harvest rate averaged about 50.1 percent.

Regulation of steelhead harvest is directed at juveniles in the Similkameen and adults in both basins. Protection of juveniles in the Similkameen is restricted by a bait prohibition and a 12-inch minimum size limit, and a delayed general stream fishing opening date. Because of underescapement, subbasin harvest of natural fish has been closed via "wild steelhead release" regulations. The Similkameen River is open from June 1 through March 31 while the Okanogan is open year-round. Both rivers have a two-fish limit. Washington Department of Wildlife enforcement agents monitor and enforce harvest.

There is no formal agreement between the Colville Tribe and Washington Department of Wildlife regarding the tribal fishery at the base of Chief Joseph Dam. It is assumed that a formal agreement will be forthcoming.

Table 37. Steelhead sport harvest, 1967-1986.

Year	Methow	Okanogan	Similkameen	Wells[1] Pool	Total	Run	Rate
1967	212	100	24	21	357	2,028	0.18
1968	428	22	0	43	493	2,213	0.22
1969	199	0	0	20	219	769	0.28
1970	358	29	7	36	430	1,624	0.26
1971	764	70	27	76	937	3,899	0.24
1972	588	14	8	59	669	1,715	0.39
1973	565	4	14	57	640	1,861	0.34
1974	62	2	0	6	70	530	0.13
1975	109	2	0	22	133	505	0.26
1976	1,616	8	0	323	1,947	4,636	0.42
1977	1,773	9	0	355	2,137	5,464	0.39
1978	636	4	0	125	765	1,475	0.52
1979	1,170	10	0	363	1,543	3,771	0.41
1980	1,501	0	10	495	2,006	3,363	0.60
1981	1,674	3	0	265	1,942	4,110	0.47
1982	1,529	6	13	2,124	3,672	7,805	0.47
1983	5,824	34	17	4,642	10,517	19,530	0.54
1984	4,779	397	339	3,578	9,093	16,663	0.55
1985	4,423	1,193	746	4,972	11,334	19,712	0.57
1986	2,891	1,042	354	2,887	7,174	13,252	0.54
1987	974	161	72	711	1,918	5,493	0.35
1988	968	131	128	622	1,849	4,401	0.42

[1] Columbia River sport harvest for Wells Pool (1967-1981) is based on a five-year average (1979-1983) of Methow River harvest where Columbia harvest was 35.4 percent of above Wells Dam harvest. Columbia River (Wells Pool) punch-card data was available starting in 1981.

Table 38. Colville tribal harvest, Chief Joseph Dam fishery (Colville Confederated Tribes and WDW).

Year	Chinook	Steelhead	Sockeye
1980	396	21	33
1981	272	130	230
1982	302	122	140
1983	391	207	228
1984	309	153	48
1985	480	694	44
1986	967	819	94
1987	540	238	68
1988	372	180	25
1989	360	52	24

Specific Considerations

The goal of steelhead management in the subbasin is to rebuild the natural run to meet spawning escapement goals. To protect the genetic integrity of natural fish, harvest is targeted on hatchery fish. Natural steelhead are managed for maximum sustainable population and escapement at that level is the minimum acceptable escapement. Spawning escapement requirements have been set with the best available information and is presently 160 adults.

The largest natural fish production limitation has been inadequate escapement reaching the subbasin as a result of dam mortalities and adult overharvest downstream of the subbasin. The System Planning Model indicated 1,522 natural fish would return to spawn under existing conditions if the mainstem dams did not exist. Natural fish destined for the Okanogan Subbasin are subjected to non-selective mixed-stock fisheries in the Columbia River. Because large hatchery programs are present that need relatively little escapement, non-selective harvest can overharvest smaller natural populations that need a relatively large amount of escapement. As hatchery programs in other basins expand, the jeopardy of overharvest by non-selective fisheries in the Columbia increases. The natural run is now about 17 fish; unless out-of-basin harvest rates or techniques are altered, this run will be terminated. Selective harvest of hatchery fish at dams would allow natural fish to escape.

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

Wells Dam has the capability to monitor natural production of juveniles from the combined Okanogan and Methow rivers through collection facilities at the dam. This would allow carrying capacities to be defined.

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

The Okanogan Subbasin has relatively little habitat present; existing habitat is often of mediocre quality due to natural constraints, irrigation and other developments. Suitable steelhead habitat exists above Enloe Dam in the Similkameen River. Most of this habitat exists in Canada and management is outside the control of the state of Washington. Indian tribes on both sides of the border have cultural concerns regarding re-establishment of fish runs above Enloe Dam. It is estimated the Similkameen could produce 170,000 smolts (609,590 by IEC Beak Consultants, LTD. 1983 and 1985). Habitat above Enloe Dam is estimated to be equivalent to Methow Subbasin habitat quality and quantity.

Another opportunity to increase habitat is to replace irrigation water taken from Salmon Creek so that Salmon Creek will become again productive. Presently, water is diverted from the stream so it goes dry. Pumps are present in the Okanogan River that could pump water to fill the irrigation needs, replacing water taken from Salmon Creek. Also, storage reservoir release is required at times. Omak Creek production may benefit if passage was provided for a blockage at RM 5.6.

Critical Data Gaps

Improved information is needed regarding potential carrying capacity to more accurately estimate spawning escapement needs. Egg-to-smolt and smolt-to-adult information is needed. The importance of winter habitat needs to be determined; severe winter mortalities may occur from icing conditions. Also, genetic impacts of hatchery fish on the natural stock needs to be determined.

Objectives

Stock: Okanogan/Similkameen Natural Summer Steelhead

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

Biological Objective: Maintain genetic integrity and biological characteristics such as run timing, age composition, and length frequency. The biological objective has priority within the subbasin for this stock. This population is managed for maximum sustainable population. Minimum spawning escapement is 160 fish.

Stock: Okanogan/Similkameen Hatchery Summer Steelhead

Utilization Objective: 10,000 for sport and tribal anglers. The utilization objective has priority over the biological objective in the subbasin for this stock.

Biological Objective: Maintain biological characteristics of existing hatchery stock or natural fish.

Alternative Strategies

Strategies for summer steelhead in this report have specific themes. Means to obtain the objectives are first attempted using natural methods followed by less natural techniques and finally, hatchery production. Actions identified under each strategy are closely related to the theme. Strategies 1 and 2 have natural production themes seeking to improve the productivity of the existing natural stock. Strategy 3 seeks to expand natural production by providing access to habitat presently unavailable. Strategy 4 is a "benign" supplementation strategy, emphasizing actions to develop a single supplemented run with yet higher productivity. Strategy 5 involves hatchery strategies although other strategies may also be involved. Note that the System Planning Model indicates that planned mainstem improvements will increase subbasin returns by about 63 percent.

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

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

This strategy provides for prudent stewardship of existing habitat and water quality in the historic distribution range through various existing laws and agreements. Streams in the subbasin need to be inventoried for summer temperature profiles; those exceeding temperature sensitivity criteria should be classified as such through the Department of Natural Resources so future impacts will be minimized. Water withdrawals should be reduced as possible. Riparian zones should be managed to provide a continuous recruitment of large organic debris. Stream typing should be reviewed and streams should be upgraded as needed.

Hypothesis: Existing habitat, if managed properly, should provide near capacity numbers of natural smolts if adequately seeded. Some irrigation diversions are substandard. Diversion entrainment losses of juvenile fish is thought to be significant. Location of diversions on smaller tributaries is unknown. Monitoring natural smolt production at Wells Dam would provide needed information on carrying capacity and spawner-recruit data from the Okanogan and Methow rivers.

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

Numeric Fish Increases: The System Planning Model indicated an additional four fish will return to the subbasin with this strategy under current conditions. MSY after mainstem improvements would increase by 425 fish.

ACTIONS: 1-3

1. Maintain at least current level of stream habitat quality and quantity. Seek improved water quality via reduction of sedimentation. Seek legislation to eliminate additional or replacement water withdrawals. Inventory and map habitat.

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

3. Operate smolt collection facilities at Wells Dam to estimate natural production from the Okanogan and Methow rivers.

Cost Estimates: Estimated one FTE year to inventory diversion screening needs and inventory and map habitat ($40,000). New screen and refurbishing costs for existing structures (includes implementation and O&M costs) for the first 25 years is estimated at $536,470 (Standard Cost Estimate). Operation of the smolt collection facility is estimated to cost $40,000 per year and should be operated for 10 years.

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

Hypothesis: Increasing streamflows will increase suitable habitat thereby increasing smolt capacity. The Department of Ecology's river basin plans provide for minimum flows only allow fish life at a subsistence level.

Assumptions: This strategy assumes state water law will be modified to allow saved or additional water to be dedicated to fisheries enhancement purposes and not revert to consumptive junior water rights. This strategy assumes smolt capacity will be increased by 10 percent and egg-to-smolt survival will be increased by a relative 10 percent. This strategy assumes the existing bass fishery in the Okanogan River will not be impacted.

Numeric Fish Increases: The System Planning Model indicated this strategy would add seven natural fish to the subbasin under current conditions. MSY after mainstem improvements would increase by 456 fish.

ACTIONS: 1-4

1. -
2. -
3. -

4. Implement water conservation or water rights acquisition measures.

Cost Estimates: Water conservation measures and acquisition of water rights is estimated to cost $1 million.

STRATEGY 3: Habitat Base Increase. This strategy seeks to increase by providing passage into inaccessible areas.

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

Assumptions: This strategy assumes capacity above Enloe Dam is 170,000 smolts. This strategy also assumes smolt-to-smolt survival will be 85 percent for those fish above Enloe. This strategy also assumes capacity of Salmon Creek is 6,867 smolts without water diversions and that smolt-to-smolt survival is 95 percent. The Canadian government supports fish passage at Enloe Dam provided disease transfer concerns and safeguards are adequately addressed, cultural concerns of both United States and Canadian Indian tribes will be resolved, and Canadians are entitled to the same angling opportunities as Americans (C. Bull, Ministry of Environment, B.C., Memorandum). Action 7 assumes the 15 miles of newly opened habitat on Omak Creek is capable of producing 6,181 smolts.

Numeric Fish Increases: This strategy would increase subbasin returns by 48 fish under existing conditions. MSY after mainstem improvements would increase by 290 fish.

