Columbia Basin System Planning

SALMON and STEELHEAD PRODUCTION PLAN

KLICKITAT RIVER SUBBASIN

September 1, 1990

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INTRODUCTION

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

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

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

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

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

PART I. DESCRIPTION OF SUBBASIN

Location and General Environment

The Klickitat Subbasin is located on the east slope of the Cascade Range in south-central Washington, comprises 1,350 square miles in Klickitat and Yakima counties, and drains into the Columbia River at River Mile 180.4. The basin trends north-south toward the Columbia River and is bounded by Mount Adams on the west, the Goat Rocks to the north, and the Simcoe Mountains on the east. Basin topography ranges from rolling hills and plateaus in the south to rugged mountains in the northwest.

There is significant variation in climate, which is related to elevation and proximity to the Cascade Crest. About three-fourths of the Klickitat Subbasin is forested. Forestry and agriculture dominate the subbasin economy.

Water Resources

The Klickitat River originates at 4,400 feet near the Goat Rocks in Yakima County and runs for 95.7 miles, dropping to a mean elevation of 74 feet at the Bonneville Pool in the Columbia River. Major tributaries include Diamond Fork (RM 76.8), West Fork (RM 63.1), Big Muddy Creek (RM 53.8), Outlet Creek (RM 39.7), Summit Creek (RM 37.3) and the Little Klickitat River (RM 19.8).

Two natural obstacles to upstream fish migration exist in the Klickitat River, Lyle Falls (RM 2.2) and Castile Falls (RM 64.2). Managers have improved fish passage at both locations, but difficulties persist, as will be discussed in a later section. In addition, a number of tributaries in the subbasin have falls and cascades near their mouths that are likely to impede fish passage.

Land Use

Land ownership information for the Klickitat Subbasin was compiled from Washington Department of Natural Resources and Yakima Indian Nation maps and is summarized in Table 1.

Table 1. Land ownership in the Klickitat Subbasin.

Area	Private (a)	State (b)	Federal (c)	Tribal (d)	Wilder- ness (e)	Wild & Scenic (f)
Off-Reservation (below RM 37.3)	339,915	39,160	3,120	0	0	4,600
Yakima Indian Reservation:						
Tract D (RM 37.3-RM 53.4)	69,671	28,960	0	22,918	9,914	0
Tract C (upper Diamond Fk)	560	14,608	0	446	0	0
Primitive Area (above RM 88.3)	0	0	0	49,296	0	0
Remainder (within 1906-07 boundary)	32,560	0	0	262,786	0	0
Reservation Total	102,791	43,568	0	335,446	9,914	0
Subbasin Total	442,706	82,728	3,120	335,446	9,914	4,600

(a) Includes municipally- and county-owned land.

(b) Owned by Departments of Natural Resources, Wildlife, and Fisheries.

(c) Owned by Bureau of Land Management.

(d) Includes tribal allotments in Reservation Tract D.

(e) Mt. Adams Wilderness; included in tribal acreage.

(f) Within Recreation River draft boundaries; included in private, federal and state acreages.

PART II. HABITAT PROTECTION NEEDS

History and Status of Habitat

Description of Habitat

Watershed Characteristics

The most extensive geologic formations in the Klickitat Subbasin are the Columbia River basalts, which are several thousand feet thick and date from the Miocene Epoch. The Klickitat River canyon is partly filled with younger basalts, which extruded after the Klickitat drainage was well established. The two mainstem barriers to fish migration discussed earlier are located in formations of highly resistant basalt. Adult fish passage on a number of Klickitat River tributaries is limited by the steepness of the tributaries' lower reaches as they enter the deep canyon cut by the river itself.

The topography of the Klickitat Subbasin changes from deeply dissected plateaus in the south to high ridges and mountains in the north. Significant variation in climate is encountered progressing from the mouth of the Klickitat River north to the river's source in the Goat Rocks. Elevation increases from 74 feet at the mouth to 4,400 feet at the source, and precipitation increases with increasing elevation and with increasing proximity to the crest of the Cascade Range.

Low pressure systems prevail off the Washington coast from November through February, bringing most of the subbasin's annual precipitation. Low pressure is replaced by high pressure during the summer months, and hot, dry weather is the result. Areas of similar elevation on the eastern and western edges of the subbasin may receive greatly differing amounts of moisture. For example, the wettest parts of the Simcoe Mountains at the northeast edge of the subbasin, which are drained by the Little Klickitat River, reach 5,000 feet and receive about 35 inches of precipitation annually. Forty miles to the northwest, at an identical elevation drained by the headwaters of the Klickitat River, annual precipitation is over 90 inches. The driest part of the subbasin is the Swale Creek drainage in the southeast, which receives about 15 inches of precipitation per year.

Average summer temperatures range from 55 degrees Fahrenheit at the north and west edges of the subbasin to over 70 F in the southeast portion. Average winter temperatures range from about 25 F to 37 F in these two areas, respectively. Annual fluctuations in temperature become more extreme from west to east in the subbasin, away from the influence of marine airflow.

Approximately three-fourths of the Klickitat Subbasin is not suited for agriculture. Almost all of this land is forested and characterized by steep topography. The pattern of the forest is affected by available moisture, soil quality, elevation and exposure. In the lowest and driest areas, Oregon white oak and ponderosa pine occur. Moving northwest through the subbasin, the following general succession of timber types occurs: pure ponderosa pine; ponderosa pine and Douglas fir; mixed conifer; and upper slope types dominated by mountain hemlock, true firs and lodgepole pine. Forestlands in the Klickitat Subbasin are managed for timber production; the Yakima Indian Nation, the Washington Department of Natural Resources, Champion International, and Boise Cascade Corporation are the principal forest landowners.

Most of the woodlands in the subbasin could be classified as grazable by livestock, and most are presently grazed by cattle. Since the advent of fire control, brush and shade-tolerant trees have gained a foothold in the forest understory, decreasing the amount of livestock forage. Without compensating adjustments in livestock numbers, overgrazing has resulted in some areas. Most of the off-reservation rangeland in good condition is in agricultural areas and is interspersed with dryland wheat fields, where alternate-year cropping gives the range a rest from grazing during the growing season (Anonymous 1983). Individual Yakima tribal members graze cattle on the reservation, where cattle numbers are limited by a permit system.

About one-fourth of the arable portion of the subbasin is irrigated, primarily in the Glenwood area, which is supplied by Big Muddy, Hellroaring, Cougar, Dairy, and Bird creeks and is drained by Outlet Creek. Irrigation also occurs near Goldendale in the Little Klickitat River and Swale Creek drainages. Although wells supply most of the irrigation water in the Goldendale area (Anonymous 1983), surface water in the Little Klickitat and Swale drainages is heavily used as well.

Road building, farming, grazing and residential development are limited along much of the river's length by high and steep canyon walls and thus have not severely impacted riparian conditions along the mainstem Klickitat River. Managers expect scenic values and fisheries and wildlife considerations under the national Wild and Scenic Rivers Act to constrain further development of the lower 10 miles of river. The degree of protection under the act may indeed extend far upstream since flows and fisheries resources in the designated reach must be maintained.

Riparian corridors along Klickitat River tributaries are more vulnerable to degradation. Unfortunately, no assessment of riparian or instream conditions in the subbasin has occurred beyond incidental observations of field personnel. This deficiency was recognized during the planning stages of the Yakima/Klickitat Production Project, since the proposed hatchery outplanting program depends on identification of suitable rearing habitat. Beginning in August 1988, a field team associated with the hatchery project will assess flows, water quality, instream habitat and riparian conditions in the upper Klickitat River and all tributaries considered to be capable of producing anadromous fish. Current knowledge about riparian impacts in the Klickitat Subbasin will be discussed in the section on land use.

Stream Characteristics

Table 2 summarizes mean monthly and annual discharge at all stream gages in the Klickitat Subbasin. Unfortunately, only the gage at RM 7 of the Klickitat River continues to operate. Between 1909 and 1979 at this station, the highest mean monthly flow occurred in May. The lowest mean monthly flow was in September, and was 47 percent of the mean annual flow. Low August flows (3 percent of annual mean) are evident from data gathered at RM 18 on the Little Klickitat River. August flow was 19 percent of the mean annual flow, on the other hand, at RM 0.3 of the Little Klickitat, due in part to the steady flow from Spring Creek, which enters the Little Klickitat at RM 8.6. During the three-year monitoring period ending in 1949, flows in sediment-laden Big Muddy Creek peaked in June as flows in the Klickitat River above Big Muddy Creek were receding. The Big Muddy gage was located below the Hellroaring irrigation diversion, which has appropriated as much as 74.5 cubic feet per second (cfs) from Big Muddy and Hellroaring creeks.

Temperatures as high as 65 F have been recorded at the U.S. Geological Survey gage at RM 7 of the Klickitat River. Stream temperature is a bigger problem in the Little Klickitat River and Swale Creek drainages, where low streamflows coincide with high air temperatures and degraded riparian habitat. Washington Department of Ecology personnel in July 1987 recorded a temperature of 87 F at a discharge of 4.5 cfs in the Little Klickitat River near Goldendale while at the same time the temperature near the mouth of the Little Klickitat was 67 F at 14.8 cfs.

Researchers noted temperatures of 70 F or more in Bowman, Mill and Blockhouse creeks during the same period. Swale Creek was checked on the same day as the upper Little Klickitat River. Water temperature was not recorded, but discharge was less than 0.1 cfs (B. Caldwell, WDOE, pers. commun.).

Table 2. Mean monthly discharge in the Klickitat River and gaged tributaries.

STREAM	RIVER MILE	WATER YEARS	MEAN DISCHARGE												
			ANN.	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Klickitat R	7.0	1909-79	1607	781	1001	1532	1870	2081	2202	2381	2595	2048	1202	851	760
		1980-85	1740	744	972	1700	2111	3164	2795	2376	2401	1959	1161	837	764
Klickitat R	50.5	1910-71	837	453	578	658	637	656	694	1178	1849	1552	859	542	441
Klickitat R	64.7	1945-77	330	129	190	233	215	231	218	435	963	786	311	144	107
Little Klickitat R	0.3	1945-78	169	39	78	215	362	402	328	257	169	85	37	26	29
Little Klickitat R	18.0	1911-70	60	7	23	72	100	166	131	115	66	31	7	2	3
Mill Cr	3.9	1965-72	16	5	6	12	22	31	40	31	25	11	5	3	4
Spring Cr	2.0?	1965-68	14	13	13	16	15	14	14	13	13	13	14	14	14
Butler Cr	0.0?	1966-68	15	3	5	15	23	36	26	28	23	12	4	1	1
Big Muddy Cr	1.8	1945, 1947-49	100	71	73	65	59	66	57	85	220	254	130	68	49
West Fork of Klickitat R	2.2	1945-48	305	201	241	265	220	242	222	302	663	561	302	233	201

The average gradient between the mouth of the Klickitat River and the probable upper limit of anadromous fish production at RM 87.5 is 0.77 percent. Tributary gradients are generally higher. The accessible reaches of Spring, Outlet, McCreedy and Piscoe creeks have average gradients over 5 percent; Bowman, Summit, White and Trout creeks, Fish Lake Stream and Diamond Fork drop between 2 percent and 5 percent. High stream gradients undoubtedly play a part in limiting the abundance and diversity of anadromous species in the subbasin. The influence of stream gradient on fish production is also discussed in later sections on chinook and coho salmon.

There is no quantitative information on substrate particle size distribution in the Klickitat Subbasin. Deposition of fine materials is considered to be a problem in the logged and grazed tributary watersheds discussed earlier. Glacial-melt and landslides in the Big Muddy Creek watershed may add significant amounts of fine particles to Klickitat River gravels during the summer when velocities in the river are too low to flush fine particles.

Table 3 summarizes 12 water quality parameters measured at the U.S. Geological Survey gage at RM 7 of the Klickitat River, and published in USGS annual water data reports from 1980 through 1985. Suspended sediment is the only parameter thought to have an impact on fish production in the subbasin, and the table shows high sediment discharges and high turbidity readings during periods of high flow. Big Muddy Creek is responsible for summertime turbidity in the Klickitat River; its contribution to these loadings cannot be estimated since physical and chemical data were not collected at other gaging stations.

Land and Water Uses

Forestry

The impacts of forest practices on fish production are well documented (see for example Salo and Cundy, eds., 1987). Potentially adverse effects of forest practices in the Klickitat Subbasin include sediment loading and loss of riparian habitat from streamside logging and road construction, passage obstructions at stream crossings, and increased fluctuations in streamflows resulting from loss of watershed cover. Selective timber cutting along with uncut riparian buffer strips on Yakima Indian Reservation lands have provided some stream protection, yet skid trails and haul roads are often poorly placed, and culverts at stream crossings are often incorrectly sized or positioned. Culverts are sometimes blocked to pond water for dust control, dewatering downstream sections or causing road erosion and stream sedimentation. All of the above problems occur off the reservation as well, with additional impacts from clearcutting. The most severe logging impacts have been noted in

Summit Creek, White Creek and its tributaries, McCreedy Creek and Diamond Fork.

Agriculture and Water Withdrawals

Agricultural practices near streams can affect fish populations through sediment and thermal loading, riparian degradation and pesticide pollution, aside from the obvious passage and flow problems associated with irrigation diversions. As noted earlier, agricultural lands are located in the Outlet Creek drainage surrounding Glenwood, which is inaccessible to anadromous fish, along with the Little Klickitat River and Swale Creek drainages in the vicinity of Goldendale. (Creeks flowing directly into the Klickitat River are also diverted to the Glenwood area, as noted above.) Low summer flows and high summer temperatures are the norm in the Little Klickitat and Swale drainages, at least partly because of irrigation withdrawals. The extent of other agricultural impacts is unknown at this time.

Grazing

The presence of livestock in riparian areas degrades fish habitat through loss of streambank cover, sloughing of streambanks and widening of stream channels. Cattle are known to prefer the riparian zone even if there is better forage in adjacent uplands. Overgrazing is considered to be most serious in the forested portion of the subbasin (see above), yet riparian degradation is evident in pastures near Goldendale as well. In the forested area of the Yakima Indian Reservation, grazing impacts are considered to be moderate overall. Managers, however, have identified several overgrazed riparian areas, including White Creek and its tributaries, Piscoe Creek and the Caldwell Prairie and McCormick Meadow reaches of the Klickitat River.

Residential and Commercial Development

Residential landscaping next to streams often includes the removal of riparian vegetation and requires riprapping to restabilize streambanks. The cumulative effects of this practice, along with pollution from septic drainfields, have become significant in areas where the resident population is expanding or where property has been developed for vacation homes. Economic factors, population and land ownership patterns, and topography have limited residential development in riparian areas of the Klickitat Subbasin. Commercial developments are generally small and scattered within populated areas. The lumber mill owned by Champion International, Inc. in the town of Klickitat (RM 13) is the largest commercial facility in the subbasin.

Table 3. Water quality data for the Klickitat River, 1980-1985 as determined at the Pitt (RM 7) gaging station.

WATER YEAR	DATE	DISCH. (cfs)	SPEC. COND. (us/cm)	pH	TEMP. (deg C)	TURBID-ITY (ntu)	DISS. OXYGEN (mg/l)	FECAL COLIFORM, 0.7 um-mf (counts per 100 ml)	HARD-NESS (mg/l as CaCO3)	ALKA-LINITY (mg/l as CaCO3)	SODIUM (mg/l as Na)	NO2 + NO3 (mg/l as N)	TOTAL PHOS-PHORUS (mg/l as P)	SEDIMENT DISCH. (t/day)
1985	1106	949	64	7.0	6.0	3.3	12.5	6	32	49	4.3	<0.10	0.03	15.0
	0213	814	94	7.4	2.0	3.8	14.0	6	39	40	4.4	0.10	0.03	13.0
	0515	1500	68	7.4	10.5	2.4	11.3	2	28	37	3.5	<0.10	0.03	41.0
	0820	645	81	7.9	14.5	3.0	9.9	4	32	45	4.4	<0.10	0.05	10.0
1984	1110	1130	79	7.9	6.5	2.2	9.7	22	29	39	3.9	<0.10	0.03	31.0
	0307	1830	77	8.1	9.5	4.8	12.2	12	31	41	4.0	<0.1	0.03	54.0
	0502	2480	70	7.6	9.0	4.9	10.4	9	27	35	3.4	<0.1	0.04	114.0
	0822	884	78	7.7	14.0	3.1	10.9	12	31	39	4.1	<0.1	0.04	17.0
1983	1102	957	77	7.6	5.5	1.5	12.4	3	31	40	4.1	<0.1	0.03	18.0
	0224	5740	76	8.1	8.0	17.0	---	14	29	36	3.6	0.30	0.10	1160.0
	0517	2770	63	8.2	10.5	1.8	11.8	11	25	33	3.3	<0.1	0.02	22.0
	0816	1060	78	8.2	14.5	8.5	9.8	--	28	37	3.6	<0.1	0.06	74.0
1982	1015	659	78	8.0	5.5	1.8	12.2	18	31	34	3.8	<0.1	0.30	11.0
	0112	1020	91	8.2	2.5	2.7	13.6	12	37	43	4.5	0.48	0.30	22.0
	0316	2980	73	7.7	5.0	2.7	12.3	5	27	34	3.4	0.23	0.30	217.0
	0511	2640	90	7.9	8.5	1.9	12.0	34	25	32	3.2	0.57	0.40	57.0
	0721	1330	63	7.5	14.5	7.4	10.1	9	25	34	3.5	<0.1	0.40	83.0
	0908	860	83	7.8	14.5	3.0	10.1	4	30	42	4.0	0.11	0.40	16.0
1981	1015	591	82	7.6	9.4	3.3	11.3	2	32	42	4.4	0.00	0.04	8.0
	1119	681	80	8.1	7.0	3.0	11.9	9	--	34	---	0.07	0.05	31.0
	1216	1100	78	7.3	3.7	8.1	12.6	29	29	35	3.9	0.28	0.09	---
	0119	1520	74	7.8	4.8	2.5	12.4	7	30	44	4.2	0.35	0.07	62.0
	0220	8310	--	7.6	4.6	58.0	12.8	--	26	23	3.6	0.41	0.17	11700.0
	0317	1470	73	---	5.2	2.6	12.2	3	30	41	4.1	0.14	0.04	75.0
	0414	1090	81	8.6	7.1	1.3	13.4	<1	34	30	4.7	0.01	0.08	8.8
	0513	1090	84	7.5	10.1	0.8	11.0	--	28	38	3.8	0.00	0.05	24.0
	0616	1020	--	7.5	12.6	1.9	10.5	20	27	36	4.0	0.08	0.10	5.5
	0715	724	--	7.8	14.9	1.9	10.0	13	30	38	4.4	0.21	0.03	9.8
	0812	666	--	8.2	18.3	2.9	9.6	12	29	38	4.1	0.02	0.06	18.0
	0916	577	81	8.2	15.7	21.0	9.4	31	29	40	4.1	<0.1	0.03	9.3
1980	1001	519	80	8.0	12.6	1.8	11.1	3	30	33	4.5	0.03	0.02	14.0
	1113	578	85	7.8	4.9	0.8	13.4	13	33	41	4.8	0.05	0.03	4.6
	1210	1000	72	7.4	4.4	5.2	13.4	6	29	35	4.4	0.33	0.04	43.0
	0107	725	90	6.9	0.1	3.2	13.8	3	36	36	4.2	0.27	0.05	17.0
	0220	2690	75	7.2	4.6	41.0	12.5	29	32	29	4.3	1.10	0.16	559.0
	MAR (1)	2205	75	6.9	7.1	4.7	12.4	3	28	29	3.7	0.27	0.06	119.3
	0407	1440	65	7.6	7.3	3.9	12.4	3	27	30	3.6	0.08	0.04	91.0
	MAY (2)	2182	71	7.6	11.7	40.4	9.9	3	25	25	3.8	0.04	0.09	315.0
	JUN (1)	1438	66	7.9	14.0	20.8	9.9	3	24	28	3.5	0.03	0.06	77.8
	0717	949	73	7.7	14.2	11.0	10.2	3	25	43	4.0	0.00	0.09	51.0
	0917	632	72	7.9	12.3	7.6	9.9	18	29	34	4.3	0.00	0.06	54.0

(1)Mean of four samples.
(2)Mean of five samples.

