Go To Next Part

Bands located in the vicinity of the Boise, Weiser, and Payette rivers were near highly productive fisheries (Murphy and Murphy 1960). In 1812, a member of the Astoria party described the Boise River as...

> ...the most renowned Fishing place in the Country. It is consequently the resort of the majority of Snakes, where immense numbers of Salmon are taken. (Stuart 1935)

The productivity of this area was apparently greater than the salmon streams to the west in Oregon; northern Paiutes from that area crossed the Snake River to fish in the Boise and Weiser (Murphy and Murphy 1960). The first runs of salmon were said to have begun in March or April (Murphy and Murphy 1960). In all probability, this was too early for spring chinook runs and these were probably spring steelhead (Steward 1938). A second run arrived soon after and lasted through the spring (Murphy and Murphy 1960). These runs were exploited with traps. With the onset of summer, root harvesting attracted groups to the Camas Prairie where roots were dried throughout the summer. Root collecting activities continued up to late summer when these groups moved back to the rivers to hunt and dry fish for winter consumption (Murphy and Murphy 1960). Winter subsistence came from caches of dried roots, salmon and meat.

The Boise, Weiser, and Payette river region was also used by groups that did not winter in the area (Murphy and Murphy 1960). Mounted groups apparently came here to fish along with the permanent residents of the area, who had only a few horses. Some of these groups, such as the Fort Hall Bannock, apparently wintered here some years (Steward 1938).

A 210-foot vertical drop at Shoshone Falls imposed the upriver limit to the distribution of anadromous salmonids in the Upper Snake River. The area below, however, between Glenn's Ferry and Shoshone Falls, was described as being more important to the Shoshoni and Bannock who wintered above the Shoshone Falls than to the small population that wintered in the immediate vicinity (Murphy and Murphy 1960). The mounted groups that seasonally visited this area also took advantage of rich camas digging grounds at the Camas Prairie near Fairfield, Idaho (Murphy and Murphy 1960). The year-around residents of Camas Prairie were described as having few horses and, therefore, did not participate in the bison hunts.

Murphy and Murphy (1960) stated that the Shoshoni below Shoshone Falls "relied heavily on the salmon runs for food and fished during spring, summer, and fall" (1960). Steward (1938) reported that for the residents of this region "fishing was their primary subsistence." Their salmon caches were centrally located to yearly food-collecting sites. Fish weirs, nets, basket traps, hooks, and spears were mentioned as procurement techniques (Steward 1938; Murphy and Murphy 1960).

Three runs of salmonids were identified by Steward (1938) for this area:

> The first "salmon," probably the salmon trout, Salmo gairdneri, came about March or April....
>
> A second run of salmon came in May or June ... This is probably Oncorhynchus schawytscha (Walbaum), Chinook salmon.
>
> In the fall there was another run of salmon or, perhaps, salmon trout....

Three factors suggest that fish runs in the upper Snake Valley were not always dependable. First, winter Indian camps were small and dispersed, consisting of only two or three lodges (Murphy and Murphy 1960). This type of winter settlement was characteristic of people who depended largely upon dispersed plant or animal resources. Second, wintering was not always near salmon stores, and groups sometimes remained near their dried root caches instead (Steward 1938). Third, Steward (1938) alluded to occasional failures of the salmon runs on the Upper Snake.

The Bannock Creek and Northern Utah Shoshoni population, which became a predatory band prior to contact with Euroamericans, was a very mobile, mounted group (Murphy and Murphy 1960). They were described as unusual among Idaho Shoshoni in dependence upon the pine nut or pinyon (Pinus edulis) for winter subsistence. These Shoshoni are mentioned because some traveled to fish at Glenn's Ferry on the Snake "where they remained throughout the salmon run" (Murphy and Murphy 1960).

The Fort Hall Shoshoni and Bannock people adopted the horse relatively early and were primarily bison hunters (Murphy and Murphy 1960). Accordingly, they lived in larger groups than was characteristic of other Shoshoni. Portions of this group would travel to Glenn's Ferry to fish for salmon. Fish apparently were consumed fresh during the fishing season, but not preserved for use later. The Fort Hall people fished with harpoons rather than with weirs (Murphy and Murphy 1960), which probably reflected the lack of demand for a surplus to preserve. The groups wintered upon dried buffalo, elk and deer from the fall hunts (Murphy and Murphy 1960).