ACTIONS: 1-3, 5-7

1. -
2. -
3. -

5. Investigate feasibility of providing adult passage and juvenile screening at Enloe Dam. A number of issues must be addressed before activities are implemented toward re-establishment of steelhead. The major issues include 1) water appropriation and potential for further development of water resources in terms of fish production (this requires international involvement); and 2) development of harvest management strategies and escapement goals. This latter requirement must include potential harvest opportunities for Canada.

6. Pump water from the Okanogan River into the irrigation system taking water from Salmon Creek.

7. Ladder the falls on Omak Creek at RM 5.6 and process the effluent from the lumber mill and divert it directly to the Okanogan River.

Cost Estimates: Enloe Dam feasibility study is estimated to cost $80,000 in O&M over two years. [Five alternative fish passage and cost scenarios have been identified at Enloe Dam and reflect 1985 cost estimates (IEC Beak Consultants, 1985); 1) Fishway from falls - $209,600; 2) Fishway below powerhouse - $2,656,000; 3) Trap and haul at falls - $3,611,000; 4) Trap and haul below powerhouse - $3,809,000; and 5) Trap and haul at railroad bridge - $3,973,000.] Pumping water from the Okanogan River using existing pumps to replace water taken from Salmon Creek is estimated to cost $200,000 with annual O&M of $50,000. Costs of laddering Omak Creek and improving the lumber mill effluent is estimated at $100,000 in capital costs with an O&M of $3,000 annually.

STRATEGY 4: Supplementation. This strategy seeks to achieve the objectives by supplementing natural production with an appropriate existing hatchery stock or natural stock. Any actions identified in Strategies 1, 2 or 3 necessary for the success of the supplementation program are also required.

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

Assumptions: This strategy assumes the natural stock can be increased enough to allow removal of 250 fish for brood stock purposes. Action 8 assumes relative smolt survival of hatchery fish will increase from 0.67 to 0.71 and viability of naturally spawning hatchery-hatchery and hatchery-natural crosses will increase by a relative 10 percent.

Numeric Fish Increases: The System Planning Model indicated this strategy would add 91 fish to the subbasin under current conditions. MSY after mainstem improvements would increase by 37 fish.

ACTIONS: 1-3, 5-8

1. -
2. -
3. -
5. -
6. -
7. -

8. Utilize captured natural brood stock for existing hatchery programs.

Costs: Estimated costs are $20,000 in capital and $10,000 in O&M costs.

STRATEGY 5: Hatchery Production. This strategy seeks to achieve the objectives through traditional hatchery production in addition to Strategy 4.

Hypothesis: Increasing hatchery plants will increase adult returns.

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

Numeric Fish Increases: This strategy would add 3,016 fish to the subbasin under current conditions. MSY after mainstem improvements would increase by 3,897 fish.

ACTIONS: 1-3, 5-9

1. -
2. -
3. -
5. -
6. -
7. -

8. -

9. Increase hatchery smolt plants to 500,000 fish.

Recommended Strategy

The recommended strategy is Strategy 5. This strategy seeks to inventory, repair and aggressively guard habitat while using natural fish for hatchery brood stock and expanding hatchery plants. In addition, the potential for providing passage above Enloe Dam, and reclaiming Salmon and Omak creeks would add about three times the current habitat for natural fish. Use of natural brood stock for hatchery supplementation should reduce genetic impacts on natural fish. Monitoring natural smolt production at Wells Dam would be a useful tool in subbasin management. This strategy was also supported by the SMART analysis (Appendix B). The natural stock in this subbasin is so depressed it will probably be destroyed unless alternate out-of-basin harvest techniques are used in Columbia River pools.

Table 39. System Planning Model results for summer steelhead (A's) in the Okanogan/Similkameen Subbasin. Baseline value is for pre-mainstem implementation, all other values are post-implementation.

Utilization Objective:
Zero natural and 10,000 hatchery fish for sport and tribal harvest.

Biological Objective:
Maintain genetic integrity and biological characteristics of natural fish.

Strategy[1]	Maximum[2] Sustainable Yield (MSY)	Total[3] Spawning Return	Total[4] Return to Subbasin	Out of[5] Subbasin Harvest	Contribution[6] To Council's Goal (Index)
Baseline	564 -N	285	881	229	0(1.00)
All Nat	867 -N	563	1,495	388	1,390(1.70)
1	989 -N	381	1,412	366	1,203(1.60)
2	1,020 -N	356	1,416	367	1,210(1.61)
3	854 -N	577	1,499	389	1,398(1.70)
4	923 -N	574	1,564	406	1,545(1.77)
5*	4,461 -N	1,559	6,196	1,608	12,037(6.03)

*Recommended strategy.

[1]Strategy descriptions:

1. Aggressive habitat protection, upgrade diversions. Post Mainstem Implementation.
2. Strategy 1 plus improve mainstem and tributary streamflows. Post Mainstem Implementation.
3. Strategy 2 plus passage at Enloe dam and reclamation of Salmon Cr. Post Mainstem Implementation.
4. Strategy 3 plus use natural fish for brood stock. Post Mainstem Implementation.
5. Strategy 4 plus increase hatchery plants to 500,000. Post Mainstem Implementation.

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

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

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

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

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

Table 39a. Estimated costs of alternative strategies for Okanogan summer steelhead. Cost estimates represent new or additional costs to the 1987 Columbia River Basin Fish and Wildlife Program; they do not represent projects funded under other programs, such as the Lower Snake River Compensation Plan or a public utility district settlement agreement. (For itemized costs, see Appendix C.)

	Proposed Strategies				
	1	2	3	4	5*
Hatchery Costs					
Capital[1]	0	0	0	0	2,300,000
O&M/yr[2]	0	0	0	0	250,000
Other Costs					
Capital[3]	1,000,000	2,000,000	1,300,000	1,320,000	1,320,000
O&M/yr[4]	8,800	108,800	63,400	73,400	73,400
Total Costs					
Capital	1,000,000	2,000,000	1,300,000	1,320,000	3,620,000
O&M/yr	8,800	108,800	63,400	73,400	323,400

* Recommended strategy.

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

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

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

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

OKANOGAN SPRING CHINOOK

Fisheries Resource

Spring chinook are now extinct in the Okanogan Subbasin. Historical distribution was probably limited to Salmon and Omak creeks. Mainstem utilization of the Okanogan or Similkameen rivers is in question with conflicting anecdotal information. Prior to construction of Enloe Dam on the Similkameen, anadromous fish may have been able to negotiate Enloe Falls, but a consensus has never been reached on this subject.

Specific Considerations

Suitable habitat for spring chinook exists above Enloe Dam in the Similkameen, and possibly in Salmon and Omak creeks. Indian tribes on both sides of the United States/Canada border have cultural concerns regarding establishment of fish runs in the Similkameen River. It is estimated the Similkameen River could produce between 1,559,250 and 4,775,540 smolts (IEC Beak Consultants, LTD. 1983). These estimates are considered by some to be quite high, although good quality habitat exists.

The Okanogan Subbasin is located above nine Columbia River Dams and juveniles and adults would suffer considerable mortality.

Objectives

The objectives listed below represent an initial attempt to quantify harvest goals for the subbasin and describe the important biological goals for the stock.

Subbasin fishery needs are one part of a complex regime of existing fisheries management. The Columbia River Fish Management Plan (CRFMP), negotiated over several years, by parties active in Columbia River fish management, describes a phased approach to initiating various fisheries as runs rebuild. This harvest management approach must be reflected in realistic subbasin fishery goals. Lower mainstem fisheries and terminal fisheries are planned under the existing CRFMP. How responsive individual subbasin stocks are in rebuilding relative to their lower river harvest management aggregate stock will influence the number of fish available for harvest in the terminal area.

The subbasin utilization or harvest objective reflects the biological goals, subbasin potential and approximate level of fishery identified as desirable in open public meetings. It is expected that these objectives will be refined as additional information and more sophisticated modeling become available through the System Monitoring and Evaluation Program.

Utilization Objective

Achieve returns that will allow harvest of 1,000 fish, to be shared between Indian and recreational fisheries according to the United States vs. Oregon agreement.

Biological Objective

Establish a spring chinook stock and evaluate its productivity. Use of the Leavenworth stock is suggested for initial releases.

Alternative Strategies

There is only one strategy for re-establishing spring chinook in the subbasin and that calls for studying the feasibility of passage above Enloe Dam, reclaiming Salmon and Omak creeks and the introduction of juveniles or adults.

Modeling results for the strategy are presented in Table 40 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 40. 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.

STRATEGY 1: Habitat Base Increase and Supplementation. This strategy seeks to achieve the objectives by providing passage into presently inaccessible areas and utilizing fingerlings to start the run.

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

Assumptions: This strategy assumes capacity above Enloe Dam is 1 million smolts. This strategy also assumes smolt-to-smolt survival will be 85 percent for those fish above Enloe. This strategy also assumes capacity of Salmon and Omak creeks is 62,787 and 32,669 smolts, respectively, without water diversions and that smolt-to-smolt survival is 95 percent. Action 2 and 3 assume post-release survival of fingerlings is 50 percent to smolt size. The Canadian government supports fish passage at Enloe Dam provided disease transfer concerns and safeguards are adequately addressed, cultural concerns of both United States and Canadian Indian tribes will be resolved, and Canadians are entitled to the same angling opportunities as Americans (C. Bull, Ministry of Environment, B.C., Memorandum).

Numeric Fish Increases: MSY after mainstem improvements would increase by 1,153 fish.

ACTIONS: 1-4

1. Investigate feasibility of providing adult passage and juvenile screening at Enloe Dam. A number of issues must be addressed before activities are implemented toward re-establishment of spring chinook. The major issues include 1) water appropriation and potential for further development of water resources in terms of fish production (this requires international involvement); and 2) development of harvest management strategies and escapement goals. This latter requirement must include potential harvest opportunities for Canada.

2. Plant the Similkameen watershed with 2 million fingerlings.

3. Provide water for the lower end of Salmon Creek and return the stream to spring chinook production with release of 125,000 additional fingerlings.

4. Investigate the feasibility of returning Omak and Salmon creeks to spring chinook production and implement fingerling plants if feasible. Barrier

removal, habitat and flow improvements would be needed. Process the effluent from the lumber mill and divert it directly to the Okanogan River.