Dams and Hydropower Projects

No hydroelectric projects are known to exist in the Klickitat Subbasin, but developers have applied for several small projects. Careful scrutiny will be required from the standpoint of fisheries if these projects are not ruled out on the basis of instream flow requirements or by designation of scenic or protected areas.

Constraints and Opportunities for Protection

Little is known about the use, much less the productive capacity, of fish habitat in the subbasin. Nevertheless, it is necessary to develop 1) an estimate of the productive capacity of the subbasin under present habitat and passage conditions, 2) a list of constraints which limit that capacity, and 3) an estimate of the productivity gains which could be realized if those constraints were eliminated. It is expected that current productivity estimates will be refined considerably by data gathered in the systematic assessment of habitat and passage conditions, which began in August 1988. That information should permit identification of specific habitat data needs.

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

Both the Minimum Water Flows and Levels Law and the Water Resources Act of 1971 (RCW 90.54) direct the Department of Ecology to set minimum or base flows that protect and preserve fish and other instream resources. Because minimum or base flow regulations do not affect existing water rights, reductions in anadromous fish runs in overappropriated streams will continue to be a problem. The Water Resources Act specifically lists fish and wildlife maintenance and enhancement as a beneficial use. It further directs the Department of Ecology (DOE) to enhance the quality of the natural environment where possible.

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

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

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

The fisheries agencies have requested that for most streams, instream flows be protected at levels that would maintain <u>existing</u> fish production, including the full range of variations that occurs naturally due to environmental conditions. For some streams, like the Yakima River, the fisheries agencies request flows to levels that would achieve <u>potential</u> production. This potential production would be determined by analyzing what could reasonably and practically be expected to return to the stream in the future.

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

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

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

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

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

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

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

Habitat Protection Objectives and Strategies

Forestry Objectives

1. Develop landslide hazard zonation maps, and restrict cut size or stage new cuts in hazardous areas. Route logging and access roads away from areas of landslide risk, especially if large cuts or fills would be entailed.

   STRATEGY 1: Organize a landslide hazard mapping project for the Klickitat Subbasin using existing personnel, or request Centennial Clean Water funds for a landslide hazard survey by forestry students.

   STRATEGY 2: Ensure enforcement of state forest practices regulations restricting roading in unstable or slide-prone areas.

2. Maintain adequate riparian management zones (RMZs) along streams at all logging sites.

   STRATEGY: Timber/Fish/Wildlife staff members must determine not only that RMZs correspond to what is required in state regulations for a given class of stream, but that leave-tree species are locally representative, and that the trees are not vulnerable to massive wind throw.

3. Locate new logging and forest access roads outside riparian management zones and atop ridges when possible.

   STRATEGY: It is impractical to prohibit roading in RMZs, but state forest practices regulations call for minimizing this practice. Timber/Fish/Wildlife staff members play an important role in determining whether the spirit of this regulation is being implemented.

4. Except when clearly needed for fire control, forest management or other long-term purposes, make the abandonment of logging roads a condition of timber sales.

   STRATEGY: State forest practices regulations require a road maintenance and abandonment plan whenever it is determined that access roads pose a potential threat to public resources. Abandonment, such as alteration to control erosion and prevent access, should be promoted in the Klickitat Subbasin.

Agriculture Objectives

1. Prevent further degradation of summer flows in the Little Klickitat River and Swale Creek drainages.

   STRATEGY: Adjudication of water rights in the Little Klickitat drainage was completed in 1986. Fisheries managers need to assist the Washington Department of Ecology in establishing minimum flows in the Little Klickitat River. A right to minimum flows, once established, has the status of a junior water right. The priority of this right will improve over the years with the attrition of more senior rights, therefore it may be possible to achieve higher flows through exercise of this right. No adjudication of water rights has occurred in Swale Creek; the validity and priority of existing water right claims have not been established.

State law provides for the relinquishment of water rights that have been abandoned or have not been used for five years, unless there is sufficient cause for non-use. Beginning in 1991, water rights in the Little Klickitat drainage not used since adjudication can be relinquished, essentially accelerating the process of attrition described above and preventing the degradation of flows that would result from reactivation of unused rights. Relinquishment is not automatic, and fisheries managers can assist in the procedure by documenting cases of non-use and bringing them to the attention of the Washington Department of Ecology.

2. Increase protection of water quality and riparian habitat in the Outlet Creek, the Little Klickitat River and Swale Creek drainages by modifying agricultural practices.

   STRATEGY: This could be accomplished through agricultural practices legislation similar to the Washington Forest Practices Act.

Grazing Objectives

1. Maintain current stocking densities on range in good condition. Reduce grazing pressure or modify grazing practices on overgrazed, eroding rangelands.

   STRATEGY 1: Overgrazing is or should be a concern of all agencies charged with preserving soils, water quality and habitat for fish and wildlife. Range managers need to be made aware of these concerns.

   STRATEGY 2: On the Yakima Indian Reservation, efforts should be made to use existing range more efficiently, such as by requiring placement of salt blocks well away from watercourses and/or by developing upland springs. After study, it may be feasible to create new on-reservation water supplies by building small impoundments at the headwaters of Toppenish Creek in the Yakima Subbasin. Besides improving fish passage through problem reaches of Toppenish Creek, such a project could be used to develop new rangelands in valley areas, making it possible to divert grazing pressure from degraded headwater areas in the Yakima and Klickitat subbasins. One of the worst overgrazing problems on the reservation, in the headwaters of Piscoe Creek, has recently been relieved somewhat by moving 500 head of cattle to an underused area near Mount Adams.

2. Eliminate or greatly reduce unrestricted riparian grazing along all streams currently producing anadromous salmonids and those with substantial production potential that are targeted for outplanting under the Yakima/Klickitat Production Project. This objective will be presented in greater detail later in this document.

   STRATEGY: Most of the potential for degradation of fish habitat by livestock is on Yakima Indian Reservation lands; field studies discussed earlier will further clarify the location and extent of impacts. Managers are proposing a fenced exclosure demonstration project for the reservation in the Yakima Subbasin Plan, and a large-scale riparian fencing program in both subbasins should follow.

PART III. CONSTRAINTS AND OPPORTUNITIES FOR ESTABLISHING PRODUCTION OBJECTIVES

Institutional Considerations

Land and water managers and administrators affecting fisheries in the Klickitat Subbasin are listed below.

Federal
- Bonneville Power Administration
- Bureau of Land Management
- Environmental Protection Agency
- National Marine Fisheries Service
- Soil Conservation Service
- U.S. Fish and Wildlife Service
- U.S. Forest Service
- U.S. Geological Survey

State
- Department of Ecology
- Department of Natural Resources
- Department of Transportation
- Department of Wildlife

County
- Klickitat County Commission

Tribal
- Yakima Indian Nation

Municipal
- City of Goldendale
- Town of Glenwood
- Town of Klickitat

Private
- Champion International, Inc.
- Boise Cascade Corp.

Cooperation Among Management Entities

Yakima/Klickitat Production Project

Implementation of the Northwest Power Planning Council sponsored Yakima/Klickitat Production Project, now in the pre-design phase, requires the cooperative efforts of the Washington Departments of Fisheries, Wildlife, and Ecology, along with the U.S. Bureau of Reclamation and the Yakima Indian Nation. A task force representing these agencies is currently developing plans for pre-design ecological studies and post-implementation production management.

The principal goal of the project is to assess the contribution that hatchery production can make to harvest and natural production without adverse genetic impacts. Efforts will be directed at rebuilding depressed natural stocks (Klickitat spring chinook and summer steelhead along with three stocks in the Yakima Subbasin) and reintroducing runs historically present, but now extinct (three runs in the Yakima Subbasin).

Planners are designing the hatchery project to be consistent with the five major subbasin planning policies stated in the Northwest Power Planning Council's Columbia River Basin Fish and Wildlife Plan. Projects are required to 1) contribute to the doubling goal, 2) attempt to minimize genetic risk, 3) employ a systemwide perspective, 4) include an inbasin harvest management plan consistent with the goal of rebuilding depressed stocks, and 5) employ the principle of adaptive management.

Timber/Fish/Wildlife Agreement

The Timber/Fish/Wildlife Agreement is a recently created consultation process among Washington's tribes and resource agencies, the environmental community and the private sector. It addresses Washington's public and private timberlands and is based on cooperative research, monitoring and evaluation. Participants in this project include the Washington departments of Natural Resources, Fisheries, Wildlife, and Ecology; the Washington Environmental Council; The Audubon Society; the Washington Forest Protection Association; the Northwest Indian Fisheries Commission; and 18 individual Indian tribes.

In addition to the review of forest practice applications by interdisciplinary teams, the agreement provides a mechanism for modifying forest practice regulations on the basis of cooperative research, monitoring, evaluation and adaptive management. There is also provision for implementing five- to 10-year basinwide management plans. In the Klickitat Subbasin, the Timber/Fish/Wildlife process has begun with evaluation of forest practices.

Opportunities for Additional Cooperation

The designation of the lower 10 miles of the Klickitat River as a national Recreation River provides an opportunity to use the Wild and Scenic Rivers Act, administered by the U.S. Forest Service, in protecting the river's fishery resources. An upstream section of the river from Summit Creek at RM 37.3 to the Little Klickitat River at RM 19.8 is also being evaluated for designation under the act.

Legal Considerations

Treaty of 1855

The rights of the Yakima Indian Nation are set forth in the Treaty of June 9, 1855 (12 Stat. 951). The fishing rights are based on the aboriginal rights of the Confederated Tribes and Bands of the Yakima Indian Nation, and are set forth in Article III of the treaty, which states:

> The exclusive right of taking fish in all the streams, whether running through or bordering said reservation, is further secured to said confederated bands and tribes of Indians, as also the right of taking fish at all usual and accustomed places, in common with the citizens of the Territory, and of erecting temporary buildings for curing them; together with the privilege of hunting, gathering roots and berries, and pasturing their horses and cattle upon open and unclaimed land.

As a result of the treaty's reservation of rights, tribes that were party to the treaty retain substantial governmental authority over activities that affect hunting and fishing. The right of treaty tribes to co-manage and participate in fishery management decisions affecting the Columbia River and its tributaries has been affirmed by the federal courts (see United States vs. Oregon and United States vs. Washington). The decisions interpreted the phrase "in common" as entitling treaty fishermen to one-half the harvestable share of anadromous fish that pass through recognized tribal fishing grounds. The Boldt II decision includes hatchery-bred fish in the harvestable population, and provides for the protection of spawning and rearing areas from environmental degradation.

Columbia River Fish Management Plan

Harvest and fish production of Columbia Basin salmon and steelhead is managed pursuant to the case law in United States vs. Oregon and the Columbia River Fish Management Plan (October 1988). The management plan provides for equitable harvest sharing between treaty and non-treaty fisheries; rebuilding of stocks; tribal participation in fisheries management; and requires state and tribal management entities to jointly develop harvest and production plans for upper Columbia River subbasins, including the Klickitat Subbasin. It is essential, then, that subbasin plans developed under the Northwest Power Planning Council's Columbia River Basin Fish and Wildlife Program be consistent with the goals set forth in the Columbia River Fish Management Plan and the United States vs. Oregon case law.

PART IV. ANADROMOUS FISH PRODUCTION PLANS

SPRING CHINOOK SALMON

Fisheries Resource

Natural Production

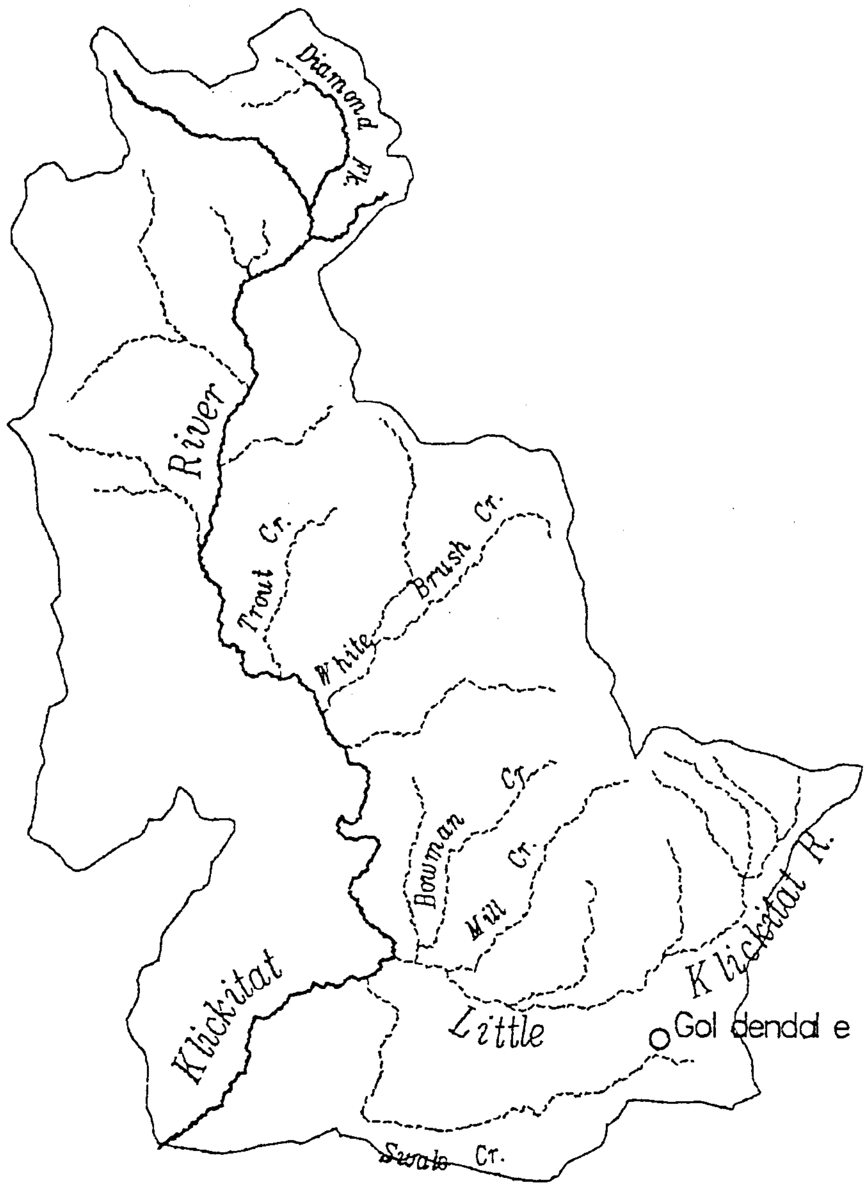
History and Status

Bryant (1949) cited reports of large runs of spring chinook and a significant Indian fishery at Lyle Falls (RM 2.2) prior to about 1920, despite difficult passage at the falls. By 1951, the annual spring chinook run varied from 1,000 adults to 5,000 adults (WDF 1951). In 1952, managers removed rock and constructed two fishways at Lyle Falls. The Washington Department of Fisheries Klickitat Hatchery at RM 42.7 was completed that same year with rearing facilities for spring chinook. Managers trapped spring chinook brood stock each year from 1952 through 1959 or later at the upper fishway (Falls 5). Counts at the trap through 1959 ranged from 110 fish to 3,588 fish, but may greatly underestimate the total runs in those years because of the lack of harvest data from the treaty fishery below Falls 5, passage over the falls itself, and off-peak periods when the trap did not operate (WDF 1960; D. Ward, WDF, pers. commun.). Spring chinook run size estimates since 1977, where available, have ranged from 1,614 fish to 3,488 fish with a mean of 2,523 fish (adults plus jacks).

In 1960 through 1962, managers blasted obstructions and constructed fishways at Castile Falls (RM 64.0 to RM 64.5) to allow the introduction of anadromous runs to the upper Klickitat River. Managers have subsequently observed spring chinook redds in the mainstem from the hatchery at RM 42.4 as far upstream as RM 84 (Stockley 1979). However, the largest number of redds managers ever counted above Castile Falls was just 13 in 1971 (Schwartzberg and Roger 1986). Bryant cited reports that spring chinook once spawned in the West Fork of the Klickitat River, which enters the mainstem just below Castile Falls at RM 63.1, although the gradient of the West Fork (1.77 percent below the falls at RM 4.7) does not appear to be ideal for spawning and rearing of this species.

Spring chinook probably also spawn in the mainstem downstream from the hatchery. However, no records of redd counts in this reach exist prior to November of any year, when fall chinook would be spawning.

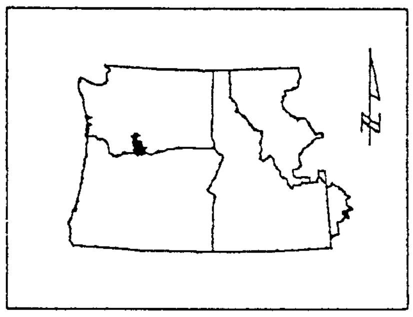
KLICKITAT SUBBASIN



SPRING 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

Life History and Population Characteristics

Information on freshwater life history of Klickitat spring chinook comes from fishery monitoring and spawning ground surveys. Spring chinook migrate into the subbasin from April through July and spawn from August through October. No information exists on the life history of naturally produced juvenile spring chinook in the Klickitat Subbasin.

Researchers cannot accurately estimate natural egg-to-smolt survival rates because spawning-ground surveys have been inconsistent, and survey conditions are often difficult between Klickitat Hatchery and Castile Falls. Moreover, there is no way to count outmigrants from the subbasin. The "standard" Northwest Power Planning Council smolt capacity for spring chinook in the Klickitat Subbasin is 620,000 smolts. The estimate depends on subjective habitat quality ratings, which in turn are based on limited observations.

Supplementation History

Examination of Klickitat Hatchery planting records from 1977 through 1988 shows that all spring chinook smolts reared at Klickitat Hatchery have been released on station. Younger fish have been released both on and off station for thinning purposes, and from spring water into cold river water with no acclimation. For this reason, releases of fry and parr have probably not contributed significantly to adult returns. Limited hatchery rearing space normally precludes holding the excess fingerlings as long as would be desired for optimum survival in the river. However, the 1988 outplants of excess parr were delayed until June to improve their likelihood of survival. As many as 1.1 million Klickitat spring chinook parr will be available for outplanting in the spring of 1989. Off-station releases of spring chinook are summarized in Table 4.

Table 4. Off-station releases of spring chinook in the Klickitat Subbasin.