The Lemhi Valley and Stanley Basin region in the mountainous headwaters of the Salmon River were occupied by bands of Northern Shoshoni, referred to as the Lemhi and Tukaduka (Steward 1938). The populations occupying the mountains of the Upper Salmon river were horseless while those of the Lemhi Valley owned large numbers of horses (Steward 1938). Lewis and Clark, who provided an excellent account of the Lemhi, estimated that the Lemhi had 400 horses when Lewis and Clark visited these people in 1804. Steward (1938) estimated the combined populations of the Lemhi and Tukaduka as about 1,200 individuals. Ferris (1940), a fur trapper who traveled through the headwaters of the Salmon River in June 1831, described the Northern Shoshoni subsistence as follows:

> Here we found a party of "Root Diggers" or Snake Indians without horses. They subsist upon the flesh of elk, deer, and bighorns, and upon salmon which ascend to the fountain sources of this river, and are here taken in great numbers. These they first split and dry, and then pulverize for winter's provision. They often, when unable to procure fish or game, collect large quantities of roots for food, whence their name. We found them extremely anxious to exchange salmon for buffalo meat, of which they are very fond, and which they never procure in this country, unless by purchase of their friends who occasionally come from the plains to trade with them. (Ferris 1940 cited in Murphy and Murphy 1960)

Citing historical accounts, Steward (1938) noted that "foods were not plentiful" for these Shoshoni groups. Steward (1938) listed the following salmonids that were taken in the Upper Salmon and its tributaries:

> 1) "a variety up to 18 inches long, which could be taken all winter; in March they went into small streams to spawn." Steward tentatively identified this species as steelhead trout.
>
> 2) A "redfish" taken in August, which Steward did not identify further, but may be sockeye;
>
> 3) Chinook salmon taken in August.

Weirs were used on the Lemhi River, but apparently not on the Upper Salmon. Other techniques included hooks, harpoons, baskets and dams (Steward 1938).

To judge from Lewis and Clark's observations, salmon did not seem plentiful far up the watershed in August 1805:

> ...one man killed a Small Sammon, and the Indians gave me another which afforded us a Sleight brackfast. Those Pore people are here depending on what fish they can catch, without anything else to depend on... (Thwaites 1905)
>
> ...one Indian out all day & killed only one Sammon with his gig. (Thwaites 1905)

According to Murphy and Murphy (1960), the Lemhi remained on the rivers fishing from May through September. Evidence also shows that some families traveled to the Camas Prairie in summer while others hunted bison (Steward 1938). Murphy and Murphy (1960) also mentioned use of a spring salmon run in April which is most plausibly interpreted as the steelhead runs. No clear or explicit report of fish storage for winter consumption exists. There is, as with Shoshoni groups between Weiser and Shoshone Falls, indication that the fishery was split into a spring/early summer season and a late summer/fall season (Murphy and Murphy 1960).

Steward (1938) summarized the nature of fishing on the Upper Snake as follows:

> The Snake River is [within the Great Basin] unique in having salmon, but their quantity and quality were somewhat less than nearer the coast. When running, the fish were sufficiently abundant to supply all who could take them. The main limitation upon them was their occasional failure to run and the restricted number of convenient fishing places. Large numbers of people gathered at fishing places, some cooperating in constructing dams and weirs, others fishing

> alone with spears, hooks, and other devices. The catch was dried for winter. Though salmon afforded considerable food, all accounts indicate that they were rarely sufficient to keep families in plenty during the remainder of the year. Consequently, subsistence was supplemented by vegetable foods and hunting.... Both game and vegetable foods required unusually long journeys, either to the camas country to the north or to the highlands to the south. Families returned to their salmon caches along the Snake River to winter if the catch had been good; otherwise they remained where the vegetable harvest had been abundant.

3.3.7.3 <u>The Northern Paiute Indians</u>

The area of the Great Basin occupied by the Northern Paiute covered central and eastern Oregon, northeastern California, and most of western Nevada. Rivers that produced chinook salmon and steelhead included the Malheur, the Owyhee, and the headwaters of the Deschutes and John Day (Fulton 1968; 1970).