Cost Estimates: Enloe Dam feasibility study is estimated to cost $80,000 in O&M over two years. [Five alternative fish passage and cost scenarios have been identified at Enloe Dam and reflect 1985 cost estimates (IEC Beak Consultants, 1985); 1) Fishway from falls - $209,600; 2) Fishway below powerhouse - $2,656,000; 3) Trap and haul at falls - $3,611,000; 4) Trap and haul below powerhouse - $3,809,000; and 5) Trap and haul at railroad bridge - $3,973,000.] Pumping water from the Okanogan River using existing pumps to replace water taken from Salmon Creek is estimated to cost $200,000 with annual O & M of $50,000. Costs of laddering Omak Creek and improving the lumber mill effluent is estimated at $100,000 in capitol costs with an O&M of $3,000 annually.

Recommended Strategy

The recommended strategy is Strategy 1. This strategy seeks to re-establish spring chinook in the subbasin by accessing or creating suitable habitat. This strategy was also supported by the SMART analysis (Appendix B) and is consistent with Northwest Power Planning Council policies for guiding the Columbia River Basin Fish and Wildlife Program.

Table 40. System Planning Model results for spring chinook in the Okanogan/Similkameen Subbasin. Baseline value is for pre-mainstem implementation, all other values are post-implementation.

Utilization Objective:
1,000 fish, to be shared between Indian and recreational fisheries according to the United States vs. Oregon agreement.

Biological Objective:
Establish a spring chinook stock and evaluate its productivity. Use of the Leavenworth stock is suggested for initial releases.

Strategy[1]	Maximum[2] Sustainable Yield (MSY)	Total[3] Spawning Return	Total[4] Return to Subbasin	Out of[5] Subbasin Harvest	Contribution[6] To Council's Goal (Index)
Baseline	0 -C	0	0	0	0(0.00)
All Nat	0 -C	0	0	0	0(0.00)
1*	1,153 -C	5,067	6,784	2,086	15,590(0.00)

*Recommended strategy.

[1]Strategy Descriptions:

1. Reintroduce stock through supplementation and implement construction of passage and screening facilities at Enloe Dam. Post Mainstem Implementation.

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

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

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

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

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

OKANOGAN SUMMER CHINOOK

Fisheries Resource

Natural Production

History and Status

Historically, summer chinook were abundant in the middle to upper Columbia River and were endemic in the Okanogan and Similkameen rivers. Prior to hydroelectric dam development, summer chinook migrated as far as Windermere Lake in British Columbia (Fulton 1968). Before completion of Grand Coulee Dam, summer chinook destined for the upper Columbia were intercepted at Rock Island Dam (1939-1941) and released into the Wenatchee, Entiat, Methow and Okanogan rivers. Along with mainstem dams, tributary developments have contributed to the depletion of these fish.

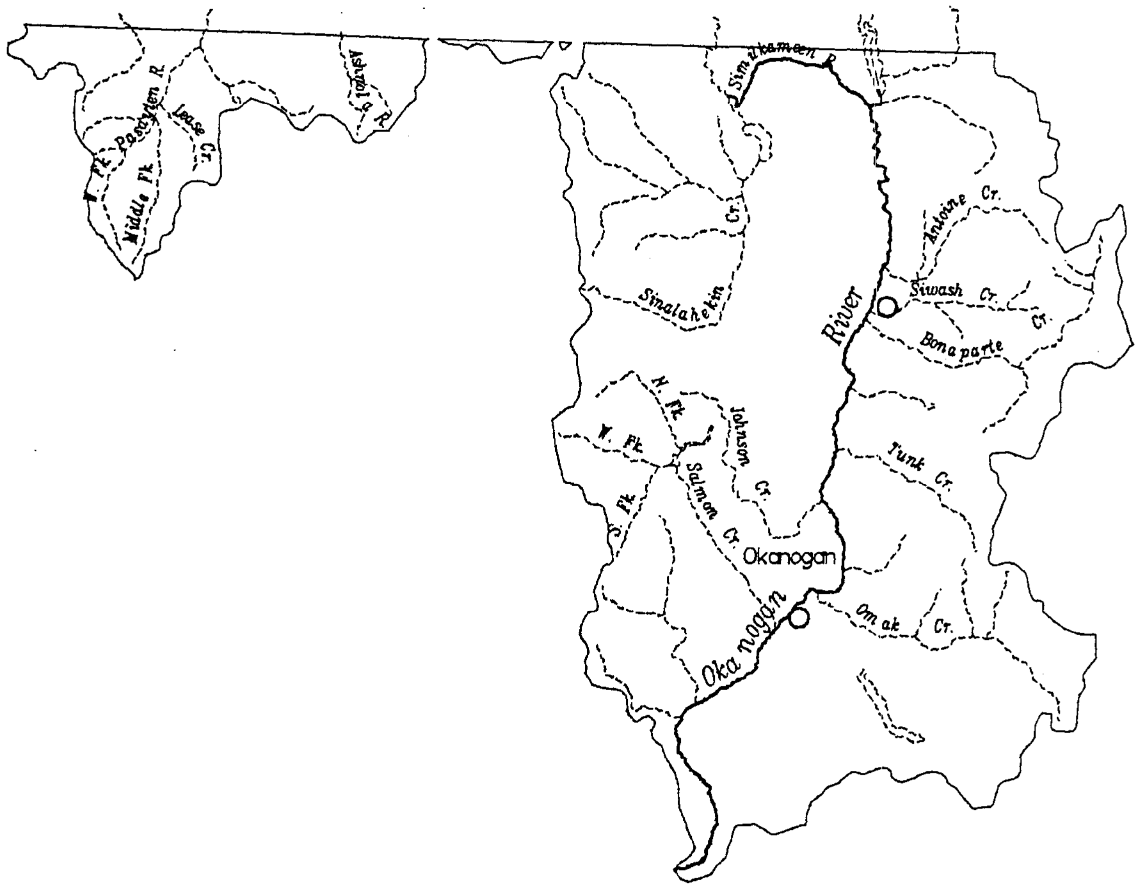
The Northwest Power Planning Council's habitat carrying capacity model estimated potential summer chinook smolt production in the subbasin at 1,435,704 smolts. However, this estimate could be misleading as so little is known about factors limiting production of summer chinook.

Life History and Population Characteristics

Summer chinook in the subbasin are managed for natural production and exploit the middle to upper reaches of the mainstem Okanogan and the area below Enloe Dam in the Similkameen. Run size for the Okanogan and Similkameen basins for 1977 through 1985 averaged 532 and 617 adults, respectively (Table 41). These counts may include a few fish from Wells Dam Hatchery that could have strayed into the system.

Stock characteristics of Okanogan Subbasin summer chinook have not been documented, but are thought to be similar to Wells Dam Hatchery fish, which were previously presented under Methow summer chinook.

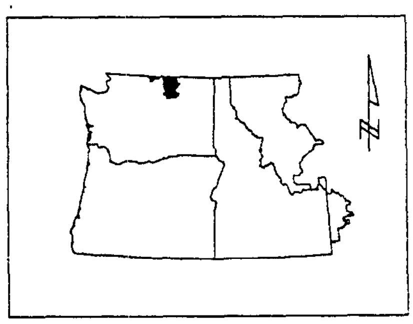
OKANOGAN SUBBASIN



SUMMER CHINOOK DISTRIBUTION*

PRESENT/POTENTIAL

ABSENT



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

GIS GEOGRAPHIC INFORMATION SYSTEM

BONNEVILLE POWER ADMINISTRATION

Table 41. Summer chinook returns to the Okanogan Subbasin.

Year	Okanogan	Similkameen
1977	860	395
1978	484	654
1979	700	553
1980	353	501
1981	444	183
1982	146	380
1983	257	402
1984	991	1253
1985	557	1236
AVE	532	617

Fish Production Constraints

The greatest limitation regarding summer chinook production in the Okanogan Subbasin is the smolt and adult mortalities encountered at Columbia River dams and impoundments. Summer chinook juvenile outmigration occurs from late spring through midfall with the greatest number moving through the system in July and August when Columbia dam or interdam passage flows are not present. Smolt mortalities are suspected to be severe from turbine mortality, predation and loss of physiological readiness to adapt to the marine environment as a result of migration delays.

Summer chinook production in the subbasin is further limited by extensive riparian and instream habitat degradation and warm water temperatures. Accelerated erosion and resulting sedimentation have substantially reduced quality of spawning and rearing habitat. Juvenile and smolt losses at substandard diversions (pump intake screens) may be significant.

Hatchery Production

The Okanogan Subbasin has not been directly supplemented with hatchery fish. However, some adults from releases at Wells Dam may have strayed to the subbasin.

As part of the Rock Island Dam Settlement Agreement (Chelan County PUD), 57,600 pounds (at 10 fish per pound) of smolts are planned for the subbasin. Adults will be collected at Wells or Rock Island Dam and reared at the Chelan PUD Eastbank Hatchery until placed in the Similkameen Rearing Station on the Similkameen River. Additional production of summer chinook may result from the Wells Dam Settlement Agreement (Douglas County PUD) depending on the success of an experimental sockeye net pen project.

Harvest

At this time, a summer chinook recreational fishery is not authorized within the mid to upper Columbia River or any regional tributaries. Such a fishery would be inconsistent with the Columbia River Fish Management Plan.

Historically a tribal fishery existed in the subbasin where fish were captured with primitive weirs (Ray 1972). Currently there is no tribal fishery on the Okanogan. A Colville tribal fishery exists at the base of Chief Joseph Dam. It is unknown if Okanogan Subbasin fish are harvested. There is no formal agreement between the Colville tribe and Washington Department of Fisheries regarding this fishery, but it may become necessary to develop one.

<u>Specific Considerations</u>

The Washington Department of Fisheries currently allows no harvest of Okanogan Subbasin summer chinook due to depressed run size. New hatchery production will use natural origin brood stock. Natural summer chinook production is limited by instream flows, poor instream habitat, sediment and high water temperatures. Currently there is no summer chinook production above Enloe Dam in the Similkameen River although suitable habitat exists. Indian tribes on both sides of the border have cultural concerns regarding re-establishing fish above Enloe.

The Columbia River Fish Management Plan sets the criteria for mainstem commercial fisheries in treaty and non-treaty fisheries. The management plan also establishes a mechanism for developing tributary fishing opportunities as run size exceeds spawning escapement objectives.

The subbasin is located above nine Columbia River dams and smolts and adults are subjected to high cumulative mortalities.

Critical Data Gaps

A life history and biological profile of subbasin summer chinook is needed. The contribution of Wells Hatchery fish to the subbasin is unknown. Egg-to-smolt and smolt-to-adult survivals have not been determined. The importance of Columbia River reservoirs for juvenile rearing needs to be determined.