Release Date	Hatchery Stock(1)	Brood Year	Number Released	Release Stream	Release Location
03/29/77	Cowlitz	1976	48,384	Klickitat	RM 77
03/29/77	Cowlitz	1976	21,744	Diamond Fk	RM 0.2
03/30/77	Cowlitz	1976	58,032	West Fork	RM 2, RM 5
05/20/77	Cowlitz	1976	115,116	Klickitat	RM 85
04/17/84	Klickitat	1983	230,400	Klickitat	RM 61
10/09/84	Klickitat	1983	181,500	Klickitat	RM 61-78
04/24/85	Klickitat	1984	258,100	Klickitat	RM 78
06/01/88	Klickitat	1987	52,785	Klickitat	RM 76
06/01/88	Klickitat	1987	72,657	Klickitat	RM 64
06/17/88	Klickitat	1987	72,005	Klickitat	RM 77
06/17/88	Klickitat	1987	67,583	Klickitat	RM 61
06/20/88	Klickitat	1987	70,296	Klickitat	RM 76
06/20/88	Klickitat	1987	93,130	Klickitat	RM 64

(1) Cowlitz stock transferred to Klickitat Hatchery as eyed eggs. Klickitat brood stock collected at hatchery trap.

Fish Production Constraints

The initial management plans for the Klickitat Hatchery stated that its purpose with respect to spring chinook was to supplement natural production and rebuild natural runs by outplanting fingerlings in the Klickitat River and its tributaries. Whether this strategy was pursued in the early years of hatchery operation is unclear, but after 36 years natural production is at a low level based on redd counts. Moreover, no evidence exists that a distinct wild population has persisted; state and tribal fishery managers consider natural spawners in the Klickitat Subbasin to be hatchery strays.

Three management-related factors, none of them unique to this subbasin, may be responsible for the present situation. First, terminal fisheries are not currently managed to provide natural escapement. Second, large numbers of smolts are released directly from hatchery ponds, dwarfing the level of production likely to have resulted from natural spawning or fingerling outplants. Third, spawning of hatchery strays with wild fish may have significantly lowered average fitness within the naturally spawning population.

Apart from the combined effects of hatchery production and fishing, the most serious constraint on natural production in the Klickitat Subbasin is obstacles to upstream migration at Castile Falls (RM 64.0 to RM 64.5). The original construction plan for the series of falls comprising Castile Falls was to bypass all 11 falls with a single straight tunnel 3,200 feet long. Drilling began at the upstream end, but a subterranean mudflow halted progress after 725 feet. This forced crews to tunnel to the point of abandonment from the canyon wall just below Falls 10, creating an 860-foot V-shaped passage that bypassed only the two upper falls (D. Stuckey, WDF, pers. commun.). Managers then constructed an open fishway around Falls 7, and drilled a 200-foot straight tunnel past Falls 4 and 5. In addition, Falls 1, 8 and 9 were blasted to facilitate passage.

On the basis of spring chinook redd counts since 1960, the fishways at Castile Falls have never been effective. The most serious problems may be 1) total darkness in the upper tunnel, and 2) little or no flow during the summer in the lower tunnel. Low flow in the lower tunnel is at least partly due to bedload accumulation, reflecting a lack of maintenance in recent years. As of October 1988, the Washington Department of Fisheries was in the process of cleaning and repairing passage structures. When this work is completed, the department will begin a regular schedule of fishway maintenance.

Little evidence of salmon or steelhead migration above the falls since construction was completed exists. This may be partly because the fishways have not been well maintained. The limited Mitchell Act funding available may still be insufficient for proper maintenance.

In addition to lack of maintenance, fishway design may be faulty. Although the upper tunnel appears to be in good condition, little or no spawning occurs above it. In September 1988, biologists observed adult spring chinook below Falls 8, which must be negotiated along with Falls 9 to reach the mouth of the tunnel (the tunnel bypasses Falls 10 and Falls 11). Falls 8 and Falls 9 were blasted in 1962 to facilitate passage, but should be inspected at low flows; more work may be required. Fish may also avoid the tunnel itself, which is long, follows a V-shaped path, and is consequently dark. To create an exit pool for the tunnel, managers constructed a 10-foot barrier dam at Falls 11, so adult migrants have no alternative route. To light the tunnel, managers would have to install a hydroelectric generator at the Falls 11 barrier.

Falls 7 is bypassed by an open fishway. The fishway was dry in August 1988 due to a lack of maintenance. Fisheries managers removed bed load and installed new stop logs in September. One of the fishway baffles was tipped over, creating a long pool with a steep drop above it. Stop-logs on the baffles above and below this point were adjusted in an attempt to equalize the drops between pools. The height of the upper baffles in this fishway and the lack of attraction flow from the fishway at low and medium river flows are still problems. Managers did not consider Falls 6 below this fishway to be a passage impediment at the time of construction.

A 200-foot straight tunnel bypasses Falls 4 and Falls 5. Flow through the tunnel was minimal in August 1988, but improved when gravel was cleaned out of the upstream end in September. Boulders remain in the river channel next to the upstream mouth of the tunnel. More importantly, the river is about six feet below the tunnel outlet at low flows. Managers blasted Falls 1 in 1963, but did not deem it necessary to correct Falls 2 and Falls 3 just below the tunnel. These falls, along with the falls upstream, should be reevaluated during summer low flows.

What appears to be a spring chinook passage problem occurs at the Klickitat Hatchery weir (RM 42.4). In years of high hatchery returns when the adult holding pond is full, spring chinook congregate below the weir and in the pond outlet creek downstream. These fish may all be hatchery returns attracted to hatchery spring water, but prevented from ascending the hatchery ladder just upstream of the pond outlet. The wide and thin sheet of water spilling over the weir in late summer could be exacerbating the problem by failing to provide sufficient upriver attraction. The 1988 and later broods will likely be more prone to stray upriver, since some of each brood will have been acclimated to river water prior to release in a study scheduled to begin in 1990.

Big Muddy and Little Muddy creeks drain glaciers on the east slope of Mount Adams. During the warmest months, the sediment plume from these creeks colors the Klickitat River from the West Fork to the Columbia River 63 miles downstream. The sediment load from Big Muddy Creek was considered serious enough to be named as a constraint on spring chinook carrying capacity of the lower Klickitat. The sediment problem was particularly severe during the summer of 1988. A slide on Mount Adams reportedly blocked the channel of Rusk Creek, a tributary of Big Muddy Creek, resulting in the cutting of a new channel. In addition, a channel change on September 5 dewatered the diversion at approximately RM 5 of Big Muddy Creek causing the entire creek flow to be discharged into the Klickitat River.

The assumed upper limit of spring chinook production is approximately at RM 87.5 of the Klickitat River, where the gradient lessens from nearly 8 percent to a modest 0.5 percent as the river passes through McCormick Meadow and Caldwell Prairie. Below RM 78, in the vicinity of Diamond Fork, the gradient increases again to an average of 1.25 percent over the 13.5 miles down to the head of Castile Falls. The river drops about 80 feet in the 0.6 miles past the 11 falls making up the Castile Falls complex. Gradient then varies mostly between 1 percent and 2 percent between Castile Falls and the Klickitat Hatchery at RM 42.4, with the steepest reaches scattered between RM 54 and RM 47. From the hatchery down to the head of Lyle Falls, the gradient generally varies between 0.4 percent and 0.8 percent, with the steepest portions between Outlet Creek (RM 39.7) and Dead Canyon (RM 31.0). The river drops approximately 90 feet between the head of Lyle Falls at RM 2.2 and the Bonneville Pool, which inundates the Klickitat River up to RM 1.2. Managers identified gradient as a constraint on spring chinook production in the 33 miles of river between Castile Falls and Dead Canyon.

Managers do not believe flow conditions are a constraint on spring chinook production in the Klickitat Subbasin. Tributaries with low summer flows are generally too small and too steep to be considered as spring chinook spawning or rearing habitat; spring chinook are not known to spawn in any Klickitat River tributary. There is recent evidence, however, that juvenile spring chinook are rearing near the mouth of the Little Klickitat River (P. Peterson, WDF, pers. commun.). Summer flows appear to be adequate for rearing in that reach (B. Caldwell, WDOE, pers. commun.).

Hatchery Production

Description of Hatcheries

The Klickitat Hatchery, completed in 1952, is located on the Klickitat River at RM 42.4. The hatchery was constructed and is operated for hydropower mitigation under the Mitchell Act of 1936.

Spring chinook are native to the Klickitat Subbasin. Hatchery production of the stock began with brood stock collected at Lyle Falls in 1952. The hatchery's current spring chinook program calls for the on-station release of 750,000 smolts at 10 fish per pound. Releases since 1977 are shown in Table 5. Redd counts suggest that spring chinook smolt production in the subbasin is now almost entirely of hatchery origin.

Table 5. On-station releases of spring chinook from Klickitat Hatchery.

Stock	Brood Year	Release Date	Number Released Fry(1)	Parr(2)	Smolt(3)
Klickitat(4)	1975	04/30/77			550,822
Klickitat	1976	04/12/77		146,776	
Klickitat(4)	1976	03/31/78			534,135
Cowlitz	1976	05/20/77		5,194	
Klickitat	1977	09/05/78		21,737	
Klickitat(4)	1977	03/30/79			576,312
Carson	1977	09/05/78		173,598	
Carson(4)	1977	03/30/79			103,340
Klickitat	1978	04/25/79		160,768	
Klickitat	1978	03/15/80			581,025
Cowlitz	1979	01/22/80		860,608	
Cowlitz	1979	03/25/80		17,787	
Cowlitz	1979	05/09/80		152,336	
Klickitat	1979	03/16/81			651,052
Klickitat	1980	04/16/81		1,002,793	
Klickitat	1980	09/15/81		296,857	
Klickitat	1980	03/15/82			692,166
Klickitat	1981	01/18/82		239,400	
Klickitat	1981	01/26/82		828,236	
Klickitat	1981	03/31/83			797,700
Klickitat	1982	04/27/83		557,100	
Klickitat	1982	03/13/84			500,000
Cowlitz	1983	02/21/84		1,116,100	
Klickitat	1983	04/01/85			614,500
Klickitat	1984	05/03/86			629,900
Klickitat	1985	04/09/87			59,300
Carson	1985	04/09/87			610,300
Klickitat	1986	05/01/88			603,400

(1) No release groups were reared less than 43 days.

(2) Age-0 juveniles released through 12/31. Earliest recorded release was 1/26/82 (43 days reared, 636 fish per pound).

(3) Age-1 (none released before 3/1).

(4) Coded-wire-tagged production release

Smoltification in the hatchery pond begins about April 1. Mortality seemingly associated with smoltification prompted hatchery personnel to lift the pond outlet screens in April 1988 to allow voluntary exit of smolts before the May 1 release date.

Spring chinook from Cowlitz and Carson hatcheries have also been released in the Klickitat Subbasin, mostly as age-0 fish (fish less than 1 year old). However, 650,000 Carson smolts were released in 1987 to meet the hatchery's production goal after a disappointing hatchery escapement in 1985. All smolts in this release were marked so the hatchery can avoid using them for brood stock upon their return. Meeting brood stock needs from Klickitat stock may be difficult in 1989 without severe restrictions on the treaty fishery at Lyle Falls.

Information on outmigration timing is available only from coded-wire tag recoveries. Tagged Klickitat Hatchery smolts from brood years 1975 through 1977 were captured at RM 46 of the Columbia River during April and May, between two and four weeks after their release from the hatchery. From 1977 through 1987, an average of 783 adults and 610 jacks have returned annually to the hatchery, with the peak of the run in June. Females comprised 53.3 percent of adult returns and 43.8 percent of total returns to Klickitat Hatchery from 1977 through 1987. Currently all returning females are spawned with about half that number of males, including a 2 percent proportion of jacks. Hatchery spawning begins in mid-August and runs to the end of September.

The largest available data base for the age of Klickitat spring chinook at return is available from recoveries of coded-wire tagged hatchery fish of the 1975 through 1977 broods and yields a 24.7 percent return at ocean age 0, 3.4 percent at age 1, 32.4 percent at age 2, 39.3 percent at age 3 and 0.2 percent at age 4. Mean fork lengths from the same data base were 296 mm at ocean age 0, 551 mm at age 1, 756 mm at age 2 and 893 mm at age 3.

The fecundity of spring chinook returns to Klickitat Hatchery from 1977 through 1987 ranged from 3,753 to 5,347 eggs per female with a mean of 4,188 eggs per female. Hatching of spring chinook alevins begins in mid-October and the first fry are ponded in mid-November.

Hatchery survival rates are calculated from egg to total plantings, and are usually inflated by thinning releases prior to the smolt release date. However, the 1975, 1977 and 1985 broods were released entirely as smolts with overall egg-to-smolt survival rates of 71 percent, 71 percent and 74 percent, respectively. Smolt-to-adult return rates to the subbasin for the coded-wire tagged 1975, 1976 and 1977 broods were 0.54 percent, 0.23 percent and 0.54 percent, respectively, with no tag recoveries from the subbasin treaty fishery. Correction for subbasin treaty harvest (explained in the Preliminary Information Report, July 8, 1988) resulted in smolt-to-adult return rates of 0.73 percent, 0.34 percent and 0.63 percent, respectively. Using the above corrections, these returns represent 86 percent of total recoveries. (Ten percent of the total was caught in saltwater and 3 percent in the Columbia River; there has been no directed fishery on spring chinook in the Columbia River since 1977.)

Constraints to Hatchery Production

Howell et al. (1985) cite enteric redmouth and bacterial hemorrhagic septicemia as the most common diseases afflicting Klickitat Hatchery spring chinook juveniles. Returning adults currently receive two erythromycin injections and juveniles receive gallimycin in feed to control bacterial kidney disease.

Spring chinook yearlings are reared in spring water and are currently not acclimated to the colder river water prior to release, which probably accounts in part for their low smolt-to-adult survival rate. Plans are under way to divert river water to the yearling pond in time to begin acclimation experiments with the 1988 brood.

The fact that an intensive fishery occurs in the Klickitat River 40 miles downstream from the hatchery trap creates problems both for the hatchery and the fishers -- escapement past the fishery is unknown until adults reach the hatchery a month later. This delay creates the opposing risks of harvesting fish needed for brood stock or of letting large numbers of surplus fish escape the fishery during temporary closures.

Anticipated Production Facilities

Planning began for the Yakima/Klickitat Production Project in 1982 as an element of the Northwest Power Planning Council's Columbia River Basin Fish and Wildlife Program. The project, as mentioned in an earlier section, has a primarily experimental purpose -- to test the assumption that new artificial production can be used to increase harvest and enhance natural production while maintaining genetic resources. Project managers will attempt to increase both the status (seeding) and productivity (recruits per spawner) of natural stocks in the two subbasins. The Yakima/Klickitat Production Project and its place in the Klickitat Subbasin Plan are treated in greater detail in subsequent sections on considerations and objectives for spring chinook.

Harvest

Treaty Indian and sport harvests of spring chinook in the Klickitat Subbasin are enumerated in Table 6. Each season's regulations are developed through consultation between the Washington Department of Fisheries and the Yakima Indian Nation. The Washington Department of Fisheries and the Yakima Indian Nation attempt to achieve an equitable sharing of harvestable spring chinook across all co-managed tributaries. The harvestable surplus within any tributary or tributaries may not necessarily be shared equally as long as the treaty and non-treaty harvest totals for all tributaries are equitable.

Harvest of spring chinook in the Klickitat Subbasin is currently managed to provide adequate escapement to Klickitat Hatchery. The fisheries are intended to be conservative because of difficulties in forecasting the run. General non-treaty angling regulations are published annually by the Washington Department of Fisheries and are subject to inseason emergency action, if necessary.

The Yakima Indian Nation regulates its members' fishery through provisions of the Yakima Indian Nation Law and Order Code. The Indian dip net fishery in the Lyle Falls reach of the Klickitat River has been an important fishery to Indian people since before the arrival of the first white settlers. The explorers Lewis and Clark took note of Indian fishing platforms in this reach during their journey to the Pacific Coast in 1805. This fishery continues to play an important role in meeting the subsistence needs of Yakima Indians and in providing income from fish sales during commercial seasons. The treaty fishery is monitored by tribal fisheries technicians. Commercial sale of the tribal catch is allowed on those days when the Columbia River Zone 6 treaty commercial fishery (directed toward sockeye) and the Klickitat fishery are simultaneously open.

When the Yakima/Klickitat Hatchery is built, managers will implement a new harvest management plan for Klickitat spring chinook. The plan will be designed to reflect a commitment to the hatchery's experimental program and to meeting hatchery production goals, while rebuilding natural runs and restoring harvest opportunities. The harvest plan for Klickitat spring chinook is discussed in greater detail in the section that follows.

Table 6. Harvest and spawning escapement of spring chinook, Klickitat Subbasin, 1977-1987, jacks and adults combined.

Year	Sport Catch (1)	Tribal Catch (2)	Hatchery Escapement (3)	Natural Escapement (4)	Total Return
1977	9	86	683	N/A	N/A
1978	312	712	508	78	1614
1979	120	N/A	3582	7	N/A
1980	11	61	2505	23	2601
1981	221	510	2196	81	3011
1982	477	1357	1611	41	3488
1983	439	1462	1443	18	3363
1984	362	427	718	N/A	N/A
1985	231	594	214	23	1063
1986	29	525	886	N/A	N/A
1987	101	648	979	299	2027

(1) From salmon punch card data, April-July.

(2) Used a combination of two estimates: YIN fishery monitoring data (April-July), and fish tickets written during the Zone 6 winter and sockeye seasons, when commercial sales are permitted. There are no monitoring estimates for the years 1979 and 1980, and no sales were recorded for 1979, 1983, 1984 or 1986. For the remaining years the higher of the two estimates was used during commercial seasons. Age-2 jacks were not considered to be vulnerable to this fishery.

(3) Ladder counts at Klickitat Hatchery.

(4) The Klickitat Hatchery weir is not impassable to spring chinook. The natural escapement estimate was derived from peak redd counts between Klickitat Hatchery (RM 42) and McCormick Meadows (RM 82) tabulated by Schwartzberg and Roger (1986), plus YIN survey data for years after 1984. Surveys varied in extent from year to year, but the areas in which spawning has traditionally been the heaviest were most consistently surveyed. An expansion of 2.3 representing the average number of females per redd in the Yakima subbasin (see Yakima subbasin PIR) was applied to each redd count regardless of the number of miles surveyed that year.

Specific Considerations

The spring chinook run to the Klickitat River is maintained primarily by smolt releases from the Washington Department of Fisheries Klickitat Hatchery. Smolt releases averaged 644,316 smolts from 1977 through 1987, and adult return estimates averaged 2,453 fish for the same period. The current hatchery program calls for annual releases of 750,000 smolts. Experimental acclimation facilities for spring chinook smolts are expected to be in place at the Klickitat Hatchery in 1990. Managers will continue to release all smolts on station.

On the basis of redd counts from 1975 through 1985, natural smolt production has averaged around 15,000 for that period of brood years (many assumptions are required here; see Klickitat Preliminary Information Report, July 8, 1988, Table 4, for calculations). This estimate is about 2 percent of the Northwest Power Planning Council's smolt carrying-capacity estimate. Habitat use by spring chinook is limited by passage bottlenecks at Klickitat Hatchery and at Castile Falls. Spawning success and juvenile survival may be reduced by late summer deposition of glacial sediment in spawning and rearing areas.

System planning model runs have demonstrated the fact that increasing hatchery or natural smolt capacity in a subbasin increases the size of returns, but does not affect population resiliency; a proportionally larger escapement is required to use more capacity. On the other hand, survival rates affect both run size and population resiliency (improving survival yields more recruits per spawner). Population resiliency or productivity can be quantified as the maximum sustainable yield (MSY) proportion (proportion surplus to spawning need). If the MSY proportion is high, a correspondingly large sustainable harvest rate is possible. In the absence of harvest, compensatory natural mortality will limit population size to subbasin carrying capacity.