According to Whiting (1950), the yearly economic cycle of the Wadadika, who were centered around Malheur and Harney lakes in eastern Oregon, began with root-digging in early May. While the women were still preparing roots for storage, the men moved to the Drewsey, a tributary of the Malheur River, where they repaired and installed their fish traps in preparation for the spring salmon run. When the runs began, the women joined the men on the river to assist in drying salmon. From the end of the spring salmon run until movement into winter camps in November, individual families dispersed to hunt (deer, sagehens, ground hogs, antelope, rabbits), and collect seeds, roots, berries and crickets. Winter subsistence depended upon a variety of stored seeds and roots, crickets, chokecherries, dried meat and fish (Whiting 1950). Although only available for brief periods, salmon, crickets, and wada seeds were the only resources that were plentiful enough to permit more than a few families to congregate.

The "Salmon eaters," or Paiute groups that occupied the lower Malheur River, undoubtedly had access to more salmon and steelhead, but details of their subsistence are lacking. Similarly, the "Tagu eaters," or Paiutes whose territory centered about the Owyhee River, must have depended to some extent upon salmon.

3.3.8 Summary

It is clear from the ethnographic, ethnohistoric and archaeological records that the aboriginal peoples of the Columbia River Basin were dependent upon the salmon and steelhead. The degree of this dependence varied in response to resource availability and therefore largely on the geographic location of any particular tribal group. Understanding this relationship is important to taking the next step in this exercise -- estimating consumption and aboriginal catch.

3.4 THE MAGNITUDE OF ABORIGINAL CATCH IN THE COLUMBIA BASIN BEFORE 1850

Using aboriginal population estimates for the Columbia drainage and estimates of the amount of fish consumed per person per year, figures can be generated for the total annual Indian catch of salmon and steelhead in the early 19th century.

It is important to note that aboriginal catch does not represent pre-1850 run sizes. Estimated catch does, however, provide a number on which to base discussion. Two previous catch estimates are considered here. After discussing these two estimates, a third is generated.

3.4.1 The Craig and Hacker Estimate

The earliest effort to estimate the amount of salmon taken by Columbia Basin Indians in the early 19th century is by Craig and Hacker (1940). They postulated that the Indians ate an average of one pound of salmon per day or 365 pounds per capita annually. Using Carey's (1922) estimate of 50,000 Columbia River Indians in the early 1800s, Craig and Hacker estimated 18 million pounds of salmon were harvested a year.

3.4.2 The Hewes Estimate

Using ethnographic data from central California to Alaska and the Yukon, Hewes estimated a total yearly salmon catch of over 127 million pounds for the entire area. To generate this estimate, Hewes (1947; 1973) relied on four kinds of information:

1. Average human daily caloric requirements per capita (estimated at 2,000 calories per day).

2. Caloric content per pound of salmon (estimated at about 900 calories per pound).

3. Estimates derived from ethnographic accounts of the importance of salmon to various native groups.

4. Aboriginal population estimates by Mooney (1928), as revised by Kroeber (1939), for 1780, the period immediately prior to major disease impacts.

In contrast to Craig and Hacker's estimators, Hewes' approach attempts to account for the variability in salmon dependence from group to group and region to region. From Hewes' data, an estimate of the total salmonid catch for the Columbia drainage can be tabulated. In Table 10, compiled from Hewes (1973), the various native groups of the Columbia Basin are shown along with estimates of populations, pounds of salmon consumed per capita annually, and pounds consumed per group annually. From numbers in the table, the total annual aboriginal catch for the Columbia drainage in pre-contact times would be more than 22 million pounds of fish per year. This figure, based upon more thorough consideration of ethnographic data than that of Craig and Hacker, is higher than their 18 million estimate, but in the same order of magnitude. The principal difference between these two figures is that Hewes relied on more accurate population estimates by Kroeber (1939) rather than the earlier, lower estimates used by Craig and Hacker. (Using the Craig and Hacker procedure, but substituting Kroeber's population estimate of 61,500 for the Columbia Basin, the estimate of salmonids consumed in the Columbia drainage rises to 22,274,500.)