Objectives

The objectives listed below represent an initial attempt to quantify harvest goals for the subbasin and describe the important biological goals for the stock.

Subbasin fishery needs are one part of a complex regime of existing fisheries management. The Columbia River Fish Management Plan (CRFMP), negotiated over several years by parties active in Columbia River fish management, describes a phased approach to initiating various fisheries as runs rebuild. This harvest management approach must be reflected in realistic subbasin fishery goals. Lower mainstem fisheries and terminal fisheries are planned under the existing CRFMP. How responsive individual subbasin stocks are in rebuilding relative to their lower river harvest management aggregate stock will influence the number of fish available for harvest in the terminal area.

The subbasin utilization or harvest objective reflects the biological goals, subbasin potential and approximate level of fishery identified as desirable in open public meetings. It is expected that these objectives will be refined as additional information and more sophisticated modeling become available through the System Monitoring and Evaluation Program.

Utilization Objective

Achieve returns that will allow the harvest of 2,000 fish to be shared between Indian and recreational fisheries according to the United States vs. Oregon agreement.

Biological Objective

Determine MSY escapement and manage accordingly. Increase the productivity and maintain the unique characteristics of the stock, including the existing balance of spawners in tributaries of the subbasin.

Alternative Strategies

Strategies for summer chinook in this report have specific themes. Means to achieve the objectives are first attempted using natural methods followed by less natural techniques and finally, hatchery production. Actions identified under each strategy are closely related to the theme. Strategies 1 and 2 have natural production themes seeking to improve the productivity of the existing natural stock. Strategy 3 seeks to expand natural production by providing access to habitat presently unavailable. Strategy 4 is a "benign" supplementation strategy, emphasizing actions to develop a single supplemented run with yet higher productivity. Strategy 5 is a hatchery only strategy where only those actions needed to maintain a traditional hatchery program are presented.

Modeling results for each strategy are presented in Table 42 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 42. 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 42a.

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

This strategy provides for prudent stewardship of existing habitat and water quality in the historic distribution range through various existing laws and agreements. Streams in the subbasin need to be inventoried for summer temperature profiles. Those exceeding temperature sensitivity criteria should be classified as such through the Department of Natural Resources so future impacts will be minimized. Water withdrawals should be reduced as possible. Riparian zones should be managed to provide a continuous recruitment of large organic debris. Stream typing should be reviewed and streams should be upgraded as needed.

Hypothesis: Existing habitat, if managed properly, should provide near capacity numbers of natural smolts if adequately seeded. Many irrigation diversions are substandard.

Assumptions: This strategy assumes there will be mainstem water quality benefits from tributary actions, although little tributary water reaches the mainstem during critical times. Action 1 assumes egg-to-smolt survival will be increased by a relative 10 percent. Action 2 assumes smolt-to-smolt survival will be increased from an estimated 85 percent to 95 percent for natural fish.

Numeric Fish Increases: MSY would increase by 994 fish after mainstem program implementation.

ACTIONS: 1-2

1. Maintain at least current level of stream habitat quality and quantity. Seek improved water quality via reduction of sedimentation. Seek legislation to eliminate additional or replacement water withdrawals. Inventory and map habitat.

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

Cost Estimates: Estimated one FTE year to inventory diversion screening needs and inventory and map habitat ($40,000). New screen and refurbishing costs for existing structures (includes implementation and O&M costs) for the first 25 years is estimated at $536,470 (Standard Cost Estimate).

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

Hypothesis: Increasing streamflows will increase suitable habitat thereby increasing smolt capacity. The Oroville-Tonasket Irrigation District (OTID) is proposing to increase the storage capacity of Palmer Lake by constructing wing dams at the lake outlet that empties into the Similkameen River above Enloe Dam. Proposed storage releases of surface water from late July to September is approximately 10,500 acre feet (50 cfs), which will be fully utilized by the irrigation district members. The district, however, has water rights to store up to 200,000 acre feet (100 cfs) in Palmer Lake. Preliminary consultation with Oroville-Tonasket Irrigation District (D. Burton, OTID, pers. commun.) indicated it would be willing to discuss alternative flow release strategies that would benefit irrigation and fisheries interests. Okanogan County PUD (L. Felton, pers. commun.) is pursuing relicensing of the abandoned Enloe Dam facility, and indicated that the irrigation district may be entitled to energy credits by providing supplemental flows for power generation at Enloe Dam.

Brennan (1938) indicated the surface water temperature of Palmer Lake can be 70+ F in summer; surface release of water will exacerbate existing temperature problems in the lower Similkameen and Okanogan rivers below Oroville. Thermal stratification occurs around 25 feet in the lake; water temperatures for July to August range from 49 F to 55 F (Brennan 1938). Cooler water (50 cfs to 100 cfs) would improve August to September river temperatures and habitat quality. Accessing this cooler water would require either a siphon or pump system. A siphon system would have to go 12 to 15 miles to obtain adequate head differential and construction costs might be prohibitive (J. Mayo, CH2 M Hill, pers. commun.). This action must be evaluated by a hydraulic engineering consulting firm.

Assumptions: This strategy assumes state water law will be modified to allow saved or additional water to be dedicated to fisheries enhancement purposes and not revert to junior consumptive water rights. This strategy assumes smolt capacity will be increased by 20 percent.

Numeric Fish Increases: MSY would increase by 1,338 fish after mainstem program implementation.

ACTIONS: 1-5

1. -
2. -

3. Implement water conservation or water rights acquisition measures. These conservation or water rights acquisition measures might include conversion to sprinkler irrigation systems, lining of earthen irrigation ditches and/or conversion to pump irrigation systems.

4. Retain a consulting engineer to examine the feasibility of constructing a dam at Palmer Lake where hypolimnic withdrawals can be made in the summer and fall.

5. Construct a dam at Palmer Lake to provide 100 cfs of cool water to the Similkameen River in summer and fall, provided Action 4 returns positive results.

Cost Estimates: Water conservation measures and acquisition of water rights is estimated to cost $2 million. Preliminary data from the Oroville-Tonasket Irrigation District indicates that it will cost approximately $800,000 to construct a dam at the mouth of Palmer Lake. Costs associated with retaining a hydraulic engineering consulting firm to evaluate a syphon or pump delivery system are estimated at $150,000.

STRATEGY 3: Habitat Base Increase. This strategy seeks to increase by providing passage into inaccessible areas.

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

Assumptions: This strategy assumes capacity above Enloe Dam is 1.5 million smolts. This strategy also assumes smolt-to-smolt survival will be 85 percent for those fish above Enloe. The Canadian government supports fish passage at Enloe Dam provided disease transfer concerns and safeguards are adequately addressed, cultural concerns of both United States and Canadian Indian tribes will be resolved, and Canadians are entitled to the same angling opportunities as

Americans (C. Bull, Ministry of Environment, B.C., Memorandum).

Numeric Fish Increases: MSY would increase by 2,192 fish after mainstem program implementation.

ACTIONS: 1-6

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

6. Investigate feasibility of providing adult passage and juvenile screening at Enloe Dam. A number of issues must be addressed before providing passage. The major issues include 1) water appropriation and potential for further development of water resources in terms of fish production (this requires international involvement); and 2) development of harvest management strategies and escapement goals. This latter requirement must include potential harvest opportunities for Canada.

Cost Estimates: Enloe Dam feasibility study is estimated to cost $80,000 in O&M over two years. [Five alternative fish passage and cost scenarios have been identified at Enloe Dam and reflect 1985 cost estimates (IEC Beak Consultants, 1985); 1) Fishway from falls - $209,600; 2) Fishway below powerhouse - $2,656,000; 3) Trap and haul at falls - $3,611,000; 4) Trap and haul below powerhouse - $3,809,000; and 5) Trap and haul at railroad bridge - $3,973,000.]

STRATEGY 4: Supplementation. This strategy seeks to achieve the objectives by supplementing natural production with an appropriate existing hatchery stock or natural stock. Any actions identified in Strategies 1, 2 or 3 necessary for the success of the supplementation program are also required.

Hypothesis: By using natural stock for hatchery releases, relative fitness should be improved and genetic identity of natural fish will be maintained. Also, the relative fitness of hatchery progeny should be increased. This strategy reflects the Rock Island Dam Settlement Agreement.

Assumptions: Action 5 assumes relative smolt survival of hatchery fish is 0.67 and viability of naturally spawning hatchery-hatchery and hatchery-natural progeny will increase by a relative 10 percent.

Numeric Fish Increases: MSY would increase by 5,973 fish after mainstem program implementation.

ACTIONS: 1-9

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

7. Use natural brood stock for hatchery programs.

8. Construct an acclimation pond for 576,000 smolts on the Similkameen River.

9. Plant 576,000 hatchery smolts as part of the Rock Island Settlement Agreement.

Costs: Actions 7-9 are presently being paid for through the Rock Island Settlement Agreement. Rearing ponds are estimated to cost about $2 million.

Recommended Strategy

The recommended strategy is Strategy 4. This strategy seeks to inventory, repair and aggressively guard habitat while using natural fish for hatchery brood stock. In addition, potential passage above Enloe Dam would substantially increase natural production. Use of natural brood stock for hatchery supplementation should reduce genetic impacts on natural fish. This strategy is also supported by the SMART analysis (Appendix B).

Table 42. System Planning Model results for summer chinook in the Okanogan/Similkameen Subbasin. Baseline value is for pre-mainstem implementation, all other values are post-implementation.

Utilization Objective:
2,000 fish harvest to be shared between Indian and recreational fisheries according to the United States vs. Oregon agreement.

Biological Objective:
Determine MSY escapement and manage accordingly. Increase the productivity and maintain the unique characteristics of the stock, including the existing balance of spawners in tributaries of the subbasin.

Strategy[1]	Maximum[2] Sustainable Yield (MSY)	Total[3] Spawning Return	Total[4] Return to Subbasin	Out of[5] Subbasin Harvest	Contribution[6] To Council's Goal (Index)
Baseline	70 -C	838	1,001	471	0(1.00)
All Nat	2,262 -C	4,784	7,298	3,430	15,397(7.29)
1	1,064 -C	2,131	3,432	1,613	5,945(3.43)
2	1,408 -C	2,715	4,266	2,005	7,983(4.26)
3	2,262 -C	4,784	7,298	3,430	15,397(7.29)
4*	6,043 -C	5,830	12,333	5,796	27,706(12.32)

*Recommended strategy.