Planners have set habitat egg capacity at a high level in all System Planning Model runs, so that smolt capacity is the factor limiting natural production. Model output is expressed in terms of maximum sustainable yield, which best shows how various actions affect the performance of exploited stocks.

The position of the Klickitat Subbasin in the Columbia River system (above only one mainstem dam) means that inbasin production measures can have a greater effect on returns to the Klickitat than in subbasins farther upriver, while mainstem factors, such as passage mortality, make a smaller difference. Increasing the production of smolts by opening up and seeding more habitat, by increasing hatchery production, and by improving the survival of hatchery and naturally produced fish can increase run size proportionally. Harvestable surplus can be increased at an even greater rate than run size through a mix of strategies that increases both capacity and resiliency.

Assessment of the status, productivity and potential of the Klickitat spring chinook stock is made more difficult by the inability to gather critical data. Major problems include the lack of juvenile or adult counting facilities, a dearth of habitat information, and turbidity and flow conditions that have often frustrated efforts to collect spawning ground data.

Klickitat spring chinook play an important role in meeting the subsistence fishing needs of Yakima tribal members, and in fulfilling the treaty share of tributary spring chinook harvest in the Columbia Basin. The subbasin provides one of the few opportunities for spring chinook harvest by tribal members while other Columbia Basin spring chinook stocks remain at low levels of abundance. Non-Indian residents of the subbasin have also voiced their interest in substantially increased sport fishing opportunity, not only for their own enjoyment, but also to help diversify the subbasin economy. Enhancement objectives must take into account the need for a significant harvest of spring chinook concurrently with efforts to rebuild the run.

It must be noted here that the spring chinook production goal for the Klickitat Subbasin and the principal means to achieve it (hatchery supplementation) have already been established during planning for the Yakima/Klickitat Hatchery. The Northwest Power Planning Council supported the ongoing hatchery planning process in its November 10, 1987 response to public comments on an earlier council staff issue paper on the Yakima/Klickitat Hatchery. On Page 18 of the response, the council made the following statement on the relationship of subbasin planning to the hatchery project.

> As noted in the issue paper, the fish and wildlife agencies, Indian tribes and others in the Columbia River Basin have started planning to double salmon and steelhead runs throughout the Basin consistent with systemwide policies. That process is expected to take about 31 months. In the meantime, this [hatchery] production project is expected to go forward. The production levels resulting from this project may not represent the ultimate objectives for the Yakima and Klickitat Subbasins, but those objectives must take this project into account. As a result, planners in the Klickitat and Yakima subbasins should coordinate with the developers of this project to ensure consistency and integration of effort. They should consider this project as a given in the Klickitat and Yakima subbasins. Any proposals for additional production in those subbasins must be consistent with this project, including its experimental

features. The Monitoring and Evaluation Group will be expected to analyze and help integrate the system and subbasin plans with this project.

The Klickitat Subbasin planning process and the Yakima/Klickitat Hatchery planning process should not be expected to arrive at incompatible production goals, since both processes embody the enhancement philosophy stated in the Power Planning Council's Columbia River Basin Fish and Wildlife Program, both rely on the same data, and both involve the same group of resource agencies. Nevertheless, the goals of the hatchery reflect its experimental purpose in addition to specific needs for the subbasin. For their part, subbasin planners are providing new data and analytical approaches that influence hatchery planning. As the Klickitat Subbasin Plan is analyzed and integrated with other subbasin plans, the ramifications of the current Klickitat spring chinook production goal will be better understood, and modification of the goal may result.

Critical Data Gaps

Redd counts represent the only source of information on the naturally spawning component of the Klickitat spring chinook stock, and are themselves subject to limitations as discussed above. Biological data in the Preliminary Information Report (July 8, 1988) come almost entirely from hatchery fish. Natural smolt production in the subbasin can be estimated only by applying generic egg-to-smolt survival rates to redd counts.

Except for the adult volunteer trap at Klickitat Hatchery, no juvenile or adult fish counting facilities exist in the Klickitat Subbasin. Spring chinook run size must be estimated by summing sport catch, treaty harvest, hatchery escapement and natural spawning escapement. All but the hatchery component are subject to significant error.

The limitations of the Northwest Power Planning Council smolt carrying-capacity estimate are well known. Its reliability is further diminished in this subbasin by limited knowledge of habitat conditions.

Objectives

Biological Objective

Increase MSY run size at recruitment by 20,000 fish.

The objective assumes a manyfold increase in the number of spawners, or a greater number of recruits per spawner, or a combination of both enhancements. Since most of the recent spring chinook hatchery releases in the subbasin have been of Klickitat stock, it may be desirable to avoid further introductions of other stocks (or the poor survival of that stock may warrant introduction of better-performing stocks). There are, to be sure, several reasons for optimism that production can be increased using the present stock: 1) the current hatchery egg take could usually produce more smolts if more rearing space were available; 2) there is room for improvement in culture techniques to enhance survival, such as with acclimation; 3) efforts to seed currently available habitat with outplants have been minimal; 4) an increase in subbasin carrying capacity can be realized by facilitating passage around Castile Falls; and 5) it may be possible to reduce sediment loading of the Klickitat River by Big Muddy Creek.

Utilization Objective

System Planning Group estimates place current combined oceanic and mainstem harvest of Klickitat spring chinook at 12 percent, although substantially larger runs could help trigger heavier downriver harvest rates. In any event, a large share of the surplus yield is expected to be harvestable in the subbasin, and should generate economic and recreational benefits for the entire community.

Alternative Strategies

Three strategies for achieving the stated objective for Klickitat spring chinook are presented. Each is intended to increase both the status and productivity of the stock, and each contains supplementation as the major action element. The strategies differ with respect to the degree of natural production enhancement. Strategy 1 emphasizes hatchery production with no efforts to enhance adult passage or improve habitat. Strategy 2 adds passage enhancement measures, and Strategy 3 adds adult and juvenile habitat improvement to the supplementation and passage actions.

Modeling results for each strategy are presented in Table 6a 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 6a. 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 6b.

STRATEGY 1: Data collection and hatchery production.

ACTIONS: 1, 2

1. Collect data necessary to evaluate the status and productivity of the Klickitat spring chinook stock.

   Reference has been made to several data deficiencies that can be addressed by 1) constructing facilities at Lyle Falls and one or more locations upstream for counting migrating juveniles and adults; 2) developing more reliable methods to determine natural spawning success and temporal and spatial distribution; 3) assessing juvenile densities in rearing areas, determining habitat quantity and quality, and refining carrying capacity estimates; 4) increasing the reliability of harvest estimates; and 5) improving mark recovery rates in fisheries and on the spawning grounds. This information will be critical when production begins under the Yakima/Klickitat Project, but refinement of data collection techniques and planning for counting facilities should begin now. This need is addressed in the October 1988 cooperative agreement between the Bonneville Power Administration and the Yakima Indian Nation.

2. Release an annual total of 3 million (2,400,000 new production) acclimated spring chinook smolts in the Klickitat Subbasin, using local brood stock collected in the vicinity of Lyle Falls (RM 1.5 to RM 2.2). Provide for natural escapement only after hatchery

brood stock needs of 2,900 fish are met (this may require one brood cycle), and limit the terminal harvest rate to 30 percent until both the hatchery brood stock goal and an interim natural escapement goal of 4,000 fish are achieved. Thus hatchery production will take precedence over natural escapement, and increased natural escapement will in turn have higher priority than increased harvest rate during the rebuilding process.

The adult production goal could be met entirely from annual releases of 3 million smolts if the hatchery smolt-to-adult survival rate were approximately 0.8 percent, which is slightly higher than the highest rate calculated from 1975 through 1977 brood coded-wire-tag recoveries. An improvement in the smolt-to-adult survival rate should indeed be realized from acclimation of smolts to river water, judging from the results of coho acclimation that are discussed in a later section. Further increases in the survival rate may result from experimentation with culture techniques.

The enhancement of natural production through outplanting juveniles in underseeded areas is, however, the central experimental goal of the Yakima/Klickitat Production Project. Outplanting will become a vital part of the Klickitat spring chinook production program once hatchery production is sufficient to ensure natural escapement of returning adults.

Another ambition of the overall project is the exclusive use of naturally spawned brood stock to limit the accumulation of maladaptive traits in supplemented stocks if deemed appropriate. However, the hatchery will need nearly 3,000 adult spring chinook each year. Outplanting of spring chinook must result in substantial natural production before the new hatchery's brood stock needs can be met from natural returns.

Sufficient space and water are available to construct a second spring chinook yearling pond at the existing hatchery. However, even if spring chinook production at Klickitat Hatchery could be doubled, the total would be less than half of what is planned under the Yakima/Klickitat Production Project; an additional facility at a different site will be required. The current hatchery plan, in fact, is scaled according to the assumption that all 3 million spring chinook smolts will be released from the new facility, leaving production of introduced fall chinook and coho to the existing hatchery. Preliminary information about facility siting, design and cost is presented in the project master plan (Fish Management Consultants, Inc. 1987).

Planners used the Northwest Power Planning Council's System Planning Model to compare total MSY run size under present conditions and with the new hatchery at full production. The hatchery is predicted to increase total MSY run size from the present 4,392 fish to 21,347 fish. The predicted MSY rate would increase from 38 percent to 91 percent.

STRATEGY 2: Data collection, hatchery production, and improved passage above the hatchery and above Castile Falls.

ACTIONS: 1-4

1. -
2. -

3. Open additional habitat for spring chinook by solving passage problems at Castile Falls.

Now that a regular maintenance program has been reestablished for the passage structures, engineers and biologists from state, federal and tribal fishery agencies should evaluate these structures along with all unladdered falls (Falls 1-3, 6, 8 and 9) to determine if fishway modification and/or additional blasting of falls is needed.

Passage around the falls during low flows is of particular concern since stray spring chinook currently approach the falls in August and September. Another possible problem is darkness in the upper tunnel. A lighting system to alleviate this problem could be powered by a small hydroelectric generator at the 10-foot weir above Falls 11. A more detailed discussion of problems at Castile Falls was presented earlier.

In modeling natural production of spring chinook, Castile Falls was assumed to be a total barrier at present, an assumption which is supported by spawning ground surveys. Removing this barrier would add 361,000 smolts to the habitat carrying capacity, and would add 2,716 fish to the total MSY run size achievable by hatchery supplementation only, according to the Northwest Power Planning Council's System Planning Model.

Planners estimate capital costs will be approximately $760,000 with annual operation and maintenance costs of $8,000.

4. Relieve the spring chinook passage bottleneck below the Klickitat Hatchery weir. Redesign the adult ladder so that fish can either be trapped for use as brood stock or be allowed to continue up the ladder and return to the river above the weir.

   The redesigned ladder could be used year-round as an upriver counting facility for adult migrants of all species. This would aid in assessing natural production and evaluating the Yakima/Klickitat Production Project. A rack would need to be constructed atop the weir to ensure accurate counts.

   The passage problem at the hatchery was modeled by expressing it as a reduction in pre-spawning survival rate of naturally spawning spring chinook from the basin default value of 0.8 down to 0.5. This effect, if it is partly due to spring water attraction, may be lessened when river water acclimation experiments begin. At least for the present, all natural spawners are affected because the hatchery marks the lower extent of the spring chinook spawning area delineated in the Tributary Planning Model. Alleviating this problem would add 270 fish to the total MSY run size achievable by the two previous actions alone, according to the Northwest Power Planning Council's System Planning Model.

   Planners estimate capital costs will be approximately $50,297 with no annual operation and maintenance costs.

STRATEGY 3: Data collection, hatchery production, passage improvement, sediment removal, and riparian improvement.

ACTIONS: 1-6

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

5. Improve spring chinook spawning and rearing conditions by reducing sediment loadings from Big Muddy Creek.

Hellroaring Irrigation Company diverts water from Hellroaring Creek and four smaller Klickitat River tributaries into Hellroaring Ditch to irrigate pasture and cropland in the Glenwood area. By midsummer in most years, streamflows in Hellroaring, Cougar, Dairy, Dry and Bird creeks decline to the point that water must also be appropriated from sediment-laden Big Muddy Creek to meet irrigation demands. At present, roughly half the late summer flow of Big Muddy Creek is diverted into Hellroaring Ditch. To reduce sediment discharge from the remaining creek flow into the Klickitat River, settling ponds could be constructed in the channel of Big Muddy Creek below the Hellroaring diversion. Settling ponds could only be expected to remove particles as small as silt; sediment deposits in the Klickitat River may be reduced far more than the turbidity of the discharge.

Removing abrasive particles could serve an additional purpose by making the discharge from Big Muddy Creek suitable for hydropower generation. Big Muddy Creek drops about 1,250 feet in the five miles between the Hellroaring diversion and the Klickitat River. Fifty to 75 cfs of streamflow at a 1,250-foot head could generate enough power to provide a cash flow of more than $1 million per year to the hydroelectric project owner.

For modeling purposes, sediment was assumed to reduce spring chinook egg-to-smolt survival rate by a rather arbitrary 25 percent below Big Muddy Creek. There is no data to support or refute this assumption. Restoring the survival rate to that in upstream reaches would add 250 fish to the total MSY run size achievable by the three previous actions alone, according to the Northwest Power Planning Council's System Planning Model.

Under Action 1, studies of natural production must address the impact of sediment loadings on spring chinook production areas. At the same time, managers should investigate Big Muddy Creek itself to rule out any salmonid production before pursuing power generation.

Under Action 2, spring chinook run size and yield are expected to increase severalfold. To the extent that extremely fine particles can be removed by settling, improving water clarity in the Klickitat River below Big Muddy Creek could help make it possible for sport fishers to harvest their share of the enhanced yield of spring chinook.

Planners estimate reducing sediment loadings from Big Muddy Creek will cost approximately $7 million in capital costs and $100,000 in annual O&M costs.

6. Improve spring chinook spawning and rearing conditions by improving riparian habitat in the upper Klickitat River.

   The Caldwell Prairie (RM 80.2 to RM 82.2) and McCormick Meadow (RM 84.5 to RM 86.5) reaches were mentioned in a previous section as areas where restricting livestock access to streambanks could be beneficial to the fishery resource. Riparian recovery could be accelerated if structures were placed in the river channel to lower the flow velocity, raise the water table and reverse the channel degradation process, which seems to have been occurring for many years. Passage problems below these reaches need not hinder habitat enhancement for spring chinook, since the upper Klickitat River can rear hatchery juveniles before it is made accessible to adults.

   It would be difficult at this time to quantify damage or estimate the benefits of riparian protection and channel improvements in these reaches. However, information gathered from future demonstration fencing and stream channel restoration projects in the Yakima Subbasin should be useful for estimating benefits.

   Planners estimate capital costs will be approximately $74,000 with annual O&M costs of $7,420.

Table 6a. System Planning Model results for spring chinook in the Klickitat Subbasin. Baseline value is for pre-mainstem implementation, all other values are post-implementation.

Utilization Objective:

Biological Objective:
Increase MSY run size at recruitment by 20,000 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	1,945 -N	376	2,432	324	0(1.00)
All Nat	3,015 -N	494	3,633	484	1,501(1.49)
1	14,577 -N	1,288	16,197	2,156	17,200(6.66)
2	14,540 -N	1,438	16,337	2,175	17,376(6.72)
3*	3,015 -N	494	3,633	484	1,501(1.49)

*Recommended strategy.

[1]Strategy descriptions:

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

1. Data collection and hatchery production. Post Mainstem Implementation.
2. Strategy 1 plus improved passage above the hatchery and above Castile Falls. Post Mainstem Implementation.
3. Strategy 2 plus sediment removal and riparian improvement. 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 6b. Estimated costs of alternative strategies for Klickitat spring chinook. Cost estimates represent new or additional costs to the 1987 Columbia River Basin Fish and Wildlife Program; they do not represent projects funded under other programs, such as the Lower Snake River Compensation Plan or a public utility district settlement agreement. (For itemized costs, see Appendix C.)

	Proposed Strategies		
	1	2	3*
Hatchery Costs			
Capital[1]	0	0	0
O&M/yr[2]	0	0	0
Other Costs			
Capital[3]	0	810,000	7,884,497
O&M/yr[4]	0	8,000	115,420
Total Costs			
Capital	0	810,000	7,884,497
O&M/yr	0	8,000	115,420

* Recommended strategy.

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

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

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

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

Recommended Strategy

Planners recommend Strategy 3, data collection, hatchery production, passage improvement, sediment removal, and riparian improvement. Section 203(d) of the Columbia River Basin Fish and Wildlife Plan (Item 4 of Appendix A in this document) stresses the need for a mix of wild, natural and hatchery production to rebuild fish runs in the Columbia Basin. Removing migration barriers and improving spawning and rearing habitat are essential for developing a natural complement to increased hatchery production, consistent with system policies.

The distinction between an action that increases carrying capacity (Action 3) and one that increases survival rate (Actions 4 and 5) is important under MSY conditions. If the survival rate increases, more recruits can be produced by the same number of spawners, while an increase in carrying capacity requires a proportionally greater escapement to be used optimally. Another way of stating this distinction is that habitat carrying capacity affects stock size, while survival rate affects stock size and stock productivity (resiliency). Action 2 can be said to increase carrying capacity (by providing additional hatchery space) and survival rate (by providing less rigorous incubation and rearing conditions). The increased pre-release survival rate is assumed to be partly compensated for by post-release mortality. Action 5 is presumed to increase carrying capacity, although its effects, as stated above, cannot be quantified at this time.

Subbasin planning guidelines stress that strategies should not drive objectives. To be consistent with this principle, the overall adult production objective should be held constant when modeling the three different strategies. For reasons given in the section on considerations, hatchery production is common to all Klickitat spring chinook strategies. To maintain a constant overall production goal, hatchery production becomes the variable that must be adjusted downward as other actions contribute additional natural production to the model scenario.

The production anticipated from the hatchery, however, dwarfs potential natural production of spring chinook. Natural production enhancements would make only about a 20 percent difference in the amount of hatchery supplementation required to meet the overall production goal. Their combined effects could be overshadowed by an increase in hatchery smolt-to-adult survival from the 0.57 percent implied by the System Planning Model to 0.7 percent. Given any degree of uncertainty about hatchery survival rates, it seems pointless to propose adjustments to the size of the hatchery on the basis of whether certain natural production enhancements are implemented.

This does not mean that increasing natural survival rates and habitat carrying capacity for spring chinook are not worthwhile. These measures have benefits beyond their direct contribution to spring chinook production. First, a naturally spawning stock component and the eventual exclusion of hatchery-reared brood stock will provide a needed element of natural selection to help prevent the accumulation of maladaptive traits within the population. Second, hatchery production is expensive; measures to enhance natural production compare well with hatchery production from a cost-benefit standpoint. Third, production of other anadromous species, most notably steelhead, will benefit as well from improvements in passage and water quality. For these reasons, planners have recommended Strategy 3, which combines both artificial and natural production enhancement actions.

SUMMER STEELHEAD

Fisheries Resource

Natural Production

History and Status

Summer steelhead are native to the Klickitat Subbasin. Bryant (1949) stated that "a fairly good run of spring steelhead" had been reported in the Klickitat River. Counts of returning adults are unavailable, although estimates have been made on the basis of harvest (see below).