Craig and Hacker and Hewes assumed that a pound of salmon per day per person, or 365 pounds per year, was a reasonable average for the entire Columbia drainage. Craig and Hacker's estimate was based on only limited use of the ethnographic and ethnohistoric data. Their estimate also may have been influenced by information regarding per capita consumption of Indians fishing at Celilo Falls in the 1930s. Hewes' per capita annual consumption estimates for individual groups were based on the assumption that a pound of

Table 10 - Estimates of population and annual salmonid consumption for Columbia Basin tribal groups prior to arrival of Euroamericans (circa 1780).[1]

Native Groups	Population	X	Estimated Annual Consumption: Per Capita (lbs.)	=	Estimated Annual Consumption: Total by Groups (lbs.)
Chinook	22,000		400		8,800,000
Tlatskanai	1,600		365		584,000
Kalapuya	3,000		100		300,000
Cowlitz[2]	1,200		365		438,000
Klickitat, Yakima, Wanapum, Palus	11,200		400		4,480,000
Tenino, Umatilla, Walla Walla	2,900		500		1,450,000
Cayuse	500		365		182,500
Wenatchi, Sinkiuse, Peskwaus, Methow, Nespelem, Sanpoil, Colville (part)	3,500		500		1,750,000
Wenatchee-Spokan group (part)	2,400		500		1,200,000
Kalispel, Coeur d'Alene Pend d'Oreille, Flathead	2,800		100		280,000
Okanogon, Lakes	2,200		500		1,100,000
Kutenai	1,200		300		360,000
Nez Perce	4,000		300		1,200,000
Bannock, North Paiute, North Shoshoni	3,000		50		150,000
TOTALS	61,500				22,274,500

[1]Note that the tribal groups listed do not necessarily represent the same groups of present day tribes with the same or similar names.

[2]Kroeber combines his population estimates for the Cowlitz with that for the Chehalis and Willapa -- areas outside the Columbia drainage system. However, Taylor (1963) provided a revised estimate of 900-1,200 for the Cowlitz alone, so the figure of 1,200 was retained.

salmon provided about half the minimum daily caloric requirements of an average person (Hewes 1973). Hewes weighted the average 365 pounds per year consumption figure for each tribal group by using his analysis of the ethnographic data on the relative importance of salmon from group to group in the basin.

The Hewes estimate appears to be low for a number of reasons. The first, and possibly most important, is that it assumes a caloric content for salmon as they enter freshwater. Since salmonids lose an average of 75 percent of their caloric content during freshwater migration (Idler and Clemens 1959), some adjustment should have been made for distance traveled upstream. As will be shown below, the total annual per capita estimate for fish consumed rises significantly when a migration calorie-loss factor is included.

A second reason that the Hewes estimate is likely to be low is that it assumes that salmon were eaten in their entirety -- an unrealistic assumption. According to Hunn (1981), about 80 percent of the weight of a salmon is edible.

A third reason for suggesting that Hewes' consumption estimates are too low, is that he only considers human dietary demands. At least three other uses of salmon have been reported -- food for dogs (Thwaites 1904), fuel where wood was scarce (Thwaites 1904), and for trade.

3.4.3 A New Estimate of Aboriginal Fish Consumption for the Columbia Basin

Recognizing that some important factors were not considered in the earlier estimates of the total annual aboriginal salmonid consumption in the Columbia Basin in the early 1800s, it is appropriate to attempt a new estimate. The three adjustments to Hewes' calculations consist of 1) revision of his per capita consumption estimates for certain groups, 2) inclusion of a migration calorie-loss factor, and 3) inclusion of an inedible-waste factor.

The ethnographic literature covered in this study, some of which was not available to Hewes at the time of his study, suggests that Hewes' per capita estimates for four groups of aboriginal inhabitants are either too high or too low. Assuming, as Hewes did, that 365 pounds of salmon were roughly equivalent to half the minimum annual caloric requirement for an average individual, Hewes' estimates seem too low for Chinook Indians and too high for the Cowlitz and Kutenai. The estimate for the combined Okanagon and Lakes Indians also appears high.