[1] Strategy descriptions:

1. Aggressive habitat protection, upgrade diversions, etc. Post Mainstem Implementation.
2. Strategy 1 plus augment water flows to increase natural smolt capacity and pre-spawning survival. Post Mainstem Implementation.
3. Strategy 2 plus passage at Enloe Dam. Post Mainstem Implementation.
4. Strategy 3 plus 1,520,000 hatchery smolts. Post Mainstem Implementation.

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

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

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

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

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

Table 42a. Estimated costs of alternative strategies for Okanogan summer chinook. Cost estimates represent new or additional costs to the 1987 Columbia River Basin Fish and Wildlife Program; they do not represent projects funded under other programs, such as the Lower Snake River Compensation Plan or a public utility district settlement agreement. (For itemized costs, see Appendix C.)

	Proposed Strategies			
	1	2	3	4*
Hatchery Costs				
Capital[1]	0	0	0	0
O&M/yr[2]	0	0	0	0
Other Costs				
Capital[3]	1,000,000	4,200,000	4,200,000	4,200,000
O&M/yr[4]	800	600,800	602,400	602,400
Total Costs				
Capital	1,000,000	4,200,000	4,200,000	4,200,000
O&M/yr	800	600,800	602,400	602,400

* Recommended strategy.

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

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

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

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

OKANOGAN FALL CHINOOK

As evidenced by dam counts (Table 32 above), a small but persistent run of fall chinook has always returned to the upper Columbia River. Little quantitative information exists on these fish except the dam counts. Timing has also cast some doubt on the classification of these fish, some observers feeling that a number of summer chinook might have been included. Spawning locations, except for an area near the mouths of the Wenatchee and Chelan Rivers went unnoticed until recently.

Upriver bright fall chinook run sizes to the Columbia River have increased dramatically since 1984. These increases have been reflected in sharply higher spawning escapements in the Hanford Reach, the free-flowing stretch of the Columbia between Priest Rapids and McNary dams. Coincident with these observations and the cessation of trapping for fall chinook at Priest Rapids Dam, scattered concentrations of spawners began to show up in locations like Sand Hollow Creek, a tributary of Wanapum Reservoir; selected locations in Wanapum and Priest Rapids Reservoirs; in the tailrace of Wells Dam; and the lower end of the Okanogan, Methow, Chelan, Entiat and Wenatchee rivers. These isolated concentrations were either a direct result of increased production in the Hanford Reach ("over runs" that actually originated from the Hanford Reach) or are just indications of improved production conditions for existing populations that may have benefitted from the same conditions that the Hanford Reach has. Either way, it remains to be seen if these production units persist past the current high levels of returns to the Hanford Reach.

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

With the limited information available at this time, it does not seem reasonable to propose production strategies for this stock. However, the status of fall chinook should be evaluated and monitored annually. This will require the continuation of the detailed spawning ground surveys conducted since 1987 by the Yakima Tribe and funded by Chelan County PUD. These surveys have identified that there is a spatial and temporal separation between summer and fall chinook spawning in the Okanogan River (Kohn 1987). Since fall chinook were not a part of this contract work, the redd counts are incomplete. In 1987, however, 40 redds were counted through November 13. These redds were scattered throughout the lower river to the area around Riverside. No final counts were attempted. In 1988 poor survey conditions precluded observations.

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

OKANOGAN SOCKEYE

Fisheries Resource

Natural Production

History and Status

Sockeye originally inhabited eight upper Columbia River lakes, but now only Lakes Osoyoos and Wenatchee remain (Mullan 1984). In the subbasin, sockeye were once present above Lake Okanogan (C. Bull, Ministry of Environment, B.C., pers. commun.). In 1939, sockeye were collected at Rock Island Dam as part of the Grand Coulee Fish Maintenance Project and transported to Lake Osoyoos or Lake Wenatchee, or to one of three hatcheries on the Wenatchee, Entiat and Methow rivers. Presently, upstream passage is prevented below Lake Vaseaux at an impassable irrigation diversion. Okanogan sockeye primarily spawn in the upper Okanogan mainstem above Lake Osoyoos, although some lake spawning occurs. Natural sockeye runs in the subbasin have fluctuated from 113,232 to 7,458 adults between 1967 and 1987.

Life History and Population Characteristics

Sockeye first enter the Columbia River in late May and early June with counts peaking at Bonneville Dam in late June to early July. Peak migration over Wells Dam occurs in late July through early August. Generally, sockeye reach Lake Osoyoos in late August to early September, however, warm water in the Okanogan River can cause a delay. Spawning generally peaks in mid-October. Sockeye counts at Wells Dam for 1980 through 1987 averaged 38,848 fish (Table 43). An unknown proportion of these survive to spawn primarily above Lake Osoyoos.

Little is known of Okanogan sockeye biological characteristics. Data for 1955 through 1974 indicates 60 percent of the population is age 3 (freshwater and ocean), although it has varied from 6.8 percent to 94.4 percent (Mullan 1986). Age-4 fish are thought to comprise most other fish, although not verified. In 1972, males comprised 72 percent of the population less than 18 inches in length and were assumed to be age-3 fish (Allen and Meekin 1973). Four-year-old sockeye were 47 percent males. Stockley and Meekin (1967) reported lengths of female and male sockeye in the Okanogan averaged 51 cm and 47 cm, respectively. No weight data was found. Fecundity of Okanogan sockeye is unknown, however, based on Leavenworth, Entiat and Winthrop hatcheries data for 1944 through 1964, 2,600 eggs per female is assumed.

Fry emerge in late March through early April. Most rear for about a year before outmigration although a small number may remain for an additional year (Mullan 1984). Smolt-to-adult survival rates are unknown. Egg-to-smolt survival is probably about 3 percent on average escapements (Mullan 1987).

Estimates of sockeye smolt production from the Okanogan Basin (Lake Osoyoos) are not included in the Northwest Power Planning Council's carrying capacity model, however, estimates of potential production range from 0.5 million to 2.1 million smolts (Meekin and Allen 1980).

Table 43. Okanogan sockeye run size (Wells Dam counts).

Year	Tribal Catch	Escapement
1967	No Data	113,232
1968	" "	81,530
1969	" "	17,352
1970	" "	50,667
1971	" "	48,172
1972	" "	33,398
1973	" "	37,178
1974	" "	16,716
1975	" "	22,286
1976	" "	27,619
1977	" "	21,973
1978	" "	7,458
1979	" "	22,655
1980	33	26,540
1981	230	28,004
1982	140	18,865
1983	228	27,697
1984	48	81,006
1985	44	53,126
1986	94	34,782
1987	68	39,880
	AVE 110	38,578

Supplementation History

Beginning in 1939, sockeye were collected at Rock Island Dam as part of the Grand Coulee Fish Maintenance Project and transported to Lake Osoyoos or Lake Wenatchee or to one of three hatcheries on the Wenatchee, Entiat and Methow rivers. Eggs and brood stock for the Methow and Okanogan subbasins were collected at Rock Island Dam, Carson Hatchery, Leavenworth Hatchery, Lake Wenatchee and Lake Whatcom (kokanee adults). Both the Methow and Okanogan subbasins were planted from Winthrop Hatchery and/or Leavenworth Hatchery from 1942 through 1958 (Table 44). Performance of past hatchery programs is unknown.

As part of the Wells Dam Settlement Agreement (Douglas County PUD) and the Rock Island Settlement Agreement (Chelan County PUD), experimental net pen programs are proposed for sockeye rearing in Lake Osoyoos and/or Palmer Lake. Depending on success, about 40,000 pounds of juveniles will be reared.

Table 44. Releases of hatchery sockeye into the Okanogan Subbasin (Mullan 1986; B. Kinnear, USFWS, pers. commun.).

Release Year	Hatchery & Stock	Number Released	#/lb	Release Location	Adult Brood Collection Site
1941	Leavenworth	569,296	95	Osoyoos	Rock Island Dam
1943	Leavenworth	84,456	117	Osoyoos	Rock Island Dam
1944	Leavenworth	510,911	106	Osoyoos	Rock Island Dam
	Winthrop	577,227	90	Osoyoos	Rock Island Dam
1947	Winthrop	337,590	95	Osoyoos	Methow River
1949	Winthrop	524,400	46	Osoyoos	Methow River
1958	Winthrop	627,460	32	Osoyoos	Lk. Wenatchee
	Winthrop	466,678	26	Osoyoos	Lk. Wenatchee

Fish Production Constraints

The greatest limitation regarding sockeye production in the Okanogan Basin is the smolt and adult mortalities encountered at each of nine Columbia River dams.

The greatest habitat impacts on the stock have occurred in Canada where spawning areas have been channelized for flood control, greatly reducing the quality of the spawning habitat. Vasseux Dam prevents sockeye from using Okanogan Lake.

Harvest

Historically, a ceremonial and subsistence tribal fishery existed in the Okanogan Basin where fish were captured by weirs and spearing (Ray 1972). Currently there is no tribal fishery on the Okanogan. A Colville tribal fishery exists at the base of Chief Joseph Dam where harvest averaged 110 fish per year for 1980 through 1987. There is no formal agreement between the Colville Tribes and Washington Department of Fisheries regarding this fishery. Canadian natives fish for sockeye above Lake Osoyoos.

Between 1977 and 1982, no commercial catch on sockeye was allowed in the lower Columbia River with only limited ceremonial and subsistence take in Zone 6. After 1983, commercial harvest has been permitted in the lower river (Table 45). Catch is composed of both Wenatchee and Okanogan origin fish. Okanogan origin fish are thought to make up about 50 percent of the lower river harvest. Using Rock Island and Rocky Reach dam counts to determine the relative strength of the two runs suggests that the recent (1980-1989) average aggregate run was composed of about 55 percent Okanogan fish. However, age composition in the catch suggests a slightly higher harvest rate on Wenatchee River fish.

Table 45. Commercial and ceremonial and subsistence harvest (in thousands) of sockeye in the lower Columbia River (Columbia River Fish Runs and Fisheries 1960-1986).

	Catch by Zones		
Year	1-5 Commercial	6 Commercial	6 C & S
1977	0.0	0.1	1.9
1978	0.0	0.0	0.1
1979	0.0	0.0	0.1
1980	0.0	0.0	0.6
1981	0.0	0.0	1.5
1982	0.0	0.0	0.7
1983	0.0	1.8	1.5
1984	9.1	22.5	2.1
1985	31.9	49.4	0.6
1986	1.8	4.3	0.0
1987	28.3	39.5	0.0
1988	17.5	31.0	0.0

Specific Considerations

The Columbia River Fish Management Plan sets the criteria for mainstem fisheries.