Estimates of both sport harvest and treaty harvest of Klickitat summer steelhead (May through February catches) exist for 1981 through 1986; the mean value is 4,070 fish. Thirty-two percent of the sampled sport catch in 1979 through 1981 was of natural origin. One-ocean fish made up 14 percent of this subsample of 151 naturally produced fish, 78 percent were 2-ocean, 5 percent were 3-ocean fish, and 3 percent were repeat spawners ranging from ocean age-3 through ocean age-6 fish. Mean fork lengths of the four groups were 60 cm, 73 cm, 80 cm and 77 cm, respectively. Females made up 55 percent of the natural subsample; the fecundity of naturally produced Klickitat females is unknown.

Biological data on the 299 hatchery fish in the above sample are presented here for comparison. Four percent of the hatchery subsample were ocean age-1 fish, 93 percent were ocean age-2 fish, 2 percent were ocean age-3 fish, and 1 percent were 4- and 5-year-old (total age) respawners. The four groups had mean fork lengths of 62 cm, 72 cm, 90 cm and 79 cm, respectively, and 64 percent of the subsample were females. Skamania-stock summer steelhead have a mean fecundity of 4,006 eggs per female according to Randolph (1986). This mean value has been adjusted for age by a procedure described in the Klickitat Subbasin Preliminary Information Report (July 8, 1988).

A map of probable summer steelhead spawning areas in Howell et al. (1985) includes the mainstem Klickitat from near the mouth to Diamond Fork (RM 76.8) plus 13 tributaries. The first steelhead spawner surveys in the Klickitat River were by helicopter on March 6, March 31, and April 26, 1988, and resulted in a peak count of 97 redds downstream of Klickitat Hatchery (RM 42.4). In most of the survey reaches, the largest number of redds was seen on the March 31 flight. The depth of the canyon made counting difficult between the hatchery and Castile Falls (RM 64.0). Biologists did not observe any redds from Castile Falls upstream to McCormick Meadow (RM 86), in spite of more favorable survey conditions in this reach. Biologists also saw seven redds in the lower portion of Swale Creek, which enters the Klickitat River at RM 17.2 (J. Weinheimer, WDW, pers. commun.).

The number of redds seen in these surveys indicates an escapement of 200 fish. By contrast, the sport catch-to-escapement ratio of 0.65 established for Kalama River summer steelhead (M. Chilcote, WDW, pers. commun.) (see Table 8) predicts an average escapement to Klickitat River spawning grounds of 958 fish from 1977 through 1985. This discrepancy indicates that additional spawning is probably occurring in tributaries and in portions of the mainstem difficult to see from the air.

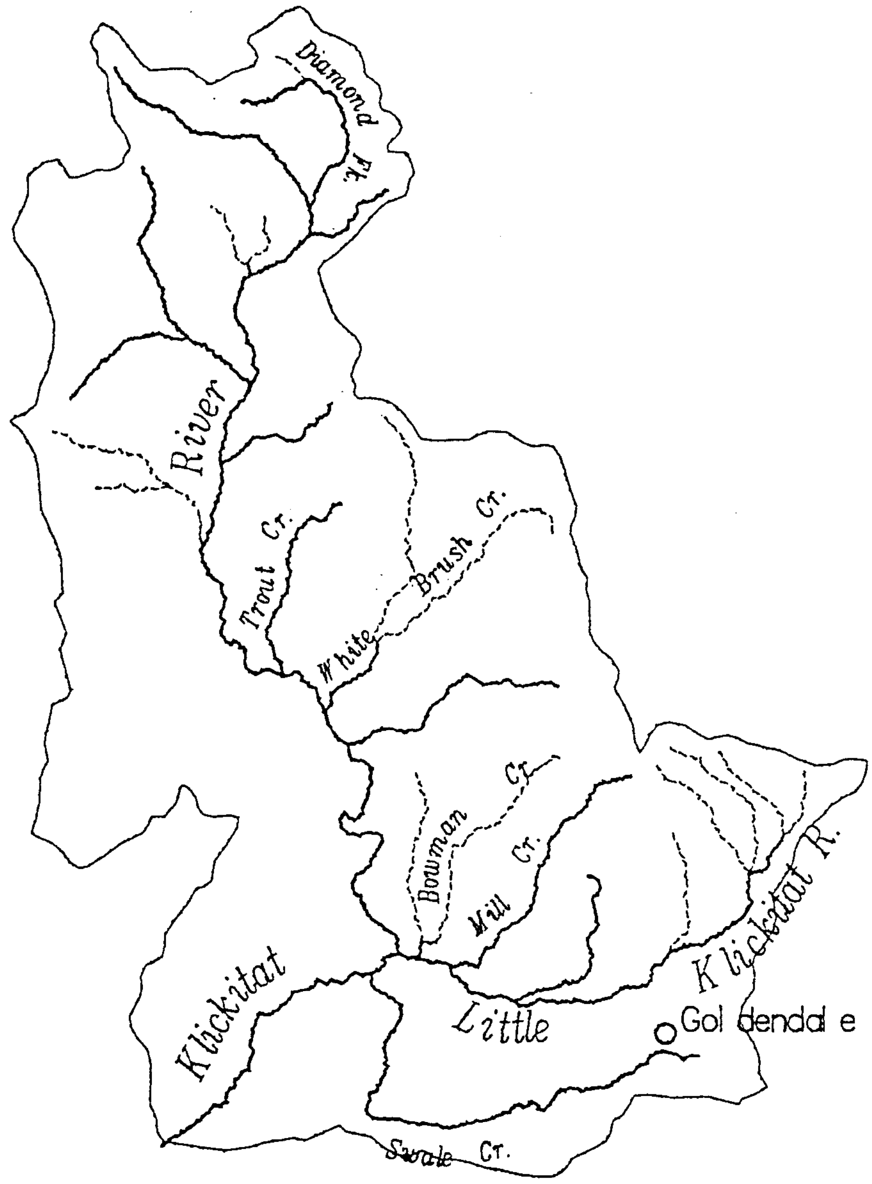
Life History and Population Characteristics

Information on freshwater life history of Klickitat summer steelhead from Howell et al. (1985) is rather speculative since fishery monitoring was the only subbasin-specific information source. Summer steelhead migrate into the Klickitat Subbasin from April through December and probably spawn from January through April of the following year. There is no data on juvenile life history of summer steelhead in the subbasin other than smolt age inferred from analysis of adult scales.

Of the 151 naturally spawned adults sampled from 1979 through 1981, 94 percent had resided in freshwater for two years and 6 percent for three years before outmigration. Managers cannot estimate natural egg-to-smolt and smolt-to-adult survival rates without complete spawning ground surveys and facilities for counting migrants. Mark Chilcote (WDW, pers. commun.) used numbers of smolts planted plus the hatchery and wild proportion and the Kalama River catch-to-escapement ratio described above to derive an estimate of 4.3 percent for hatchery smolt-to-adult survival from 1977 through 1982.

The "standard" Northwest Power Planning Council carrying capacity estimate for steelhead in the Klickitat Subbasin is 328,000 smolts, assuming no production above Castile Falls. The estimate depends on subjective habitat quality ratings, which in turn are based on limited observations.

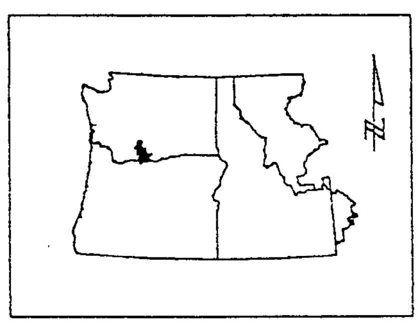
KLICKITAT SUBBASIN



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.

Planners also used an alternative model, developed by the Washington Department of Wildlife, to estimate density of late summer steelhead parr in each Klickitat Subbasin reach on the basis of stream discharge and gradient. This density estimate was then multiplied by reach area. Planners corrected the resulting parr capacity for parr-to-smolt mortality using the smolt age discussed above, and summed the reach smolt capacities over the entire subbasin. This method predicts a smolt carrying capacity of 95,437 smolts below Castile Falls and 26,434 smolts above the falls for a total of 121,871 smolts.

It would be less difficult to choose between these two estimates if current run size or current smolt-to-adult survival rates could be estimated with precision. For the Yakima Subbasin, the ratio of the two estimates was similar, but the adult run size estimate based on the Washington Department of Wildlife method was closer to the estimated historic steelhead carrying capacity after adjustments for habitat degradation and for passage mortality caused by Columbia River dams. Nevertheless, for consistency with other subbasins, the Northwest Power Planning Council estimate was used for all System Planning Model runs.

Howell et al. (1985) cite an interim escapement goal of 2,965 wild steelhead adults for the Klickitat Subbasin. Dividing the most recent WDW carrying capacity estimate of 95,437 smolts by the WDW's estimate of 32.25 smolts per female results in an escapement of 2,959 females (5,380 spawners).

Supplementation History

Managers have planted Skamania Hatchery summer steelhead smolts in the Klickitat River annually since about 1960. The Skamania stock was derived in the late 1950s from wild Washougal and Klickitat summer steelhead. From 1977 through 1986, managers planted an average of 111,120 smolts each year in the Klickitat River; generally about half between RM 15.3 and RM 19.8, and about half between RM 30 and RM 32.2 (U. Rasmussen, WDW, pers. commun.). Skamania stock fish from the Washington Department of Wildlife's Vancouver Hatchery were planted in reduced numbers in 1987-1988 when an infectious hematopoietic necrosis (IHN) outbreak forced a quarantine of Skamania Hatchery, causing an overall shortage of Skamania smolts. Annual plants are summarized in Table 7.

Table 7. Releases of hatchery steelhead in the Klickitat Subbasin 1977-1988.

Release Year	Hatchery Stock	Brood Year	Number Released	Release Stream	Release Location
1977	Skamania	1976	101,192	Klickitat	(1)
1978	Skamania	1977	101,955	Klickitat	
1979	Skamania	1978	111,188	Klickitat	
1980	Skamania	1979	104,130	Klickitat	
1981	Skamania	1980	104,133	Klickitat	
1982	Skamania	1981	103,797	Klickitat	
1983	Skamania	1982	79,302	Klickitat	
1984	Skamania	1983	150,289	Klickitat	
1985	Skamania	1984	120,126	Klickitat	
1986	Skamania	1985	135,089	Klickitat	
1987	Skamania	1986	56,500	Klickitat	
1988	Skamania	1987	60,341	Klickitat	

(1) Release locations described in text.

Planners can estimate current natural production of steelhead smolts with the knowledge that plants averaging 104,778 smolts from 1977 through 1979 produced 68 percent of the returns from 1979 through 1981 (all returns were assumed to be 2-ocean fish to simplify calculations). Assuming the same smolt-to-adult survival rate for hatchery and natural fish, annual natural production of about 49,000 smolts would have been required to produce the other 32 percent. The required natural production would, of course, have been less if natural smolts survived better than hatchery smolts.

The subbasin appears, therefore, to be producing steelhead well below its capacity, even if the lower Washington Department of Wildlife capacity estimate is used. Admittedly this conclusion does not seem to agree with the results of System Planning Model runs, which indicate that the subbasin is being harvested at slightly below the MSY rate. These model results probably have their basis in MSY calculations and the fact that hatchery releases tend to skew the spawner-recruit curve so that MSY run size is achieved at low seeding levels.

Fish Production Constraints

If the observations made from eight to 10 years ago are still valid, about one-third of the adult steelhead returning to the Klickitat Subbasin are of natural origin (anglers have told this writer that most of the steelhead hooked in 1988 through the month of July were not fin-clipped). The constraints listed below have the potential to reduce natural steelhead production, although there is no way to measure the extent of any long-term decline in production.

Hatchery steelhead have undoubtedly made a genetic contribution to the naturally spawning population in the Klickitat Subbasin. Whether this contribution has had deleterious effects is unknown.

Hatchery steelhead have been harvested selectively in the Klickitat River sport fishery since 1986. The treaty dip net fishery at Lyle Falls remains non-selective, harvesting an average of 691 unmarked summer steelhead per year from 1981 through 1987, based on the hatchery-natural ratio of approximately 2-to-1.

Passage difficulties cited in the section on spring chinook apply also to summer steelhead. Like spring chinook, summer steelhead negotiated Lyle Falls even before fishways were constructed. The aerial surveys made in 1988 suggest that Castile Falls, on the other hand, may be as serious a barrier to summer steelhead as it is to spring chinook.

Passage obstructions in tributaries to the Klickitat River undoubtedly have a greater impact on steelhead than on spring chinook, given the propensity of steelhead spawners for smaller tributaries. Falls in the Little Klickitat River and in the West Fork of the Klickitat River may be the most significant of the remediable natural obstacles to the passage of adult steelhead. Fish passage is also likely to be impeded by clogged or perched culverts in a number of tributary drainages including those of Diamond Fork and Summit, White, Trout, Surveyors, McCreedy and Piscoe creeks.

Forest practices and/or livestock grazing has degraded riparian and instream habitat most significantly in Summit Creek, the White Creek drainage, McCreedy Creek, Piscoe Creek, Diamond Fork and in portions of the Klickitat mainstem above RM 80. Passage and habitat must be considered together, since the value of passage improvements obviously depends on habitat conditions upstream.

Sediment loads from Mount Adams glaciers were discussed in the earlier section on spring chinook. Sediment from the creeks draining these glaciers, especially Big Muddy Creek, was considered serious enough to be named as a constraint on steelhead carrying capacity of the lower Klickitat. It is possible that turbidity has some beneficial effect on escapement by limiting angler success.

Hatchery Production

Planning began for the Yakima/Klickitat Production Project in 1982 as an element of the Northwest Power Planning Council's Columbia River Basin Fish and Wildlife Program. As mentioned earlier, the project has a primarily experimental purpose -- to test the assumption that new artificial production can be used to increase harvest and enhance natural production while maintaining genetic resources. Project managers will attempt to increase both the status (seeding) and productivity (recruits per spawner) of natural stocks in the two subbasins. Planners discussed this project's relationship to the Klickitat Subbasin Plan in the spring chinook plan.

Harvest

Treaty and sport harvests of summer steelhead in the Klickitat Subbasin since 1977 are summarized in Table 8. The United States vs. Oregon Columbia River Fish Management Plan (October 1988) stipulates that steelhead harvest shares be based on the aggregate of mainstem and tributary catches by tribal and recreational fisheries and, further, that neither the treaty share nor the non-treaty share shall exceed 50 percent of the aggregate harvestable steelhead. Within this framework, each season's regulations for the Klickitat River are developed through consultation between the Washington Department of Wildlife and the Yakima Indian Nation.

The process for establishing treaty fishing seasons in the Klickitat Subbasin was described in the spring chinook plan. In 1988, the Yakima Indian trout season on the Klickitat River was set for June 1 through November 30 between the mouth and the Yakima Indian Reservation boundary (actually the 1906-1907 Campbell Line). The treaty fishing area between RM 1.5 and RM 2.2 was closed to sport fishing. As discussed above, a WDW regulation allows only hatchery steelhead to be retained by sport fishermen. The objective of the wild steelhead release regulation is to increase escapements of naturally produced steelhead and decrease the likelihood of hatchery-natural hybridization.

Table 8. Harvest and spawning escapement of summer steelhead, Klickitat Subbasin, 1977-1987.

Year	Sport Catch (1)	Tribal Catch (2)	Escapement (3)	Total Return
1977	1909	2128	2940	6977
1978	2383	522	3670	6575
1979	2632	N/A	4053	N/A
1980	1452	N/A	2236	N/A
1981	3878	1823	5972	11673
1982	1506	1567	2319	5392
1983	867	995	1335	3197
1984	1980	1316	3049	6345
1985	886	1626	1364	3876
1986	1482	6491	N/A	N/A
1987	N/A	1305	N/A	N/A

(1) March and April catches were assumed to be winter steelhead, except for two fish caught in March and April, 1986 after wild steelhead release regulations had gone into effect.

(2) March and April catches were assumed to be winter steelhead. There are no monitoring data for the 1979 and 1980 seasons. The 1978 estimate covers 3/25 through 5/31 and 8/1 through 9/10. Data are also missing for 9/82-11/82 and for 10/84.

(3) Escapement was estimated by multiplying sport catch times 1.54/. This factor is based on 11 years of known escapement and sport catch estimates for the Kalama River (Mark Chilcote, WDW, pers. comm.). It should be noted that although the Klickitat River supports an intensive tribal fishery, the fishery is located downstream of most sport fishing, spawning and outplanting areas and therefore may not itself invalidate the relationship between sport catch and escapement. Differences in fishing effort between the two rivers may be a more important source of error. Wild steelhead release regulations preclude the use of this estimator for years after 1985.

During the planning process for the Yakima/Klickitat Production Project, a conflict has arisen regarding the applicability of this regulation under the new hatchery's supplementation program. Specifically, the practice of harvesting the hatchery component of steelhead runs by retaining marked fish and releasing unmarked fish is at odds with the hatchery project goal of rebuilding natural runs through escapement of hatchery fish. Proponents of the hatchery's planned approach to supplementation have argued that continuing to manage marked and unmarked steelhead as separate stocks will be counterproductive in light of precautions to be taken in hatchery brood stock selection, and will only retard the repopulation of underseeded areas of the subbasin. A plan is currently being developed that, among other things, will limit the harvest of hatchery steelhead when the new hatchery facility goes into production.

Specific Considerations

Managers estimate the Klickitat summer steelhead run has averaged 6,097 fish from 1981 through 1985. On the basis of 1979 and 1981 data, about two-thirds of the run is considered to be of hatchery origin, returning from plants of Skamania smolts averaging 111,120 fish annually from 1977 through 1986.

By most of the possible calculation methods, natural smolt production in the subbasin is less than half of carrying capacity. Reasons for this deficit may include 1) unknown, but possible negative, impacts of interbreeding of wild and hatchery adults; 2) glacial sediment loading in the Klickitat mainstem; and 3) terminal harvest, although there is no reliable way to estimate escapements, much less to determine whether they are adequate. Carrying capacity itself is limited by Castile Falls in the mainstem and falls in two major tributaries, and by road crossings and riparian degradation in a number of smaller tributaries.

Assessment of the status, productivity and potential of Klickitat summer steelhead is made more difficult by the inability to gather critical data. Major problems include the lack of juvenile or adult counting facilities, a dearth of habitat information, and less-than-ideal conditions for collecting spawning-ground data.

Klickitat summer steelhead play an important role in meeting the subsistence fishing needs of Yakima tribal members, and in fulfilling the treaty share of steelhead harvest in the Columbia Basin. Sport fishers in the subbasin have also voiced their interest (albeit not unanimously) in greater sport fishing opportunity for steelhead, partly because of expected economic benefits to the area. Enhancement objectives must take into account the need for continued treaty and sport harvest while runs are being rebuilt.

Critical Data Gaps

As noted earlier, no juvenile or adult fish counting facilities exist in the Klickitat Subbasin. Managers can estimate summer steelhead run size only by summing estimates of sport and treaty harvests, and adding a calculated natural spawning escapement based on sport catch. Estimates of survival rates are equally speculative.

Smolt and adult age distribution, and the sex ratio and sizes of returning adults are based entirely on a 151-fish sample collected in 1979 through 1981 creel census surveys. More sampling is needed to increase the precision of estimates and to document population trends.

Recent aerial surveys have provided the first hints about the success, location and timing of steelhead spawning in the Klickitat mainstem. Almost nothing is known about tributary spawning. Better information about spawning location and timing would aid in the identification of reproductively isolated steelhead substocks, if any. Managers have not surveyed tributaries to the Klickitat River thoroughly enough to rule out additional passage impediments, which would diminish the reliability of current steelhead carrying capacity estimates.