There is nothing in the ethnographic evidence to suggest that the Chinook Indians depended any less on salmonids than the Tenino, Umatilla, Walla Walla or Wenatchi. Therefore, raising the 400 pounds per capita estimate for the Chinook to 500 pounds, as assigned to these other groups, is more consistent with the ethnographic data. Judging from the limited ethnographic evidence discussed earlier, the Cowlitz' per capita estimate seems rather high and has been adjusted from 365 pounds to 200 pounds per capita. The Hewes estimate for the Kutenai has been reduced from 300 pounds to 150 pounds per capita, and the combined estimate for the Okanogon and Lakes from 500 pounds to 400 pounds per capita.

An adjustment for caloric loss during migration was the second important modification to Hewes' procedure. Following Hunn (1981), the calorie loss factor is computed as a ratio of the entire length of the Columbia (1,936 km) to the distance in river-kilometers from the mouth of the Columbia to the approximate middle of each group's territory. If a group was located entirely on a tributary, then the ratio was calculated as the distance from the mouth of the Columbia to the middle of the group's territory over the distance to the upriver limit of salmon in that tributary. This ratio is then multiplied by 0.75, the average calorie loss during salmon migration, and the product subtracted from one. All distances were taken from Fulton (1968, 1970).

The third component of the revised estimate involves dividing the per capita consumption estimate by a waste factor of 0.8 to get the weight of fish used. The loss factor is derived from Hunn's suggestion that 80 percent of the total weight of a salmon is edible.

Table 11 presents the data used in these calculations. Calculating per capita catch for each group involves multiplying Hewes' per capita

Table 11 - Annual salmonid catch estimates by tribal groups using migration calorie loss and waste factors.[1]

Native Groups	Hewes' Per Capita (lbs.)	Migration Calorie Loss Factor	Per Capita Consumption Adjusted for Calorie Loss (lbs.)	Waste Factor	Per Capita Catch (lbs.)	Estimated Total Catch (lbs.)
Chinook	500	.94	532	0.8	665	14,630,000
Tlatskanai	365	.97	376	0.8	470	752,000
Kalapuya	100	.49	204	0.8	255	765,000
Cowlitz	250	.50	500	0.8	625	750,000
Klickitat, Yakima, Wanapum, Palus	400	.58	690	0.8	863	9,665,600
Tenino, Umatilla, Walla Walla	500	.84	595	0.8	744	2,157,600
Cayuse	365	.81	451	0.8	564	282,000
Wenatchi, Sinkiuse, Peskwaus, Methow, Nespelem, Sanpoil, Colville (part)	500	.64	781	0.8	976	3,416,000
Wenatchi-Spokan group (part)	500	.66	758	0.8	948	2,275,200
Kalispel, Coeur d'Alene, Pend d'Orielle, Flathead	100	.57	175	0.8	219	613,200
Okanogon, Lakes	400	.40	1,000	0.8	1,250	2,750,000
Kutenai	150	.39	385	0.8	481	577,200
Nez Perce	300	.58	517	0.8	646	2,584,000
Bannock, N. Paiute N. Shoshoni	50	.35	143	0.8	179	537,000
			TOTAL			41,754,800[2]

[1]Note that the tribal groups listed do not necessarily represent the same groupings of present day tribes with the same or similar names.

[2]Approximately 4.5 to 5.6 million fish (see Table 31).

consumption estimate (Column 1) by the migration calorie loss factor (Column 2) to get an adjusted per capita consumption estimate (Column 3). This adjusted per capita consumption estimate is then divided by 0.8, the waste factor (Column 4), to arrive at the per capita annual catch estimate (Column 5). To obtain annual catch estimates for tribal groups (Column 6), the per capita annual catch estimate is multiplied by the population estimates in Table 10. Calculated in this way, the annual salmonid catch by Columbia River Basin Indians in the early 19th century is estimated to be nearly 42 million pounds.

Although this figure is nearly twice as large as previous estimates, there are reasons to suspect that it may be low. The aboriginal population estimates are central to these calculations, but these estimates are only rough approximations. Almost half a century has passed since the population estimates were examined systematically for the region.

Since Mooney's original study of aboriginal populations, the only comprehensive reanalysis of historical data on this subject is a recent study by Robert Boyd (1985). He provides a reconstruction of the epidemic history of these two areas of the Columbia Basin and documents significant differences in their patterns of disease history and population decline.