Natural production in the Okanogan Basin is limited by poor instream flows, numerous irrigation diversions, sediment, and high water temperatures. High water temperatures in the lower Okanogan in late summer are suspected of inflicting substantial mortalities through disease and reduction of spawning fitness resulting from delay of upstream migration. Protection and enhancement of habitat is a high priority and should be coordinated with the provincial government of British Columbia. Adults hold in the Canadian portion of Lake Osoyoos after arrival in the lake and most spawning occurs in Canada. The International Joint Commission controls the amount and quantity of water released into Lake Osoyoos at all times of the year.

The Okanogan Subbasin is located above nine Columbia River dams and smolts and adults are subjected to high mortalities at each facility.

Critical Data Gaps

Data deficiencies regarding the freshwater life history and egg-to-smolt and smolt-to-adult survival of sockeye in the Okanogan are numerous. Carrying capacity is necessary to establish escapement goals consistent with habitat limitations and to provide a quantitative basis for evaluating the benefits associated with habitat improvement or enhancement efforts.

Objectives

The objectives listed below represent an initial attempt to quantify harvest goals for the subbasin and describe the important biological goals for the stock.

Subbasin fishery needs are one part of a complex regime of existing fisheries management. The Columbia River Fish Management Plan (CRFMP), negotiated over several years by parties active in Columbia River fish management, describes a phased approach to initiating various fisheries as runs rebuild. This harvest management approach, must be reflected in realistic subbasin fishery goals. Lower mainstem fisheries and terminal fisheries are planned under the existing CRFMP. How responsive individual subbasin stocks are in rebuilding relative to their lower river harvest management aggregate stock will influence the number of fish available for harvest in the terminal area.

The subbasin utilization or harvest objective reflects the biological goals, subbasin potential and approximate level of fishery identified as desirable in open public meetings. It is expected that these objectives will be refined as additional information and more sophisticated modeling become available through the System Monitoring and Evaluation Program.

Utilization Objective

Harvest 15,000 fish, to be shared between Indian and recreational fisheries according to the United States vs. Oregon agreement.

Biological Objective

Increase the productivity and maintain the unique characteristics of the stock. Determine MSY escapement and manage accordingly.

Alternative Strategies

Strategies for sockeye in this report have specific themes. Means to obtain the objectives are first attempted using natural methods followed by less natural techniques and finally, hatchery production. Actions identified under each strategy are closely related to the theme. Strategies 1 and 2 have natural production themes seeking to improve the productivity of the existing natural stock. Strategy 3 seeks to expand natural production by providing access to habitat presently unavailable. Strategy 4 is a "benign" supplementation strategy, emphasizing actions to develop a single supplemented run with yet higher productivity.

The System Planning Group did not model sockeye and consequently, no fish production increases are generated. The recommended strategy is based on subjective estimates of the most viable strategy to improve return numbers.

Estimated costs of the alternative strategies below are summarized in Table 46.

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

This strategy provides for prudent stewardship of existing habitat and water quality in the historic distribution range through various existing laws and agreements.

Hypothesis: Existing habitat, if managed properly, should provide near capacity numbers of natural smolts if adequately seeded.

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

ACTIONS: 1, 2

1. Maintain at least current level of stream habitat quality and quantity. Seek improved water quality via reduction of sedimentation. Seek legislation to eliminate additional or replacement water withdrawals.

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

Cost Estimates: Estimated one FTE year to inventory diversion screening needs and inventory and map habitat ($40,000). New screen and refurbishing costs for existing structures (includes implementation and O&M costs) for the first 25 years is estimated at $536,470 (Standard Cost Estimate).

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

Hypothesis: Sockeye upstream migration is delayed as the result of high water temperatures in the Okanogan River, resulting in spawning delays, increased pre-spawning mortality, and reduced spawning fitness. Low flows between Vaseaux Dam and the head of Lake Osoyoos limit available spawning areas. Improvements in late summer and fall water supplies, and reduction in water temperatures in the subbasin will substantially improve pre-spawning survival and reproductive success.

The Oroville-Tonasket Irrigation District is proposing to increase the storage capacity of Palmer Lake by constructing wing dams at the lake outlet that empties into the Similkameen River above Enloe Dam. Proposed storage releases from late July to September is about 50 cfs, which will be fully utilized by irrigation district members. The district, however, has water rights to store up to 200,000 acre feet (100 cfs). Preliminary consultation with the Oroville-Tonasket Irrigation District (D. Burton, OTID, pers. commun.) indicates it would be willing to discuss alternative flow release strategies that would benefit both irrigation and fisheries interests. Okanogan County PUD (L. Felton, pers. commun.) is actively pursuing relicensing of the abandoned Enloe Dam facility and has indicated the irrigation district may be entitled to energy credits by providing supplemental late season flows in the Similkameen River for power generation at Enloe Dam.

Brennan (1938) indicated surface water temperature of Palmer Lake can be 70+ F during late July to August; surface releases of water could exacerbate existing temperature problems in the Okanogan River below Oroville. Thermal stratification occurs around 25 feet and water temperatures for July to August range from 49 F to 55 F (Brennan 1938). Water at this temperature would improve the August to

September water temperatures and habitat quality in the mid-Okanogan River. Delivering cooler water would require a siphon or pump system. A siphon system would have to go 12 to 15 miles to obtain adequate head differential and construction costs might be prohibitive (J. Mayo, CH2 M Hill, pers. commun.). This action should be evaluated by a hydraulic engineering firm to determine how temperatures would be affected in the Okanogan River.

Assumptions: This strategy assumes state water law could be modified to allow saved or additional water to be dedicated to fisheries enhancement purposes and not revert to consumptive junior water rights.

ACTIONS: 1-5

1. -
2. -

3. Implement water conservation or water rights acquisition measures.

4. Retain a consulting engineer to examine the feasibility of constructing a dam at Palmer Lake where hypolimnic withdrawals can be made in the summer and fall.

5. Construct a dam at Palmer Lake to provide 100 cfs of cool water to the Similkameen River in summer and fall, provided Action 4 returns positive results.

Cost Estimates: Water conservation measures and acquisition of water rights is estimated to cost $2 million. Preliminary data from Oroville-Tonasket Irrigation District indicates that it will cost approximately $800,000 to construct a dam at the mouth of Palmer Lake. Costs associated with retaining a hydraulic engineering consulting firm to evaluate a syphon or pump delivery system are estimated at $150,000.

STRATEGY 3: Supplementation. This strategy seeks to achieve the objectives by supplementing natural production with an appropriate existing hatchery stock or natural stock.

Hypothesis: By using natural stock for hatchery releases, relative fitness should be improved and genetic identity of natural fish will be maintained. Also, the relative fitness of hatchery progeny should be increased. This strategy reflects the mid-Columbia settlement agreements.

Assumptions: This strategy assumes net pen rearing of sockeye will be successful. Net pen culture of sockeye is still somewhat experimental.

ACTIONS: 1-7

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

6. Use natural brood stock for hatchery programs.

7. Construct net pens for 2 million smolts.

Costs: Actions 6-7 are presently being paid for through the Rock Island Dam and Wells Dam settlement agreements.

Recommended Strategy

The recommended strategy is Strategy 3. This strategy seeks to inventory and improve habitat, especially water quality, while using natural fish for a net pen supplementation program. Use of natural brood stock for hatchery supplementation should reduce genetic impacts on natural fish.

Table 46. Estimated costs of alternative strategies for Okanogan sockeye. 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]	1,000,000	4,200,000	4,200,000
O&M/yr[4]	800	600,800	600,800
Total Costs			
Capital	1,000,000	4,200,000	4,200,000
O&M/yr	800	600,800	600,800

* Recommended strategy.

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

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

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

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

PART V. SUMMARY AND IMPLEMENTATION

Objectives and Recommended Strategies

Methow Summer Steelhead

The objective calls for a subbasin harvest of zero natural and 10,000 hatchery fish. Planners recommend Strategy 3, which seeks to inventory, repair and aggressively guard habitat while using natural fish for hatchery brood stock. Also, enumeration of natural smolt production at Wells Dam is sought for management purposes.

Methow Spring Chinook

The objective is to provide a subbasin harvest of 2,000 fish. Planners recommend Strategy 5, which seeks to inventory, repair and aggressively guard habitat while supplementing natural fish with 550,000 smolts as per the Rock Island and Wells Dam settlement agreements; increase the Winthrop Hatchery production to 1.4 million smolts; improve the brood stock for the hatchery; and construct 10 groundwater channels.

Methow Summer Chinook

The objective is to provide a subbasin harvest of 3,000 fish. Planners recommend Strategy 4, which seeks to inventory, repair and aggressively guard habitat while supplementing natural fish with 400,000 yearlings and 400,000 fingerlings as per the Rock Island and Wells Dam settlement agreements.

Okanogan Summer Steelhead

The objective is to provide a subbasin harvest of zero natural and 10,000 hatchery fish. Strategy 4 is recommended, which seeks to inventory, repair and aggressively guard habitat while using natural fish for hatchery brood stock, reclaiming Salmon and Omak creeks via replacing irrigation water from the river, and studying the feasibility of providing passage at Enloe Dam. Also, enumeration of natural smolt production at Wells Dam is sought for management purposes.

Okanogan Spring Chinook

The objective is to re-establish a run and provide a subbasin harvest of 1,000 fish. Planners recommend Strategy 1, which studies the feasibility of passage over Enloe Dam; reclaims Salmon and Omak creeks via replacing creek water used for irrigation water with river water; and seeds the watershed with 2 million fingerlings to initiate the run.

Okanogan Summer Chinook

The objective is to provide harvest of 2,000 fish. Planners recommend Strategy 4, which calls for aggressively protecting habitat; upgrading irrigation diversions; conserving water or acquiring water rights; examining the feasibility of constructing (and implementing if feasible) a dam on Palmer Lake to increase flow and cool temperatures; studying the feasibility of providing passage over Enloe Dam; and supplementing the stock with 576,000 smolts as per the Rock Island Dam Settlement Agreement.