Objectives

Biological Objective

Increase MSY run size at recruitment by 25,000 fish.

The objective assumes a large increase in the number of spawners, or a greater number of recruits per spawner, or a combination of both.

Utilization Objective

System Planning Group estimates place the current oceanic harvest rate at zero and the current mainstem Columbia harvest rate at 22 percent, although substantially larger runs could permit higher downriver harvest rates. In any event, a large share of any additional yield is expected to be harvestable in the subbasin. This should generate economic and recreational benefits for the entire community.

Alternative Strategies

Three strategies for achieving the stated objective for Klickitat summer steelhead are presented. Each is intended to increase both the status and productivity of the stock, and each contains supplementation as the major action element for reasons discussed in the spring chinook section. The strategies differ with respect to the degree of natural production enhancement. Strategy 1 emphasizes hatchery production with no efforts to enhance adult passage or improve habitat. Strategy 2 adds passage enhancement measures, and Strategy 3 adds adult and juvenile habitat improvements to the supplementation and passage actions. For Strategies 2 and 3, actions that improve passage and habitat are added to, rather than being substituted for, hatchery production. Planners discussed the reasons for this in the section on spring chinook strategies.

Modeling results for each strategy are presented in Table 8a 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 8a. 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 8b.

STRATEGY 1: Data collection and hatchery production.

ACTIONS: 1, 2

1. Collect data necessary to evaluate the status and productivity of the Klickitat summer steelhead stock.

   Previously mentioned data deficiencies can be addressed by 1) constructing facilities at Lyle Falls and one or more locations upstream for counting migrating juveniles and adults, 2) developing more reliable methods to determine natural spawning success and temporal and spatial distribution, 3) identifying substocks through spawning ground surveys, genetic stock identification techniques, radio tracking and/or scale pattern analysis, 4) evaluating the potential for detrimental interactions with resident rainbow trout, 5) assessing juvenile densities in rearing areas, determining habitat quantity and quality, and refining carrying capacity estimates, 6) increasing the reliability of harvest estimates, and 7) improving mark recovery rates in fisheries and on the spawning grounds. Research needs are addressed in the October 1988 cooperative agreement between the Bonneville Power Administration and the Yakima Indian Nation.

2. Outplant an annual total of 250,000 acclimated summer steelhead smolts in the Klickitat Subbasin. Use naturally spawned local brood stock collected at locations dictated by any substock identification component that may be taken under Action 1.

   New facilities must be constructed on the Klickitat River to spawn and rear spring chinook and summer steelhead smolts. Preliminary information about facility siting, design and cost is presented in the Yakima/Klickitat Production Project Master Plan (Fish Management Consultants, Inc. 1987).

   According to the master plan, the Yakima/Klickitat Hatchery will eventually take over supplementation of the Klickitat summer steelhead stock, and plants of Skamania summer steelhead will cease. The experimental purpose of the hatchery was discussed in the earlier section on spring chinook. Several measures will be taken for supplementing the Klickitat summer steelhead stock with minimal potential for adverse genetic impact, including the following.

A) All releases will be marked, and all brood stock will be taken randomly from naturally spawned, unmarked returns so that supplementation (hatchery) and natural fish will share the same genotype.

B) Up to 10 percent of the natural returning adult population will be taken for brood stock, with the intention of conserving the largest possible gene pool.

C) Efforts may be made to identify discrete substocks of Klickitat summer steelhead before supplementation begins, and a variety of stock characteristics will be monitored during supplementation to detect any changes caused by hatchery influence.

Increasing the run size fivefold with a little more than a twofold increase in the number of smolts released will obviously require a smolt-to-adult survival rate that is more than double the present rate. The smolt-to-adult survival rate should indeed improve under the new hatchery program as a result of pre-release acclimation and the use of local, unmarked brood stock, among other measures. However, a doubling of the rate is by no means assured, and it is unlikely that hatchery smolt production -- the subject of considerable debate over the past three years -- will be increased to make up for any deficiency.

Planners use the Northwest Power Planning Council System Planning Model to compare total MSY run size under present conditions and with the new hatchery at full production. The hatchery is predicted to increase the total MSY run size from the present 6,162 fish to 12,401 fish. This increase represents only a fraction of the production goal. The small size of the increase is due in part to the use of a genetic effects model distributed by Northwest Power Planning Council to set an overall post-release smolt survival rate (actually the product of two hatchery smolt survival rates) at 63 percent. The predicted MSY rate increases from 64 percent to 73 percent with the new hatchery in production.

Steelhead harvest management in the Klickitat River will attempt to balance competing needs for tributary harvests, natural stock escapements, genetic resource conservation, and hatchery brood stock. The harvest management plan currently being developed by the Yakima

Indian Nation and the Washington Department of Wildlife calls for restriction of terminal harvest rates until an interim natural escapement goal of 5,000 adults is reached. After hatchery production begins, and while natural summer steelhead runs remain below 3,000 fish, tribal harvest will be limited to 5 percent of the natural run while sport fishers will be allowed to retain only fin-clipped steelhead. For natural runs between 3,000 and 6,300 fish, sport fishers will still be required to release unclipped steelhead while tribal harvest will be limited to 15 percent of the natural run. Until the interim natural escapement goal is reached, the maximum terminal harvest rate for fin-clipped summer steelhead will be 55 percent in all fisheries. Induced variation in annual escapements above the interim goal will provide an empirical basis for selection of an MSY escapement goal.

STRATEGY 2: Data collection, hatchery production, and improved access above Castile Falls, West Fork Falls and Little Klickitat Falls.

ACTIONS: 1-3

1. -
2. -

3. Open additional habitat for summer steelhead by solving passage problems at Castile Falls. (A discussion of problems, current work and proposed actions at Castile Falls is found in the spring chinook plan.) As mentioned in the spring chinook plan, planner estimate passage at Castile Falls will cost approximately $760,000 in capital and $8,000 in annual operation and maintenance costs.

   In addition, ladder the 12-foot falls on the West Fork of the Klickitat River to make spawning and rearing habitat in Fish Lake Stream accessible to summer steelhead. Besides constructing the ladder, it may be necessary to create resting pools in the series of cascades near the mouth of the West Fork. Modifying the 6-foot falls at RM 2.3 of Fish Lake Stream, which enters above West Fork Falls, may also be advisable. (Planners estimate capital costs will be approximately $180,000 with annual O&M costs of $2,400.)

   Third, ladder the 16-foot falls at RM 6.1 of the Little Klickitat River. The modeled benefits of the second and third proposed passage improvements may be quite inaccurate because of some uncertainties about passage conditions above West Fork Falls and about temperature, flow and passage above and below Little Klickitat Falls. West Fork Falls is on tribal trust land in the Yakima Indian Reservation, and Little Klickitat Falls is on private land. (Planners estimate costs to be $160,000 in capital and $2,400 in annual O&M.)

Fourth, relieve passage impediments caused by perched or blocked culverts within the Yakima Indian Reservation. A total of 19 of these have been identified in the Klickitat Subbasin so far, in the Summit, White, Trout, Surveyors, McCreedy, Piscoe and Diamond Fork drainages. More survey work is needed to complete the list. Managers are preparing a proposal for identifying and remedying culvert problems on the Yakima Indian Reservation (L. Wasserman, YIN, pers. commun.). No attempt is made in the present document to quantify the benefits of culvert rehabilitation; the proposed culvert project could easily incorporate such an analysis. (Planners estimate costs to be $50,000 in capital and $5,000 in annual O&M.)

Benefits of the passage actions were simulated with the Northwest Power Planning Council System Planning Model. Increases in MSY run size (compared to hatchery supplementation only) are predicted to be 577 fish for Castile Falls, 77 fish for West Fork Falls and 26 fish for Little Klickitat Falls. These run size increases are the result of increases in smolt carrying capacity (Northwest Power Planning Council method) amounting to 49,000 smolts for Castile Falls, 9,000 smolts for West Fork Falls and 3,000 smolts for Little Klickitat Falls.

STRATEGY 3: Data collection, hatchery production, passage improvement, sediment removal, and riparian improvement.

ACTIONS: 1-5

1. -
2. -
3. -

4. Improve summer steelhead spawning and rearing conditions by reducing sediment loadings from Big Muddy Creek. (This action received detailed discussion in the spring chinook plan.) As mentioned earlier, planners estimate costs will total approximately $7 million in capital and $100,000 in annual O&M.

The impact of sediment loadings on summer steelhead depends on the importance of mainstem spawning and rearing to overall production. This impact should be addressed as part of Action 1. For present modeling purposes, sediment was presumed to reduce the egg-to-smolt survival rate of summer steelhead in the mainstem below Big Muddy Creek by one-fourth. Removing this sediment load increases the predicted total MSY run size by 1,013 fish over what could be realized from hatchery supplementation and passage improvement only.

5. Improve summer steelhead spawning and rearing conditions by improving riparian habitat in meadows adjacent to the upper Klickitat River and in tributaries to the Klickitat River. These include, but are not limited to, the Little Klickitat River west of Goldendale, White Creek and its tributaries, and Piscoe Creek.

   Riparian recovery could be accelerated at some of the sites if structures were placed in stream channels to lower flow velocity, raise the water table and reverse the process of channel degradation. Mainstem passage problems below some of these sites need not deter habitat enhancement for summer steelhead, since the upper Klickitat River can rear hatchery juveniles before it is made accessible to adults.

   Habitat surveys of Klickitat River tributaries must be completed before an exhaustive list of problem areas can be compiled. Even in the reaches with obvious overgrazing, it would be difficult at this time to quantify damage or estimate the benefits of riparian protection. However, information gathered from future demonstration fencing projects in the Yakima Subbasin should be useful for estimating benefits.

   Planners estimate the costs of Action 5 will total approximately $74,200 in capital and $7,420 in annual O&M.

Table 8a. System Planning Model results for summer steelhead (A's) in the Klickitat Subbasin. Baseline value is for pre-mainstem implementation, all other values are post-implementation.

Utilization Objective:

Biological Objective:
Increase MSY run size at recruitment by 25,000 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	3,522 -N	2,203	5,970	637	0(1.00)
All Nat	3,920 -N	2,256	6,427	686	561(1.08)
1	7,481 -N	3,468	11,335	1,210	6,584(1.90)
2	7,575 -N	3,671	11,654	1,244	6,975(1.95)
3*	3,920 -N	2,256	6,427	686	561(1.08)

*Recommended strategy.

[1]Strategy descriptions:

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

1. Data collection and hatchery production. Post Mainstem Implementation.
2. Strategy 1 plus improved passage above Castile Falls, West Fork Falls and Little Klickitat Falls. Post Mainstem Implementation.
3. Strategy 2 plus sediment removal and riparian improvement. 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 8b. Estimated costs of alternative strategies for Klickitat 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]	0	1,150,000	8,224,200
O&M/yr[4]	0	17,800	125,220
Total Costs			
Capital	0	1,150,000	8,224,200
O&M/yr	0	17,800	125,220

* Recommended strategy.

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

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

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

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

Recommended Strategy

Planners recommend Strategy 3 for summer steelhead, a combination of artificial and natural production enhancement actions. Section 203(d) of the Columbia River Basin Fish and Wildlife Plan (Item 4 of Appendix A in this document) stresses the need for a mix of wild, natural and hatchery production to rebuild fish runs in the Columbia Basin. Removing migration barriers and improving spawning and rearing habitat are essential for maintaining a natural complement to increased hatchery production, consistent with system policies.

WINTER STEELHEAD

Howell et al. (1985) recognized both summer and winter races of steelhead in the Klickitat Subbasin, with an adult winter steelhead migration period of January through May and a spawning period of March through June. In the absence of direct counts, a winter race is assumed to exist because bright steelhead have been observed in late winter and early spring steelhead catches. To protect the winter run, current regulations prohibit sport fishing for steelhead in the Klickitat River from December through May, and the treaty fishery is closed from January through March. Both seasons have been longer in previous years. In the Preliminary Information Report (July 8, 1988), March and April steelhead catches were assumed to be winter steelhead, and ranged from two fish to 105 fish during the years 1977 through 1986 (Table 9). Managers have never supplemented the winter steelhead race. The race is not a target for supplementation under the Yakima/Klickitat Production Project.

Plans for supplementation of summer steelhead cannot ignore potential impacts on winter steelhead in the Klickitat Subbasin. Leider et al. (1984) observed temporal and spatial overlap between summer and winter steelhead spawners in the Kalama River; a known summer-winter steelhead pair was even seen spawning together. Assuming that 1) summer and winter races indeed coexist in the Klickitat Subbasin, and 2) the spawning overlap observed in the Kalama also occurs in the Klickitat, a large increase in escapement of summer-run fish to the Klickitat may increase the rate of gene flow to the unsupplemented winter race. The increased natural production of summer steelhead resulting from larger escapements could also increase the degree of juvenile intraspecific competition, perhaps to the detriment of the winter race. Continuation of the winter fishing season closures discussed above, plus additional precautions in selection and segregation of steelhead brood stock, could minimize negative impacts on winter steelhead.

An obvious need exists for studies of temporal and spatial isolation among Klickitat steelhead, in addition to determining abundance, distribution and survival rate. The results of these studies will help determine how to tailor a supplementation program toward conservation of unique population attributes.

Table 9. Harvest and spawning escapement of winter steelhead, Klickitat Subbasin, 1977-1987.

Year	Sport Catch (1)	Tribal Catch (2)	Escapement (3)	Total Return
1977	54	Ø	N/A	N/A
1978	59	36	"	"
1979	28	N/A	"	"
198Ø	33	N/A	"	"
1981	94	11	"	"
1982	31	Ø	"	"
1983	15	27	"	"
1984	Ø	4	"	"
1985	Ø	28	"	"
1986	2	Ø	"	"
1987	Ø	12	"	"

(1) Steelhead catches reported for March and April in the WDW punch card database were assumed to be winter steelhead (M. Chilcote, WDW, pers. commun.); except for 2 fish caught in March and April, 1986 after wild steelhead release regulations had gone into effect. 1987 catch was assumed to be zero.

(2) March and April catches were assumed to be winter steelhead. There are no monitoring data for the 1979 and 198Ø seasons, and the 1978 program operated from 8/1 through 9/1Ø only.

(3) Only the portion of the Klickitat River below Fisher Hill Bridge (RM 1.5) has been open to sport fishing during the winter steelhead run, and in some years the season was essentially closed in March and April. Current regulations prohibit all sport fishing during this period. The catch-to-escapement factor used for summer steelhead was therefore deemed to be invalid for the winter race.

FALL CHINOOK SALMON

Fisheries Resource

Natural Production

Prior to the first hatchery plants of fall chinook in 1946, fall chinook were not found in the Klickitat Subbasin. The usual explanation for this is that Lyle Falls (RM 2.2) was impassable to chinook during the low water conditions that generally prevail in late summer and early fall (Bryant 1949). With annual releases from Klickitat Hatchery (RM 42.4) and passage improvements at Lyle Falls, fall chinook counts in the fish trap at Lyle Falls 5 rose to over 2,000 fish (probably an underestimate) by 1956, according to the 1959 Washington Department of Fisheries annual report. From 1977 through 1986, the average return of fall chinook to the Klickitat Subbasin was estimated to be 1,452 fish, jacks and adults combined (Table 10).

Natural production of hatchery-origin fall chinook evidently occurs in the Klickitat Subbasin. Washington Department of Fisheries estimates of natural spawners in the Klickitat River, derived from peak fish counts, averaged 384 fish (jacks and adults) from 1977 through 1986. In 1987 the estimate was 2,377 fish; over two-thirds of these were considered to be stray upriver bright fish (G. Norman, WDF, pers. commun.) (see Table 10). The "standard" Northwest Power Planning Council carrying capacity estimate for fall chinook in the Klickitat River is 843,000 smolts. The Klickitat River from its mouth to Klickitat Hatchery at RM 42.4 was considered to be fall chinook spawning and rearing habitat in calculating smolt carrying capacity.

Hatchery Production

The Bonneville Pool Hatchery (BPH) stock was the source of the first fall chinook plants in the Klickitat River and the first releases of fall chinook from Klickitat Hatchery in 1952 (Howell et al. 1985). Escapements to the hatchery have usually been insufficient to meet egg-take goals. Managers have transferred both Bonneville Pool Hatchery and Lower River Hatchery fall chinook eggs to the Klickitat Hatchery for eventual release as smolts into the Klickitat River. Since 1987, fall chinook egg transfers to Klickitat Hatchery have been of upriver bright stock due to poor returns of the Spring Creek BPH stock. Managers have not determined whether the Bonneville Pool Hatchery stock or the upriver bright stock is the preferred stock for the long-term program. The current hatchery program sets an on-station release goal of 4 million upriver bright smolts, the number of smolts prescribed by the 1987 United States vs. Oregon Columbia River Fish Management Plan.

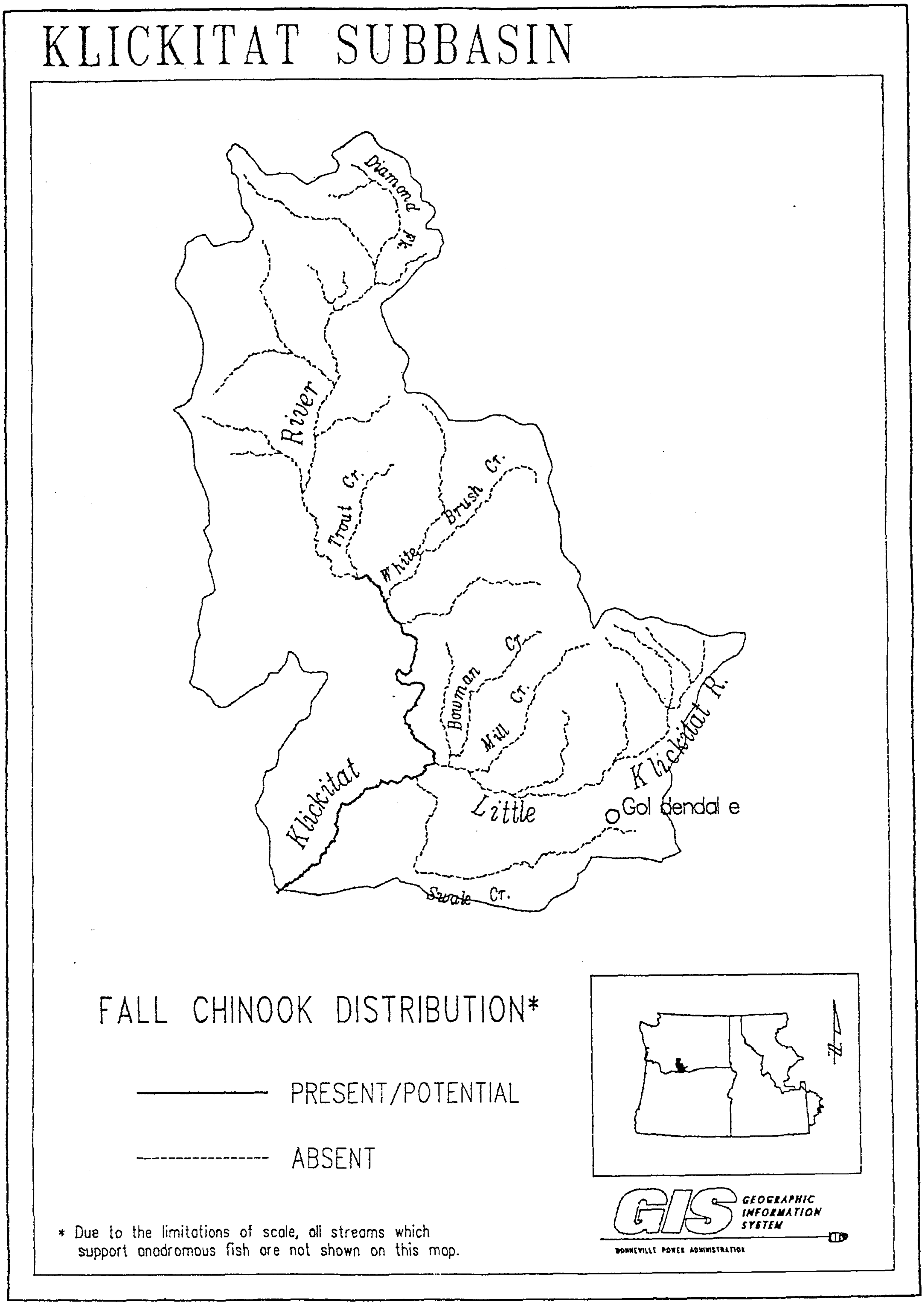

KLICKITAT SUBBASIN
Diamond Fk.
River
Trout Cr.
White
Brush Cr.
Bowman Cr.
Mill Cr.
Klickitat
Little
Klickitat R.
Goldendale
Swale Cr.
FALL CHINOOK DISTRIBUTION*
PRESENT/POTENTIAL
ABSENT
* Due to the limitations of scale, all streams which support anadromous fish are not shown on this map.
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Table 10. Harvest and spawning escapement of fall chinook, Klickitat Subbasin, 1977-1987, jacks and adults combined.