Using methods of historical demography and crosschecking the reliability of various estimates, Boyd provides revisions to the Lewis and Clark estimates upon which Mooney largely depended. Although Boyd revises the Lewis and Clark estimates downward for some groups in the basin, he raises the estimates for a number of groups. Boyd's revisions result in a population estimate of about 60,000 for the Columbia Basin in 1805. The cumulative result of his revisions is a figure that is close to Mooney's figure for the <u>pre-epidemic</u> population of the basin. In other words, Boyd's analysis suggests that population levels were as high in 1805 after two major smallpox epidemics had occurred as Mooney had estimated for the period immediately preceding the epidemics. Based upon an estimated combined mortality rate of 45 percent for the 1775 and 1801 epidemics, Boyd projects populations for the Columbia Plateau tribes for the interval immediately before 1775. His pre-epidemic estimates do not include lower Columbia or upper Snake River groups, but application of the same mortality rates to the other groups of the basin suggests that roughly 100,000 people may have occupied the basin in the early 1770s.

Use of these higher population estimates in calculations similar to those presented above would result in a higher estimate for the total aboriginal salmonid catch in the Columbia Basin. That will not be done here because the approach to estimating consumption levels used above requires both population estimates and average annual per capita consumption rates for individual groups. In developing his per capita estimates, Hewes relied on an extensive body of ethnographic and ethnohistoric literature that was quite relevant to the early part of the 19th century. The relevance of that same data base to the period prior to 1775, however, is not so clear. There are no ethnographic or ethnohistoric accounts available for that earlier time period and, as was noted earlier in the chapter, this was an interval of dynamic change. With the mobility options provided by the horse, demographic changes would almost certainly have been accompanied by changes in the nature and extent of salmonid exploitation.

The catch estimates presented here did not consider uses of salmon other than as food for humans. At least three other uses are documented in the ethnohistoric accounts: for dog food, for fuel, and for trading. Dogs can be traced many centuries back into the prehistory of this region and there can be little doubt that fish were used for feeding dogs. The Lewis and Clark expedition, which periodically subsisted on dogs obtained from Indians, complained of the dismal quality of the dogs before the arrival of the salmon in the spring (Thwaites 1905).

As indicated in earlier sections of this chapter, there was extensive trade in salmon in numerous different areas of the Columbia Basin. Kalapuyan groups, which lacked fall run salmon in their own territory, traded for salmon at the Willamette Falls. Chinookans that fished at the falls of the Willamette traded spring run salmon to the Cowlitz. The Wishram and Wasco seem to have been the focal point in the most extensive trade network in the plateau -- one that reached to the mouth of the Columbia and out onto the plains east of the Rockies. They traded dried fish for bison hides and other commodities that originated on the plains (Griswold 1953). On a reduced scale, Kettle Falls, Okanogan Falls, and Spokane Falls appear to have been centers for salmon trade in their respective areas.

Horses greatly facilitated trade of bulky subsistence items, such as fish, and groups such as the Nez Perce, which owned large numbers of horses, played key roles in conveying dried salmon from fish-rich areas to fish-poor areas. Although it is difficult to quantify the amount of salmon traded annually, two points seem clear. The first is that much of the salmon, probably the vast majority that was traded, was traded to groups within the basin. (The fish traded within the basin already have been quantified in the tribal consumption estimates discussed in a previous section.) The second point is that much of the fish that was actually taken beyond the boundaries of the Columbia watershed was taken eastward by groups positioned at or near the headwaters of the basin (e.g., Shoshoni, Nez Perce). In view of the periodic shortfalls in salmon harvests that were documented during the first half of the 19th century, it is likely that extra-basin trade primarily involved surpluses during years when runs were strong enough to exceed the needs of local populations within the basin.

The last step in this process is to convert the aboriginal catch from pounds to numbers of fish. The aboriginal catch is difficult to convert to numbers of fish because the proportion of the catch represented by any particular species cannot be determined with any precision. One way to solve this problem is to assume that the species composition in the aboriginal catch was proportional to the species composition in the lower river commercial catch from 1880 to 1920. Using this method, a range of about 4.5 to 5.6 million fish can be estimated for aboriginal catch (Table 12). Therefore, it can be estimated using biological, ethnographic, and historical data that a population of about 50,000 to 62,000 Columbia Basin aboriginal peoples caught about five to six million fish annually in the early 1800s.

Table 12 - Aboriginal catch in numbers of fish.