Okanogan Sockeye

The objective calls for providing harvest of 15,000 fish. Planners recommend Strategy 3, which consists of aggressively protecting habitat; upgrading irrigation diversions; conserving water or acquiring water rights; examining the feasibility of constructing (and implementing if feasible) a dam on Palmer Lake to increase flow and cool temperatures; and supplementing the stock with net pen reared fish as per the Rock Island Dam and Wells Dam settlement agreements.

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: Methow Stock: Summer steelhead Strategy: 1

Criteria	Rating	Confidence	Weight	Utility	Discount Utility
1 EXT OBJ	4	0.6	20	80	48
2 CHG MSY	2	0.6	20	40	24
3 GEN IMP	7	0.6	20	140	84
4 TECH FEAS	5	0.9	20	100	90
5 PUB SUPT	5	0.6	20	100	60
TOTAL VALUE				460	
DISCOUNT VALUE					306
CONFIDENCE VALUE					0.67

Subbasin: Methow Stock: Summer steelhead Strategy: 2

Criteria	Rating	Confidence	Weight	Utility	Discount Utility
1 EXT OBJ	4	0.6	20	80	48
2 CHG MSY	3	0.6	20	60	36
3 GEN IMP	7	0.6	20	140	84
4 TECH FEAS	2	0.3	20	40	12
5 PUB SUPT	4	0.6	20	80	48
TOTAL VALUE				400	
DISCOUNT VALUE					228
CONFIDENCE VALUE					0.57

Subbasin: Methow Stock: Summer steelhead Strategy: 3

Criteria	Rating	Confidence	Weight	Utility	Discount Utility
1 EXT OBJ	5	0.9	20	100	90
2 CHG MSY	4	0.6	20	80	48
3 GEN IMP	8	0.6	20	160	96
4 TECH FEAS	8	0.9	20	160	144
5 PUB SUPT	9	0.9	20	180	162
TOTAL VALUE				680	
DISCOUNT VALUE					540
CONFIDENCE VALUE					0.79

Subbasin: Methow Stock: Spring Chinook Strategy: 1

Criteria	Rating	Confidence	Weight	Utility	Discount Utility
1 EXT OBJ	3	0.6	20	60	36
2 CHG MSY	3	0.6	20	60	36
3 GEN IMP	2	0.9	20	40	36
4 TECH FEAS	5	0.6	20	100	60
5 PUB SUPT	6	0.6	20	120	72
TOTAL VALUE				380	
DISCOUNT VALUE					240
CONFIDENCE VALUE					0.63

Subbasin: Methow Stock: Spring Chinook Strategy: 2

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

Subbasin: Methow Stock: Spring Chinook Strategy: 3

Criteria	Rating	Confidence	Weight	Utility	Discount Utility
1 EXT OBJ	5	0.6	20	100	60
2 CHG MSY	6	0.6	20	120	72
3 GEN IMP	3	0.9	20	60	54
4 TECH FEAS	8	0.6	20	160	96
5 PUB SUPT	6	0.6	20	120	72
TOTAL VALUE				420	
DISCOUNT VALUE					258
CONFIDENCE VALUE					0.61

Subbasin: Methow		Stock: Spring Chinook		Strategy: 4

Criteria	Rating	Confidence	Weight	Utility	Discount Utility
1 EXT OBJ	5	0.6	20	100	60
2 CHG MSY	6	0.6	20	120	72
3 GEN IMP	3	0.9	20	60	54
4 TECH FEAS	9	0.9	20	180	162
5 PUB SUPT	6	0.9	20	120	108
TOTAL VALUE				580	
DISCOUNT VALUE					456
CONFIDENCE VALUE					0.79

Subbasin: Methow		Stock: Spring Chinook		Strategy: 5

Criteria	Rating	Confidence	Weight	Utility	Discount Utility
1 EXT OBJ	5	0.6	20	100	60
2 CHG MSY	6	0.6	20	120	72
3 GEN IMP	3	0.9	20	60	54
4 TECH FEAS	8	0.6	20	160	96
5 PUB SUPT	6	0.6	20	120	72
TOTAL VALUE				420	
DISCOUNT VALUE					258
CONFIDENCE VALUE					0.61

Subbasin: Methow Stock: Summer Chinook Strategy: 1

Criteria	Rating	Confidence	Weight	Utility	Discount Utility
1 EXT OBJ	3	0.6	20	60	36
2 CHG MSY	3	0.6	20	60	36
3 GEN IMP	2	0.9	20	40	36
4 TECH FEAS	5	0.6	20	100	60
5 PUB SUPT	6	0.6	20	120	72
TOTAL VALUE				380	
DISCOUNT VALUE					240
CONFIDENCE VALUE					0.63

Subbasin: Methow Stock: Summer Chinook Strategy: 2

Criteria	Rating	Confidence	Weight	Utility	Discount Utility
1 EXT OBJ	5	0.9	20	100	90
2 CHG MSY	5	0.6	20	100	60
3 GEN IMP	2	0.9	20	40	36
4 TECH FEAS	6	0.6	20	120	72
5 PUB SUPT	6	0.6	20	120	72
TOTAL VALUE				480	
DISCOUNT VALUE					330
CONFIDENCE VALUE					0.69

Subbasin: Methow Stock: Summer Chinook Strategy: 3

Criteria	Rating	Confidence	Weight	Utility	Discount Utility
1 EXT OBJ	5	0.9	20	100	90
2 CHG MSY	6	0.9	20	120	108
3 GEN IMP	2	0.9	20	40	36
4 TECH FEAS	6	0.9	20	120	108
5 PUB SUPT	6	0.6	20	120	72
TOTAL VALUE				500	
DISCOUNT VALUE					414
CONFIDENCE VALUE					0.83

Subbasin: Methow Stock: Summer Chinook Strategy: 4

Criteria	Rating	Confidence	Weight	Utility	Discount Utility
1 EXT OBJ	5	0.9	20	100	90
2 CHG MSY	5	0.6	20	100	60
3 GEN IMP	2	0.9	20	40	36
4 TECH FEAS	7	0.6	20	140	84
5 PUB SUPT	5	0.9	20	100	90
TOTAL VALUE				480	
DISCOUNT VALUE					360
CONFIDENCE VALUE					0.75

Subbasin: Okanogan Stock: Summer Steelhead Strategy: 1

Criteria	Rating	Confidence	Weight	Utility	Discount Utility
1 EXT OBJ	4	0.6	20	80	48
2 CHG MSY	2	0.6	20	40	24
3 GEN IMP	7	0.6	20	140	84
4 TECH FEAS	5	0.9	20	100	90
5 PUB SUPT	5	0.6	20	100	60
TOTAL VALUE				460	
DISCOUNT VALUE					306
CONFIDENCE VALUE					0.67

Subbasin: Okanogan Stock: Summer Steelhead Strategy: 2

Criteria	Rating	Confidence	Weight	Utility	Discount Utility
1 EXT OBJ	4	0.6	20	80	48
2 CHG MSY	3	0.6	20	60	36
3 GEN IMP	7	0.6	20	140	84
4 TECH FEAS	5	0.6	20	100	60
5 PUB SUPT	6	0.6	20	120	72
TOTAL VALUE				500	
DISCOUNT VALUE					300
CONFIDENCE VALUE					0.60

Subbasin: Okanogan Stock: Summer Steelhead Strategy: 3

Criteria	Rating	Confidence	Weight	Utility	Discount Utility
1 EXT OBJ	7	0.9	20	140	126
2 CHG MSY	5	0.6	20	100	60
3 GEN IMP	8	0.6	20	160	96
4 TECH FEAS	7	0.9	20	140	126
5 PUB SUPT	7	0.9	20	140	126
TOTAL VALUE				500	
DISCOUNT VALUE					534
CONFIDENCE VALUE					0.79

Subbasin: Okanogan Stock: Summer Steelhead Strategy: 4

Criteria	Rating	Confidence	Weight	Utility	Discount Utility
1 EXT OBJ	8	0.6	20	160	96
2 CHG MSY	6	0.6	20	120	72
3 GEN IMP	8	0.9	20	160	144
4 TECH FEAS	7	0.6	20	140	84
5 PUB SUPT	7	0.6	20	140	84
TOTAL VALUE				720	
DISCOUNT VALUE					480
CONFIDENCE VALUE					0.67

Subbasin: Okanogan Stock: Spring Chinook Strategy: 1

Criteria	Rating	Confidence	Weight	Utility	Discount Utility
1 EXT OBJ	3	0.6	20	60	36
2 CHG MSY	3	0.6	20	60	36
3 GEN IMP	2	0.9	20	40	36
4 TECH FEAS	5	0.6	20	100	60
5 PUB SUPT	6	0.6	20	120	72
TOTAL VALUE				380	
DISCOUNT VALUE					240
CONFIDENCE VALUE					0.63

Subbasin: Okanogan Stock: Summer Chinook Strategy: 1

Criteria	Rating	Confidence	Weight	Utility	Discount Utility
1 EXT OBJ	3	0.6	20	60	36
2 CHG MSY	3	0.6	20	60	36
3 GEN IMP	2	0.9	20	40	36
4 TECH FEAS	5	0.6	20	100	60
5 PUB SUPT	6	0.6	20	120	72
TOTAL VALUE				380	
DISCOUNT VALUE					240
CONFIDENCE VALUE					0.63

Subbasin: Okanogan Stock: Summer Chinook Strategy: 2

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

Subbasin: Okanogan Stock: Summer Chinook Strategy: 3

Criteria	Rating	Confidence	Weight	Utility	Discount Utility
1 EXT OBJ	5	0.6	20	100	60
2 CHG MSY	6	0.6	20	120	72
3 GEN IMP	3	0.9	20	60	54
4 TECH FEAS	8	0.6	20	160	96
5 PUB SUPT	6	0.6	20	120	72
TOTAL VALUE				420	
DISCOUNT VALUE					258
CONFIDENCE VALUE					0.61

Subbasin: Okanogan Stock: Summer Chinook Strategy: 4

Criteria	Rating	Confidence	Weight	Utility	Discount Utility
1 EXT OBJ	5	0.6	20	100	60
2 CHG MSY	6	0.6	20	120	72
3 GEN IMP	3	0.9	20	60	54
4 TECH FEAS	9	0.9	20	180	162
5 PUB SUPT	6	0.9	20	120	108
TOTAL VALUE				580	
DISCOUNT VALUE					456
CONFIDENCE VALUE					0.79