Year	Sport Catch (1)	Tribal Catch (2)	Hatchery Escapement (3)	Natural Escapement (4)	Total Return
1977	53	1243	136	134	1566
1978	44	835	164	241	1284
1979	95	571	920	402	1988
1980	34	1311	56	770	2171
1981	47	833	281	558	1719
1982	6	973	337	556	1872
1983	7	617	160	348	1132
1984	36	219	146	230	631
1985	37	696	15	188	936
1986	125	1392	247	415	2179
1987	N/A	436	43	2377 (5)	N/A

(1) Represents chinook catch after July 31. Punch card jack data are not species-specific. Post-September jack catches were counted as coho. The August and September jack catch was apportioned to fall chinook up to the proportion of fall chinook jacks which returned that year to the Klickitat Hatchery. The remainder of the August and September jack catch was then apportioned to coho.

(2) Used a combination of two estimates: (1) YIN fishery monitoring data (August-November), and (2) fish tickets written during the fall commercial season, when commercial sales are permitted. There are no monitoring estimates for the years 1979 and 1980, and no sales were recorded for 1984. For the remaining years the higher of the two estimates was used during the commercial season.

(3) King (1987) for 1977 through 1986; Klickitat Hatchery weekly reports for 1987.

(4) WDF population estimate; derived from peak fish count. Jack proportion estimated from a combination of biological sampling, dip net fishery sampling and hatchery escapement (L. LaVoy, WDF, pers. commun.).

(5) Sum of two preliminary WDF population estimates: 664 adults in late October (considered to be BPH stock) and 1713 adults in early November (considered to be URB strays). URB fish had not been observed prior to 1987 (Guy Norman, WDF, pers. comm.).

Table 11 summarizes the releases of all fall chinook stocks from Klickitat Hatchery from 1977 through 1988. Releases from 1977 through 1987 were of Bonneville Pool Hatchery and Lower River Hatchery origin. Managers first released upriver bright smolts (4,705,400) in 1988. Since the hatchery was constructed, all releases of fall chinook have been on station.

Biological data on the fall chinook stocks that have been reared at Klickitat Hatchery are available from other sources, such as Howell et al. (1985). Fall chinook that return to the subbasin presumably have had a varied genetic makeup reflecting the contributions of Lower River Hatchery and BPH stocks and, recently, the upriver bright hatchery stock.

Managers have released six coded-wire-tagged groups of fall chinook from Klickitat Hatchery since 1977, representing brood years 1976 through 1981. Managers spawned two groups from hatchery returns while the remainder were of Bonneville Pool and Lower River Hatchery origin. Survival rates of the tag groups to all fisheries and escapement ranged from 0.058 percent to 1.063 percent, while return rates to the subbasin ranged from 0.012 percent to 0.153 percent. These rates incorporate corrections for low tag recoveries in the subbasin treaty fishery as explained in the Preliminary Information Report appendix (July 8, 1988). Sixty-four percent of the adults recovered from the six groups were caught in salt water, 17 percent were caught in the Columbia River, and 19 percent (corrected as above) reached the Klickitat River.

Harvest

The coded-wire-tag data described above indicates that most of the harvest of fall chinook adults originating from Klickitat Hatchery occurs before the fish return to the subbasin. Table 10 summarizes treaty and sport harvest of fall chinook in the Klickitat Subbasin since 1977. Management of sport and treaty fisheries in the Klickitat Subbasin is substantially the same as that described in the earlier section on spring chinook. The fall chinook harvest is not managed to provide escapement to the hatchery, and egg transfers to Klickitat Hatchery are usually necessary. Low hatchery returns may actually be related more to attraction problems in late summer and fall than to poor escapement (D. Peterson, Klickitat Hatchery, pers. commun.). This view is supported somewhat by the poor correlation between hatchery returns and natural escapement estimates (Table 10).

Table 11. Releases of fall Chinook from Klickitat Hatchery.

Stock(1)	Brood Year	Release Date	Number Released Fry(2)	Parr(3)	Smolt(4)
BPH	1976	02/16/77		437,928	
BPH	1976	05/23/77			472,710
KLI(5)	1976	06/03/77			139,694
BPH	1976	06/03/77			263,652
LRH	1977	03/28/78		225,000	
KLI(5)	1977	06/06/78			147,247
LRH	1977	06/06/78			3,149,987
LRH	1978	05/14/79			1,560,146
LRH(5)	1978	05/21/79			113,024
KLI(5)	1978	06/01/79			117,025
LRH	1978	06/01/79			1,779,601
LRH(5)	1979	05/27/80			3,139,434
BPH(5)	1980	06/05/81			2,479,132
BPH(5)	1981	06/04/82			3,679,620
KLI	1982	06/01/83			426,700
BPH	1982	06/01/83			4,437,900
LRH	1983	06/07/84			1,021,300
KLI	1983	06/07/84			174,500
KLI	1984	04/19/85			59,900
KLI	1984	05/09/85			63,200
LRH	1985	04/02/86			1,000,000
LRH	1985	04/18/86			1,426,600
LRH	1985	05/01/86			1,417,000
BPH	1985	06/02/86			358,900
KLI	1986	05/06/87			99,200
URB	1986	04/08/87			900,000
URB	1986	05/05/87			1,793,600
URB	1986	06/05/87			2,011,800
KLI	1987	05/27/88			16,000
KLI	1987	06/23/88			39,500
URB	1987	05/27/88			984,000
URB	1987	06/21/88			384,500
URB	1987	06/23/88			2,140,200

(1) BPH: spawned from Bonneville Pool Hatchery returns, LRH: Lower River Hatchery, URB: Upriver Bright, KLI: Klickitat Hatchery.
(2) No release groups were reared less than 82 days.
(3) Age-0 juveniles released prior to 4/1. Earliest recorded release was 3/28/78 (82 days reared, 250 fish per pound).
(4) Age-0 juveniles released 4/1 or later.
(5) Coded-wire-tagged group.

The Yakima/Klickitat Production Project is concerned with enhancing existing natural fish stocks and reestablishing extinct runs. No plans exist to enhance the fall chinook run in the Klickitat Subbasin under the new hatchery project (the WDF fall chinook program for Klickitat Hatchery is not affected).

Specific Considerations

Several of the constraints discussed in earlier sections may also limit fall chinook production. From the mouth of the Klickitat River to Dead Canyon Creek at RM 31, glacial sediments were noted as the major production constraint, while steep gradient was considered more important above this reach.

Klickitat fall chinook contribute to the terminal treaty fishery as well as to ocean and Columbia River fisheries. Treaty and sport harvest estimates for fall chinook in the Klickitat Subbasin have averaged 869 fish and 48 fish, respectively, for 1977 through 1986. Fall chinook appear to be spawning naturally in the Klickitat River, although the recent large concentration is attributed mostly to straying from other hatcheries. Current annual plants of 4 million fall chinook smolts from Klickitat Hatchery may provide larger returns because of the recent substitution of upriver bright stock for Bonneville Pool Hatchery stock.

The discussion of objectives and strategies that follows is based on two assumptions. First, new production facilities will be devoted to other fish stocks, consistent with the philosophy underlying the Yakima/Klickitat Production Project. Second, escapement needs of introduced stocks, including fall chinook, will continue to be met from other facilities in the Columbia Basin. Natural production of fall chinook may occur, but cannot be relied upon to meet adult production goals. The term "maximum sustained yield" will not be used in reference to fall chinook to avoid the implication that runs will be managed for sustainable yield. For the same reason, planners did not use the Northwest Power Planning Council's System Planning Model to evaluate objectives for Klickitat fall chinook.

Objectives

Biological Objective

Increase fall chinook run size at recruitment to 40,000 fish.

The objective can be achieved under the present hatchery program if the smolt-to-adult survival rate of fall chinook from Klickitat Hatchery to all fisheries and escapement reaches 1 percent. Appendix A of the Preliminary Information Report (July 8, 1988) shows that only one of the six coded-wire-tagged groups of tule fall chinook released from Klickitat Hatchery between 1977 and 1982 had a survival rate to all fisheries and escapement of 1 percent or greater (Bonneville Pool Hatchery stock). However, a survival rate goal of 1 percent appears to be achievable for upriver bright fall chinook in view of the 0.8 percent rate reported for Priest Rapids Hatchery releases, which must pass four Columbia River dams (Howell et al. 1885).

Utilization Objective

Provide harvest opportunity to ocean, mainstem and terminal fisheries.

System Planning Group estimates indicate that two-thirds of each brood's recruits are likely to be harvested outside the subbasin. The benefits of a large run of bright fall chinook to the subbasin include providing an opportunity for tribal fishers to harvest high-quality salmon during late summer and fall months with a small capital outlay. This can also provide additional income to tribal fishers, since Klickitat River catches are currently sold on days when the fall commercial season is open. Sport fishers will also benefit from the opportunity to harvest salmon along with steelhead during these months.

Alternative Strategies

Planners did not identify alternative strategies for this introduced race of chinook. Instead, they listed a series of actions that is designed to determine the status of fall chinook in the Klickitat Subbasin, and increase adult returns from existing smolt production. The actions complement each other and should be implemented together.

A) Collect data necessary to evaluate run size, harvest and natural production of fall chinook in the Klickitat Subbasin. Monitoring programs designed for the natural stocks can also gather data on fall chinook without large additional outlays. Conduct tagging studies to assess survival rate, contributions to various fisheries, natural spawning and straying of upriver bright fall chinook smolts released from Klickitat Hatchery. Results will be more reliable if studies are postponed until intensive subbasin tag recovery efforts begin under the Yakima/Klickitat Production Project.

B) Continue upriver bright fall chinook egg transfers to Klickitat Hatchery to increase returns and provide a higher quality catch to the tribal dip net fishery. Two possible objections to continued releases of upriver bright smolts have not been fully resolved. First, large runs of chinook in early fall resulting from an improved survival rate could create a mixed-stock harvest management problem while the steelhead run is being rebuilt under the Yakima/Klickitat Production Project. Switching production back to Bonneville Pool Hatchery fall chinook would affect this situation only insofar as survival rate and run size would decrease, since the two stocks appear to have similar run timing (see for example Howell et al. 1985).

Second, sport fishers might prefer the catchability of Bonneville Pool Hatchery fish to that of upriver bright fish, although a much larger run size, if achievable at present release sizes, may more than compensate for this difficulty. Sport harvests of fall chinook in the Klickitat River have generally been quite low in comparison to escapements (Table 10), and few sport fishers seem to have opinions on fall chinook in the Klickitat.

C) Use findings from the Yakima/Klickitat Production Project to evaluate fall chinook cultural practices at Klickitat Hatchery. Acclimation of smolts to river water is one possible way to increase the smolt-to-adult survival rate.

D) Reduce sediment inputs from Big Muddy Creek, which should benefit natural production of fall chinook as well as spring chinook and steelhead. The benefits for fall chinook may not be as pronounced, however, since fall chinook spawn farther downstream in the Klickitat River and presumably do not rear as long in the river as do spring chinook and steelhead.

Recommended Strategy

Planners did not identify alternative strategies, but do recommend implementing the above four actions. As mentioned earlier, the actions are intended to be implemented together.

COHO SALMON

Fisheries Resource

Natural Production

Like fall chinook, coho are not believed to be native to the Klickitat Subbasin. Although Klickitat Hatchery was not completed until 1952, coho releases apparently began in the Klickitat River in 1951 or earlier since 29 adults were reported to have returned to the hatchery in 1952. Since 1952, hatchery returns have fluctuated between zero and 4,283 adults, and have been less than 1,000 adults every year since 1972. Coho counts in the trap at Lyle Falls 2 peaked at 4,348 fish (adults plus jacks, probably an underestimate) in 1956. For 1977 through 1985, the average return of coho to the Klickitat Subbasin was estimated to be 919 fish, jacks and adults combined (Table 12). The run size estimate for 1986 was 25,954 fish, the largest on record.

Biologists have not recently observed natural production of coho in the Klickitat Subbasin (Washington Department of Wildlife personnel said they found juvenile coho in Summit Creek), and have not made significant attempts to establish natural runs through outplanting. If the additional plants mandated under United States vs. Oregon were to be made in a number of areas with natural production potential, perhaps a run could be established. Late coho interception rates in the ocean and the Lower Columbia River, and the low rate of escapement of coho to the subbasin would make it difficult to develop self-sustaining production, however.

The standard Northwest Power Planning Council carrying capacity estimate for coho in the Klickitat Subbasin is 28,000 smolts, assuming no production potential above Castile Falls. With no known past or present natural production of coho in the subbasin, there is little confidence in this estimate.

Table 12. Harvest and hatchery escapement of coho, Klickitat Subbasin, 1977-1987, jacks and adults combined.

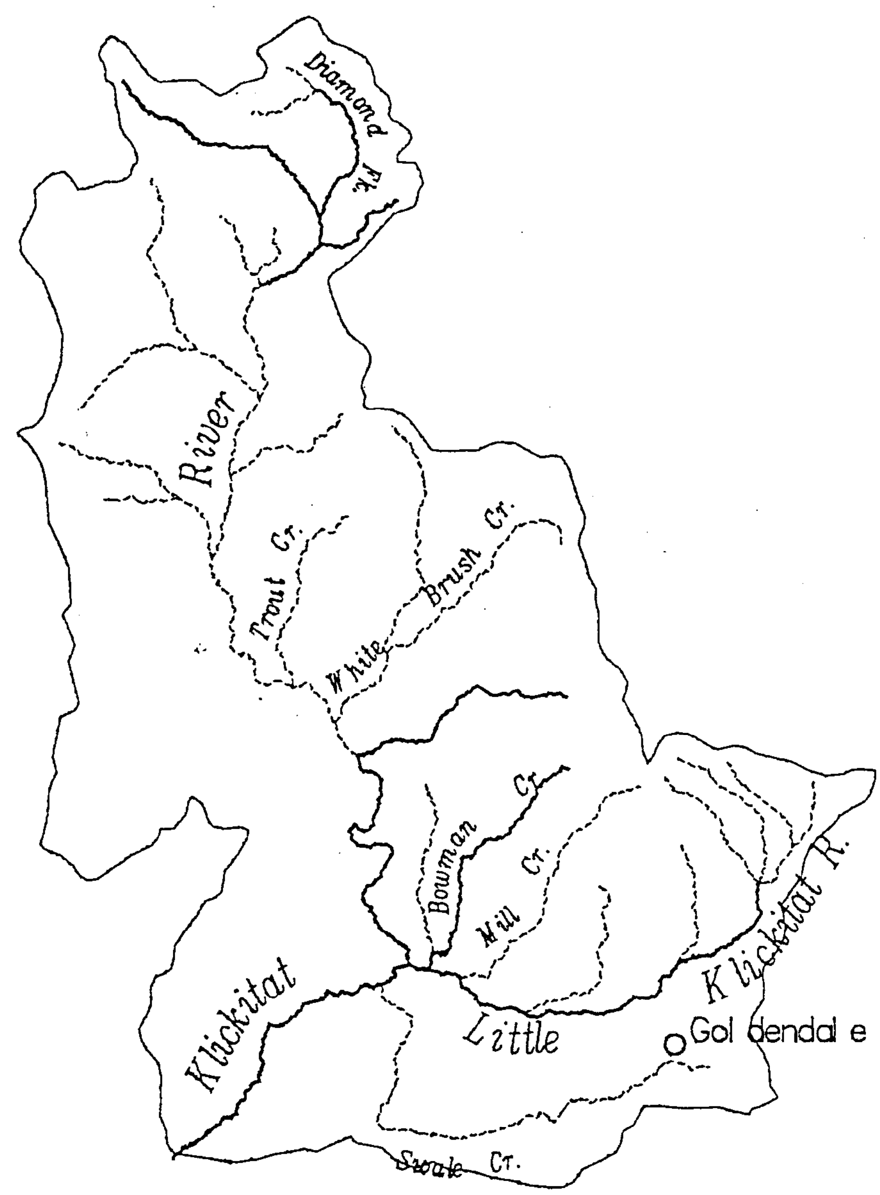
Year	Sport Catch (1)	Tribal Catch (2)	Hatchery Escapement (3)	Total Return
1977	52	330	104	486
1978	139	749	177	1065
1979	769	693	123	1585
1980	219	10	55	284
1981	518	2066	0	2584
1982	372	9	0	381
1983	446	136	0	582
1984	438	N/A	40	478
1985	436	2706	0	3142
1986	1617	23551	786	25954
1987	N/A	130	0	N/A

(1) Punch card jack data are not species-specific. Post-September jack catches were counted as coho. The August and September jack catch was apportioned to fall chinook up to the proportion of fall chinook jacks which returned that year to the Klickitat Hatchery. The remainder of the August and September jack catch was then apportioned to coho (L. LaVoy, WDF, pers. commun.).

(2) Used a combination of two estimates: (1) YIN fishery monitoring data, and (2) fish tickets written during the fall commercial season, when commercial sales are permitted. There are no monitoring estimates for the years 1979, 1980, 1982 and 1984, and no sales were recorded for 1983 or 1984. For the remaining years the higher of the two estimates was used during the commercial season.

(3) King (1987) for 1977 through 1986; Klickitat Hatchery weekly reports for 1987.

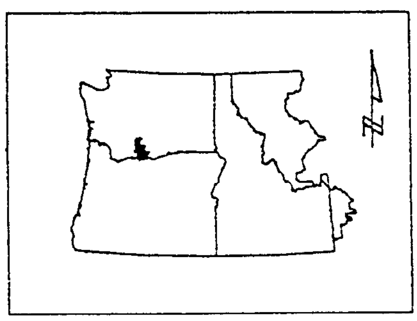
KLICKITAT SUBBASIN



COHO DISTRIBUTION*

——————— PRESENT/POTENTIAL

- - - - - - - - ABSENT



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

Hatchery Production

Managers have reared both early and late coho at Klickitat Hatchery. The current hatchery program calls for the on-station release of 1,350,000 late coho smolts. Late coho have the advantage of extending the period of fishing opportunity while early coho are in better condition when they reach the subbasin and may return to the subbasin in larger numbers (see below). Table 13 summarizes coho releases from Klickitat Hatchery since 1977. The Preliminary Information Report (July 8, 1988) breaks those releases down into early-run, late-run, and progeny of hatchery returns. All fingerlings and smolts have been released on station.