Species	Lower River Catch Range[1]	% of Total Lower River Catch	Aboriginal Catch in Pounds per Species[2]	Average Pounds Per Fish[3]	Aboriginal Catch Range Expressed as Numbers of Fish
Spring chinook	400,000 - 1,150,000	6 - 14	2,505,000 - 5,846,000	18.5	135,000 - 316,000
Summer chinook	1,700,000 - 2,300,000	26 - 28	10,856,000 - 11,691,000	18.5	587,000 - 632,000
Fall chinook	1,100,000 - 1,150,000	17 - 14	7,098,000 - 5,846,000	18.5	384,000 - 316,000
Sockeye	1,905,000 - 1,300,000	30 - 16	12,526,000 - 6,681,000	3.5	3,579,000 - 1,909,000
Coho	605,000 - 890,000	9 - 11	3,758,000 - 4,593,000	8.9	422,000 - 516,000
Chum	359,000 - 697,000	6 - 9	2,505,000 - 3,758,000	12.2	205,000 - 308,000
Steelhead	382,000 - 674,000	6 - 8	2,505,000 - 3,340,000	7.3	343,000 - 458,000
Total	6,451,000 - 8,161,000				5,655,000 - 4,455,000

[1]Range is based on a five-year mean and a one-year peak catch in the lower Columbia River commercial fishery (see Chapter 2).

[2]Aboriginal catch (41,754,800) multiplied by percent of each species in the lower river catch.

[3]Beiningen 1976a.

Chapter 4
DECLINES IN FISH RUNS AND HABITAT

4.1 INTRODUCTION

As a basis for assessing the magnitude and causes of losses of salmon and steelhead, it is important to look at changes in fish runs and their habitat over time. Sizes of fish runs fluctuate through time in response to changes in climate, water supply and other natural phenomena. In addition, many of man's activities, as described in Chapter 5, influence these fluctuations.

This chapter reviews the changes in salmon and steelhead runs, and the habitat used by these species, from the beginning of development (about 1850) to the present. Descriptions of runs are based on adult fish counts and redd counts. Another set of data that is useful in assessing fish abundance is harvest records. Generally, prior to 1938, lower river commercial catches are the best indicators of fish run size because fish counts and redd counts are not usually available for this time period. Information on fishing is displayed in the fishing section of this compilation (see Section 5.2).

For purposes of discussion, the Columbia River Basin is separated into six major areas described in Table 13. Fish species discussed are chinook (spring, summer, and fall runs), coho, sockeye, and chum salmon and steelhead trout.

4.2 ADULT FISH AND REDD COUNTS

4.2.1 Overview

Adult fish counts have been made at various locations in the Columbia River Basin (e.g., dams, waterfalls, hatchery racks, spawning grounds). Adult fish counts give a rough estimate of escapement and can be used in combination with catch estimates to determine run size.

Redd (fish spawning nest) counts are done annually in many areas of the Columbia Basin. Redd counts are best used for assessing the relative abundance and trends of fish runs and not as absolute measures of population abundance because they are generally done only once each year for each area.

Table 13 - Columbia River Basin description.

Major Area	Major Tributary River Basins	
Columbia River Below Bonneville Dam	Sandy Washougal Lewis and Clark Youngs Cowlitz	Lewis Kalama Grays Willamette Columbia River mainstem
Columbia River Between Bonneville Dam and its confluence with the Snake	Walla Walla Umatilla John Day Deschutes Hood	Klickitat White Salmon Little White Salmon Wind Columbia River mainstem
Columbia River Between its confluence with the Snake River and Chief Joseph Dam	Methow Okanogan Wenatchee Chelan	Entiat Yakima Columbia River mainstem
Columbia River Above Chief Joseph Dam	Sanpoil Kettle Pend Oreille Spokane	Coeur d'Alene St. Joe Kootenay Columbia River mainstem
Snake River Below Hells Canyon Dam	Salmon Grande Ronde Clearwater	Tucannon Imnaha Snake River mainstem
Snake River Above Hells Canyon Dam	Powder Malheur Owyhee Boise Payette	Bruneau Burnt Weiser Snake River mainstem

The problem with using one-time "peak" redd count data for stock trend analysis is that the timing of spawning varies annually (Schwartzberg 1985). Ocean conditions, river flows and temperatures, passage obstructions, dam delays, irrigation patterns, and pollutant discharges are examples of factors that influence the timing of salmon and steelhead spawning (USFWS 1981).