Subbasin: Okanogan Stock: Summer Chinook Strategy: 5

Criteria	Rating	Confidence	Weight	Utility	Discount Utility
1 EXT OBJ	5	0.6	20	100	60
2 CHG MSY	6	0.6	20	120	72
3 GEN IMP	3	0.9	20	60	54
4 TECH FEAS	8	0.6	20	160	96
5 PUB SUPT	6	0.6	20	120	72
TOTAL VALUE				420	
DISCOUNT VALUE					258
CONFIDENCE VALUE					0.61

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: Methow River
Stock: Summer Steelhead

Action	Cost Categories*	Proposed Strategies 1	2	3**
Inventory & Mapping	Capital:	0	0	0
	O&M/yr:	40,000	40,000	40,000
	Life:	1	1	1
Screening	Capital:	1,000,000[a]	1,000,000[a]	1,000,000[a]
	O&M/yr:			
	Life:	50	50	50
Augmentation Facilities	Capital:		50,000,000	
	O&M/yr:		250,000	
	Life:		50+	
Natural Brood Stock	Capital:			20,000
	O&M/yr:			10,000
	Life:			50
Smolt Monitoring Study	Capital:	0	0	0
	O&M/yr:	40,000	40,000	40,000
	Life:	10	10	10
Hatchery Production	Capital:			
	O&M/yr:			
	Life:			
TOTAL COSTS	Capital:	1,000,000	51,000,000	1,020,000
	O&M/yr:	8,800	258,800	18,800
	Years:	50	50	50
Water Acquisition		N	N	N
Fish to Stock	Number/yr:			
	Size:			
	Years:			

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

** Recommended strategy.

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

ESTIMATED COSTS FOR ALTERNATIVE STRATEGIES

Subbasin: Methow River
Stock: Spring Chinook

Action	Cost Categories*	Proposed Strategies 1	2	3	4	5**
Inventory & Mapping	Capital:	0	0	0		0
	O&M/yr:	40,000	40,000	40,000		40,000
	Life:	1	1	1		1
Screening	Capital:	1,000,000[a]	1,000,000[a]	1,000,000[a]		1,000,000[a]
	O&M/yr:					
	Life:	50	50	50		50
Water Conservation	Capital:		2,000,000	2,000,000		2,000,000
	O&M/yr:		50,000	50,000		50,000
	Life:		50	50		50
Groundwater Channels	Capital:		300,000	300,000		300,000
	O&M/yr:		10,000	10,000		10,000
	Life:		50	50		50
Improve Brood Stock	Capital:				0	0
	O&M/yr:				200,000	200,000
	Life:				50	50
Hatchery Production	Capital:				1,909,000	1,909,000
	O&M/yr:				207,500	207,500
	Life:				50	50
TOTAL COSTS	Capital:	1,000,000	3,300,000	3,300,000	1,909,000	5,209,000
	O&M/yr:	800	60,800	60,800	407,500	468,300
	Years:	50	50	50	50	50
Water Acquisition		N	N	N	N	N
Fish to Stock	Number/yr:				414,000	414,000
	Size:				S, 5/lb.	S, 5/lb.
	Years:				50	50

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

** Recommended strategy.

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

ESTIMATED COSTS FOR ALTERNATIVE STRATEGIES

Subbasin: Methow River
Stock: Summer Chinook

Action	Cost Categories*	Proposed Strategies 1	2	3**
	Capital:	0		0
Inventory	O&M/yr:	40,000		40,000
& Mapping	Life:	1		1
	Capital:	1,000,000[a]		1,000,000[a]
	O&M/yr:			
Screening	Life:	50		50
	Capital:			
Barrier	O&M/yr:			
Removal	Life:			
	Capital:			
Misc.	O&M/yr:			
Projects	Life:			
	Capital:			
Hatchery	O&M/yr:			
Production	Life:			
	Capital:	1,000,000	0	1,000,000
TOTAL	O&M/yr:	800	0	800
COSTS	Years:	50		50
Water Acquisition		N	N	N
	Number/yr:			
Fish to	Size:			
Stock	Years:			

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

** Recommended strategy.

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

ESTIMATED COSTS FOR ALTERNATIVE STRATEGIES

Subbasin: Okanogan River
Stock: Summer Steelhead

Action	Cost Categories*	Proposed Strategies 1	2	3	4	5**
Inventory & Mapping	Capital:	0	0	0	0	0
	O&M/yr:	40,000	40,000	40,000	40,000	40,000
	Life:	1	1	1	1	1
Screening	Capital:	1,000,000[a]	1,000,000[a]	1,000,000[a]	1,000,000[a]	1,000,000[a]
	O&M/yr:					
	Life:	50	50	50	50	50
Water Conserv. & Rights Acquisition	Capital:		1,000,000			
	O&M/yr:		100,000			
	Life:		50			
Enloe Dam Feasibility Study	Capital:			0	0	0
	O&M/yr:			80,000	80,000	80,000
	Life:			2	2	2
Salmon & Omak Crks.	Capital:			300,000	300,000	300,000
	O&M/yr:			53,000	53,000	53,000
	Life:			50	50	50
Natural Brood Stock	Capital:				20,000	20,000
	O&M/yr:				10,000	10,000
	Life:				50	50
Smolt Monitoring Study	Capital:	0	0	0	0	0
	O&M/yr:	40,000	40,000	40,000	40,000	40,000
	Life:	10	10	10	10	10
Hatchery Production	Capital:					2,300,000
	O&M/yr:					250,000
	Life:					50
TOTAL COSTS	Capital:	1,000,000	2,000,000	1,300,000	1,320,000	3,620,000
	O&M/yr:	8,800	108,800	63,400	73,400	323,400
	Years:	50	50	50	50	50
Water Acquisition		N	Y	Y	Y	Y
Fish to Stock	Number/yr:					500,000
	Size:					S, 5/lb.
	Years:					50

(continued)

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

** Recommended strategy.

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

ESTIMATED COSTS FOR ALTERNATIVE STRATEGIES

Subbasin: Okanogan River
Stock: Spring Chinook

Action	Cost Categories*	Proposed Strategies 1**
Habitat Enhancement	Capital:	
	O&M/yr:	
	Life:	
Enloe Dam Feasibility Study	Capital:	0
	O&M/yr:	80,000
	Life:	2
Salmon & Omak Creeks	Capital:	300,000
	O&M/yr:	53,000
	Life:	50
Misc. Projects	Capital:	
	O&M/yr:	
	Life:	
Hatchery Production	Capital:	488,750
	O&M/yr:	53,125
	Life:	50
TOTAL COSTS	Capital:	788,750
	O&M/yr:	107,725
	Years:	50
Water Acquisition		Y
Fish to Stock	Number/yr:	2,125,000
	Size:	J, 100/lb.
	Years:	50

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

** Recommended strategy.

ESTIMATED COSTS FOR ALTERNATIVE STRATEGIES

Subbasin: Okanogan River
Stock: Summer Chinook

Action	Cost Categories*	Proposed Strategies 1	2	3	4**
Inventory & Mapping	Capital:	0	0	0	0
	O&M/yr:	40,000	40,000	40,000	40,000
	Life:	1	1	1	1
Screening	Capital:	1,000,000[a]	1,000,000[a]	1,000,000[a]	1,000,000[a]
	O&M/yr:				
	Life:	50	50	50	50
Palmer Lake Facilities	Capital:		1,200,000	1,200,000	1,200,000
	O&M/yr:		500,000	500,000	500,000
	Life:		50	50	50
Water Conserv. & Rights Acquisition	Capital:		2,000,000	2,000,000	2,000,000
	O&M/yr:		100,000	100,000	100,000
	Life:		50	50	50
Enloe Dam Feasibility Study	Capital:			0	0
	O&M/yr:			80,000	80,000
	Life:			2	2
Hatchery Production	Capital:				
	O&M/yr:				
	Life:				
TOTAL COSTS	Capital:	1,000,000	4,200,000	4,200,000	4,200,000
	O&M/yr:	800	600,800	602,400	602,400
	Years:	50	50	50	50
Water Acquisition		N	Y	Y	Y
Fish to Stock	Number/yr:				
	Size:				
	Years:				

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

** Recommended strategy.

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

ESTIMATED COSTS FOR ALTERNATIVE STRATEGIES

Subbasin: Okanogan River
Stock: Sockeye Salmon

Action	Cost Categories*	Proposed Strategies 1	2	3**
Inventory & Mapping	Capital:	0	0	0
	O&M/yr:	40,000	40,000	40,000
	Life:	1	1	1
Screening	Capital:	1,000,000[a]	1,000,000[a]	1,000,000[a]
	O&M/yr:			
	Life:	50	50	50
Palmer Lake Facilities	Capital:		1,200,000	1,200,000
	O&M/yr:		500,000	500,000
	Life:		50	50
Water Conserv. & Rights Acquisition	Capital:		2,000,000	2,000,000
	O&M/yr:		100,000	100,000
	Life:		50	50
Hatchery Production	Capital:			
	O&M/yr:			
	Life:			
TOTAL COSTS	Capital:	1,000,000	4,200,000	4,200,000
	O&M/yr:	800	600,800	600,800
	Years:	50	50	50
Water Acquisition		N	Y	Y
Fish to Stock	Number/yr:			
	Size:			
	Years:			

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

** Recommended strategy.

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

APPENDIX D
WATER RESOURCES SITES
IN THE METHOW BASIN

Water resources sites in the Methow River Basin (PNWRBC 1977a).

Site #	Site Name	Stream	Sec.	T/N	R/E	Storage Potential (ac/ft)
1	Caloway Cr.	Methow	Uns.	36	19	198000
2	Goat Cr.	Methow	5	35	20	134000
3	Chewack Cr.	Chewack	Uns.	39	22	42000
4	Sheep Cr.	Chewack	Uns.	38	22	35000
5	Eightmile Cr.	Chewack	25-26	21	10	369000
6	Pearrygin Lk.	Lake	35	36	21	34000
7	Bridge Cr.	Twisp	12	33	20	205000
8	Twisp	Methow	17	33	22	1273000
9	Baltic #1	Beaver	Uns.	34	22	Unknown
10	Baltic #2	Beaver	Uns.	34	22	Unknown
11	Pipestone #1	Frazer	Uns.	33	23	Unknown
12	Pipestone #2	Frazer	Uns.	33	23	Unknown
13	Gold Cr.	Methow	16	31	22	592000
14	McFarland Cr.	Methow	27	31	22	792000
15	Squaw Cr.	Methow	19,24	30	22,23	1451000