Coho returns to Klickitat Hatchery have been extremely low in recent years, fewer than 100 fish in eight of the last 10 years (Table 12). Managers released seven coded-wire-tagged groups of early and late coho smolts from Klickitat Hatchery from 1977 through 1985, representing brood years 1975 through 1977 and 1983. Before the acclimation pond existed, survival rates of two early groups and three late groups (brood years 1975 through 1977) to all fisheries and escapement ranged from 1.478 percent to 2.529 percent. The two early groups (brood year 1983) that were acclimated to river water had survival rates of 5.837 percent and 5.876 percent. This brood also returned in exceptionally large numbers to the subbasin, no doubt aided by ocean and Lower Columbia River fishing restrictions on early fall chinook and coho harvest to meet the treaty Indian fall chinook harvest allocation in Zone 6. These survival rates incorporate corrections for low tag recoveries in the subbasin treaty fishery as explained in the Preliminary Information Report (July 8, 1988) appendix.

Fifty-four percent of the adults recovered from the four groups of early coho were caught in salt water, 28 percent were caught in the Columbia River, and 19 percent (corrected as above) were recovered in the Klickitat Subbasin. For the three groups of late coho the percentages were 76 percent, 22 percent and 2 percent, respectively.

Table 13. Releases of coho salmon from Klickitat Hatchery.

Race(1)	Brood Year	Release Date	Number Released Fry(2)	Parr(3)	Smolt(4)
Early(5)	1975	04/06/77			277,998
Early(5)	1975	04/30/77			66,993
Late(5)	1975	04/30/77			669,023
Early	1976	03/23/77		149,621(6)	
Early	1976	04/12/77		36,517	
Early	1976	12/02/77		415,455	
Early(5)	1976	04/28/78			878,818
Late(5)	1976	05/04/78			359,948
Early	1977	04/16/79			382,614
Early	1977	04/20/79			382,002
Late	1977	05/14/79			616,669
Late	1978	04/30/80			1,366,561
Klickitat	1979	01/11/80	24,286		
Klickitat	1979	01/20/80	40,246		
Late	1979	04/30/81			1,018,727
Early	1980	01/30/81	315,249		
Late	1980	03/15/82			277,939
Late	1980	04/15/82			1,375,748
Late	1981	05/11/83			9,757
Late	1981	05/16/83			1,447,153
Late	1982	04/24/84			540,000
Early	1982	04/24/84			799,300
Early(5)	1983	06/13/85(6)			1,163,488
Late(5)	1984	06/09/86(6)			1,117,424
Late	1985	06/10/87(6)			1,383,500
Klickitat	1986	02/24/87		194,500	
Late	1986	07/01/87(6)			1,320,800

(1) Klickitat: spawned from Klickitat Hatchery returns.
(2) Age-0, released prior to 3/1.
(3) Age-0 and released 3/1 or later, or age-1 and released prior to 3/1.
(4) Age-1 and released 3/1 or later.
(5) Coded-wire-tagged group.
(6) Released volitionally prior to this date.

Since 1983, coho yearlings reared at Klickitat Hatchery have been transferred to an acclimation pond (Pond 25) each February and allowed volitional release over a three-month period beginning in April. The pond water discharges well above the water surface into a shallow portion of the river. During the release period, managers have observed as many as 300 gulls at the acclimation pond outfall feeding on coho smolts. The predation rate could be lessened by placing the outlet in deep water. A need also exists for a greater spring water supply to the acclimation pond, and for facilities to more effectively remove sediment and debris from the river water intake.

The United States vs. Oregon Columbia River Management Plan calls for 2 million late coho smolts and 500,000 early coho smolts from Lower Columbia River hatcheries to be released in the Klickitat River in an effort to restore upriver coho fisheries. These plants began in 1988 at RM 17 and are to be made in addition to the existing Klickitat Hatchery program.

Harvest

As with fall chinook, coded-wire-tag data indicates that most of the coho adults originating from Klickitat Hatchery are harvested before reaching the subbasin (see above). Table 12 summarizes treaty and sport harvest of coho in the Klickitat Subbasin since 1977. Management of sport and treaty fisheries in the Klickitat Subbasin is substantially the same as that described earlier for other species. Escapement of coho is not currently a constraint in Klickitat River harvest management as brood stock is generally obtained from lower river hatchery facilities.

The Yakima/Klickitat Production Project is concerned with enhancing natural fish stocks and reestablishing extinct runs. No plans exist to enhance a coho run in the Klickitat Subbasin under the new hatchery project (the Washington Department of Fisheries coho program for Klickitat Hatchery is not affected).

Specific Considerations

There is little evidence that natural production of coho has ever occurred in the Klickitat Subbasin. Biologists assume that runs have been sustained solely by releases from Klickitat Hatchery, averaging 1,285,000 smolts annually from 1977 through 1987. Currently programmed annual releases of 1,350,000 late smolts are now being augmented by United States vs. Oregon mandated plants of 2 million late smolts and 500,000 early smolts from Lower Columbia River hatcheries.

Treaty and sport harvest estimates in the subbasin have averaged 670 fish and 339 fish, respectively, from 1977 through 1985. Releases of early coho would likely provide larger and better quality runs to the subbasin, while late coho runs would diversify and extend the fishing opportunity (see above).

The term "maximum sustainable yield" does not apply to Klickitat coho since it is doubtful that the run will be managed for escapement. Given the high interception rate outside the subbasin and the ultimate probability of more intensive terminal fisheries, natural production and even consistent hatchery returns are an unlikely prospect. If natural escapement were to become a consideration, the greatest production potential may be above Castile Falls. A smolt carrying capacity of 61,600 was calculated for the subbasin above the falls using the Northwest Power Planning Council method.

As with fall chinook, objectives and strategies for coho will be constrained by the assumptions that 1) inbasin hatchery production will not increase beyond the present level, and 2) natural production cannot be counted on to help fulfill the adult production goal.

Objectives

Biological Objective

Increase run size at recruitment to 50,000 fish.

If the 2.5 million United States vs. Oregon coho survive to recruitment half as well as the average unacclimated coded-wire-tag group of late coho released from Klickitat Hatchery (0.99 percent versus 1.98 percent), the resulting annual run size at recruitment will surpass 50,000 fish. It may be necessary to experiment with different release strategies, such as releasing pre-smolts, if the United States vs. Oregon smolts do not survive well after transportation and planting.

Utilization Objective

Provide harvest opportunity for ocean and mainstem fisheries, and an extended harvest opportunity for terminal fisheries.

The System Planning Group currently estimates the late coho harvest rate in ocean and mainstem fisheries to be 88 percent, while ocean and mainstem recoveries of coded-wire-tagged late coho from Klickitat Hatchery accounted for 98 percent of total recoveries (see Preliminary Information Report, July 8, 1988). Based on this information, it seems unlikely that more than 5,000 fish will reach the subbasin annually from a total run size of 50,000. Nevertheless, late coho are of value in extending the fishing season, and tribal fishers find them useful for smoking and drying.

Late coho appear to enter the Klickitat River after the peak of the summer steelhead run, on the basis of tribal fishery monitoring data. The timing of the late coho run should make it possible to harvest a large proportion of the run without interfering with summer steelhead rebuilding efforts.

Alternative Strategies

Planners did not identify alternative strategies for this introduced species. Instead, they listed a series of actions that is designed to determine the status of coho in the Klickitat Subbasin, and increase adult returns from existing smolt production. The actions complement each other and should be implemented together.

A) Collect data necessary to evaluate run size, harvest, and any natural production of coho in the Klickitat Subbasin. Inbasin data on migration and harvest of coho will be collected incidentally to monitoring efforts directed at spring chinook and steelhead. Spawning ground surveys could be pursued if there was evidence of natural coho production from juvenile monitoring.

B) Conduct tagging studies to assess survival rate, contributions to various fisheries, and performance of coho planted pursuant to the Columbia River Fish Management Plan (United States vs. Oregon). Results would be more reliable if these studies were postponed until intensive subbasin tag recovery efforts begin under the Yakima/Klickitat Production Project. However, the current planting program is scheduled to be reviewed along with the other components of the Columbia River Fish Management Plan in 1991.

C) Use findings from the Yakima/Klickitat Production Project to evaluate coho cultural practices at Klickitat Hatchery. Use hatchery research data on transportation and acclimation effects along with survival information from the above tagging studies to develop alternative release strategies for United States vs. Oregon coho, if appropriate.

D) Make several modifications to the coho acclimation pond at Klickitat Hatchery. First, to keep debris and sediment from fouling the intake screens and filling the pond, a settling pond and/or better intake screens must be constructed. There may be a problem with disposal of sediment and debris collected by a new intake system -- pumping settled material back to the river violates water quality regulations.

Second, if a greater flow of spring water could be piped to the pond, it would reduce the need for river water early in the acclimation period. More water is available from the hatchery's two spring sources than is currently used. Third, the pond outlet must be modified to lessen the opportunities for avian predation on smolts volitionally released from the acclimation pond.

Recommended Strategy

As mentioned earlier, planners did not identify alternative strategies, but do recommend implementing the above four actions in concert with each other.

SOCKEYE SALMON

Sockeye salmon have never been reported in the Klickitat Subbasin, although it may be feasible to introduce the species if access is provided to Fish Lake in the West Fork drainage. Members of the Yakima Tribal Council along with Yakima Indian Nation fishery biologists have expressed interest in studying the potential for successful introduction of sockeye to the Klickitat Subbasin.

Planners discussed providing fish passage around West Fork Falls in the earlier section on summer steelhead. Fish Lake is located within the Primitive Area of the Yakima Indian Reservation, 10 miles above the mouth of Fish Lake Stream, which flows into the West Fork just above West Fork Falls. The lake has an area of 81 acres. There are three other lakes nearby; Howard Lake discharges through Howard Lake Stream into Fish Lake, and Two Lakes discharge via Two Lakes Stream into Fish Lake Stream. These three lakes are probably inaccessible to anadromous fish, however.

Introduction of sockeye would have to be preceded by studies of 1) passage conditions for sockeye below Fish Lake (there are at least two falls up to 6 feet high in Fish Lake Stream), 2) the productivity of the lake itself, and 3) the suitability of Howard Lake Stream, which feeds Fish Lake, for sockeye spawning. Biologists are collecting sockeye brood stock from the Wenatchee River for a sockeye reintroduction study in the Yakima Subbasin; this could be the source for introductions to the Klickitat Subbasin as well.

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PART V. SUMMARY AND IMPLEMENTATION

Objectives and Recommended Strategies

Strategies for the Klickitat Subbasin are cumulative and represent a hierarchical series of actions. Where applicable, the first action for each stock involves supplementation through production of hatchery fish from a program that is currently in place for the Yakima and Klickitat subbasins. The remaining actions, currently non-funded, are aimed at increasing primarily natural stocks by various means. Because the actions build upon one another, the highest numbered strategies are the preferred ones. This choice often differs with the preferred strategies arrived at through the SMART analysis, which generally indicated strategies in the middle numbers rather than the highest or lowest numbers. Planners feel, however, that the modeling results for the higher numbered actions are conservative in the sense that greater benefits than those indicated by the System Planning Model would be realized if those actions were implemented.

Spring Chinook

The objective for spring chinook is to increase the MSY (maximum sustainable yield) run size at recruitment by 20,000 fish. Planners recommend Strategy 3, which is a combination of artificial and natural production enhancement actions. The strategy consists of data collection, hatchery production, passage improvements, sediment removal, and riparian improvements.

Summer Steelhead

The summer steelhead objective calls for increasing the MSY run size at recruitment by 25,000 fish. Planners recommend implementing Strategy 3, a combination of artificial and natural production enhancement actions.

Winter Steelhead

Planners are not identifying objectives and alternative strategies for winter steelhead. Managers have not attempted to identify a winter race of steelhead; the only available information on winter steelhead is anecdotal.

Fall Chinook

The objectives call for increasing the fall chinook run size at recruitment to 40,000 fish and providing harvest opportunity to ocean, mainstem and terminal fisheries. Planners did not identify alternative strategies, but do recommend implementing a series of actions that is designed to determine the status of fall chinook in the Klickitat Subbasin, and to increase production within constraints discussed under fall chinook objectives.

Coho

The coho salmon objectives call for increasing the run size at recruitment to 50,000 fish and providing harvest opportunity for ocean and mainstem fisheries, and an extended harvest opportunity for terminal fisheries. Planners did not identify alternative strategies, but do recommend implementing a series of actions designed to determine the status of coho salmon in the subbasin, and to increase production within constraints discussed under coho objectives.

Sockeye

Planners did not identify objectives or strategies for sockeye salmon. Sockeye have never been reported in the Klickitat Subbasin. It may be feasible, however, to introduce sockeye if access is provided to Fish Lake in the West Fork drainage (see sockeye section).

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: KLICKITAT

STOCK: SPRING CHINOOK

STRATEGY: 2

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1 EXT OBJ	8	0.9	20	160	144
2 CHG MSY	9	0.9	20	180	162
3 GEN IMP	4	0.6	20	80	48
4 TECH FEAS	7	0.6	20	140	84
5 PUB SUPT	5	0.9	20	100	90

TOTAL VALUE 660

DISCOUNT VALUE 528

CONFIDENCE VALUE 0.8

SUBBASIN: KLICKITAT

STOCK: SPRING CHINOOK

STRATEGY: 3

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1 EXT OBJ	8	0.9	20	160	144
2 CHG MSY	9	0.9	20	180	162
3 GEN IMP	4	0.6	20	80	48
4 TECH FEAS	3	0.6	20	60	36
5 PUB SUPT	5	0.9	20	100	90

TOTAL VALUE 580

DISCOUNT VALUE 480

CONFIDENCE VALUE 0.82758620

SUBBASIN: KLICKITAT

STOCK: SPRING CHINOOK

STRATEGY: 4

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1 EXT OBJ	8	0.6	20	160	96
2 CHG MSY	9	0.9	20	180	162
3 GEN IMP	4	0.6	20	80	48
4 TECH FEAS	3	0.6	20	60	36
5 PUB SUPT	5	0.9	20	100	90

TOTAL VALUE 580

DISCOUNT VALUE 432

CONFIDENCE VALUE 0.74482758

SUBBASIN: KLICKITAT

STOCK: SPRING CHINOOK

STRATEGY: 5

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1 EXT OBJ	8	0.6	20	160	96
2 CHG MSY	9	0.9	20	180	162
3 GEN IMP	4	0.6	20	80	48
4 TECH FEAS	6	0.6	20	120	72
5 PUB SUPT	5	0.9	20	100	90

TOTAL VALUE 640

DISCOUNT VALUE 468

CONFIDENCE VALUE 0.73125

SUBBASIN: KLICKITAT

STOCK: FALL CHINOOK

STRATEGY: 1

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1 EXT OBJ			20	0	0
2 CHG MSY			20	0	0
3 GEN IMP			20	0	0
4 TECH FEAS	6	0.6	20	120	72
5 PUB SUPT	5	0.9	20	100	90

TOTAL VALUE 220

DISCOUNT VALUE 162

CONFIDENCE VALUE 0.73636363

SUBBASIN: KLICKITAT

STOCK: LATE COHO

STRATEGY: 1

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1 EXT OBJ			20	0	0
2 CHG MSY			20	0	0
3 GEN IMP			20	0	0
4 TECH FEAS	7	0.6	20	140	84
5 PUB SUPT	5	0.9	20	100	90

TOTAL VALUE 240

DISCOUNT VALUE 174

CONFIDENCE VALUE 0.725

SUBBASIN: KLICKITAT

STOCK: SUMMER STEELHEAD

STRATEGY: 1

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1 EXT OBJ	8	0.6	20	160	96
2 CHG MSY	7	0.6	20	140	84
3 GEN IMP	6	0.6	20	120	72
4 TECH FEAS	6	0.6	20	120	72
5 PUB SUPT	6	0.9	20	120	108

TOTAL VALUE 660

DISCOUNT VALUE 432

CONFIDENCE VALUE 0.65454545

SUBBASIN: KLICKITAT

STOCK: SUMMER STEELHEAD

STRATEGY: 2

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1 EXT OBJ	8	0.9	20	160	144
2 CHG MSY	8	0.9	20	160	144
3 GEN IMP	6	0.6	20	120	72
4 TECH FEAS	7	0.6	20	140	84
5 PUB SUPT	5	0.9	20	100	90

TOTAL VALUE 680

DISCOUNT VALUE 534

CONFIDENCE VALUE 0.78529411

SUBBASIN: KLICKITAT

STOCK: SUMMER STEELHEAD

STRATEGY: 3

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1 EXT OBJ	8	0.6	20	160	96
2 CHG MSY	9	0.9	20	180	162
3 GEN IMP	6	0.6	20	120	72
4 TECH FEAS	4	0.6	20	80	48
5 PUB SUPT	5	0.9	20	100	90

TOTAL VALUE 640

DISCOUNT VALUE 468

CONFIDENCE VALUE 0.73125

SUBBASIN: KLICKITAT

STOCK: SUMMER STEELHEAD

STRATEGY: 4

CRITERIA	RATING	CONFIDENCE	WEIGHT	UTILITY	DISCOUNT UTILITY
1 EXT OBJ	8	0.6	20	160	96
2 CHG MSY	9	0.9	20	180	162
3 GEN IMP	6	0.6	20	120	72
4 TECH FEAS	7	0.6	20	140	84
5 PUB SUPT	5	0.9	20	100	90

TOTAL VALUE 700

DISCOUNT VALUE 504

CONFIDENCE VALUE 0.72

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: Klickitat River
Stock: Spring Chinook

Action	Cost Categories*	Proposed Strategies[a] 1	2	3**
Habitat Enhancement	Capital:			74,200
	O&M/yr:			7,420
	Life:			50
Screening	Capital:			
	O&M/yr:			
	Life:			
Barrier Removal	Capital:		760,000	760,000
	O&M/yr:		8,000	8,000
	Life:		50	50
Misc. Projects	Capital:		50,297	7,050,297
	O&M/yr:		N/A[b]	100,000
	Life:		50	50
Hatchery Production	Capital:			
	O&M/yr:			
	Life:			
TOTAL COSTS	Capital:	0	810,297	7,884,497
	O&M/yr:	0	8,000	115,420
	Years:		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] Strategies are cumulative.

[b] Costs are not available.

ESTIMATED COSTS FOR ALTERNATIVE STRATEGIES

Subbasin: Klickitat River
Stock: Summer Steelhead

Action	Cost Categories*	Proposed Strategies[a] 1	2	3**
Habitat Enhancement	Capital:			74,200
	O&M/yr:			7,420
	Life:			50
Screening	Capital:			
	O&M/yr:			
	Life:			
Barrier Removal	Capital:		1,150,000	1,150,000
	O&M/yr:		17,800	17,800
	Life:		50	50
Misc. Projects	Capital:			7,000,000
	O&M/yr:			100,000
	Life:			50
Hatchery Production	Capital:			
	O&M/yr:			
	Life:			
TOTAL COSTS	Capital:	0	1,150,000	8,224,200
	O&M/yr:	0	17,800	125,220
	Years:		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] Strategies are cumulative.