Fish and redd counts are converted into run size in some instances. This conversion involves estimating the number of fish the count represents. Usually no conversion is necessary for dam counts where every fish is potentially counted. Redd and fish counts on the spawning grounds require an estimate of fish per redd or fish per fish counted. The last step in estimating run size is to add numbers of fish caught to the converted count.

Because adult fish counts at mainstem Columbia River dams are indicative of abundance of all fish runs originating above the count points, counts below the confluence of the Snake and the Columbia are presented separately from the six specific areas identified in Table 13. Therefore, tributary counts are the only counts included in the fish runs description for the two lower Columbia areas.

4.2.2 Mainstem Dam Fish Counts and Run Size Estimates Below the Confluence of the Snake and Columbia Rivers

Fish counts on the mainstem Columbia River are made at the four Corps of Engineers dams: Bonneville, The Dalles, John Day, and McNary. Figures A-15 through A-29 (Appendix A) show counts of salmon and steelhead at these dams since their construction (see also Appendix A, Tables A-3 through A-6). These figures generally indicate a decline in salmon and steelhead abundance, particularly at the dams upstream from Bonneville Dam.

Using dam counts, an estimate has been made for run sizes of spring, summer, and fall chinook and sockeye salmon, and steelhead (Table 14) produced above Bonneville Dam in the 1950s. The average inriver run (column 2) is a combination of Bonneville Dam counts and inriver harvest below Bonneville Dam. Column 3 applies estimated ocean harvest rates to the inriver run size to estimate ocean harvest (column 4). Adding average inriver run (column 2) to estimated ocean catch (column 4) yields the estimated average total run (column 5) of 2,257,200 fish.

Table 14 - Run sizes of Columbia Basin salmon and steelhead in the 1950s based on dam counts (CBFWC 1986, Junge 1980, Fish Commission of Oregon and Washington Department of Fisheries).

Species/Race	Inriver Average Run Size Above Bonneville Dam	Ratio of Ocean Catch to Inriver Run Size	Estimated Ocean Catch	Estimated Average Run Size Originating Above Bonneville Dam	Estimated Maximum Run Size Originating Above Bonneville Dam[4]	Estimated Minimum Run Size Originating Below Bonneville Dam[5]
Spring chinook[1]	230,200	0.1	23,000	253,200	300,000	64,946
Summer chinook[2]					200,000	
Snake River	121,500	0.1	12,100	133,600		
Mid-Columbia R.	59,900	2.9	173,700	233,600		
Fall chinook[2]	276,900	2.9[3]	803,000	1,079,900	1,200,000	35,080
Sockeye[1]	241,500	--	--	241,500	250,000	
Steelhead[1]	315,400	--	--	315,400	400,000	57,740
				2,257,200	2,350,000	

[1]1951-55 average.

[2]1955-59 average.

[3]Ratio based on average of data from 1961-64 fall chinook marking studies presented by Pulford (1970) and Wahle and Vreeland (1978).

[4]Junge 1980.

[5]Minimum runs sizes are from Fish Commission of Oregon and Washington Department of Fisheries (1972).

Another 1950s run size estimate for production above Bonneville Dam based on dam counts expanded for harvest was done by Junge (1980). Junge's estimates are shown in column 6 of Table 14. His estimate of a maximum total run of 2,350,000 is for the period in the early 1950s before McNary Dam was constructed.

Estimated minimum run sizes for spring and fall chinook, and steelhead are also displayed in column 7 of Table 14. These estimates do not include all escapement and do not include ocean catch and are therefore considered minimum. Estimates for coho are not available prior to 1960.

4.2.3 Columbia River Below Bonneville Dam

4.2.3.1 Spring Chinook

Annual counts of spring chinook have been taken at Willamette Falls since 1946 (Bennett 1985). The trend in count is generally upward (Appendix A, Figure A-49). The fishway at the falls, completed in 1971, made habitat more accessible to spring chinook.

Spring chinook escapement over Leaburg Dam on the McKenzie River, in the Willamette Basin, was 13,200 and 9,000 in 1958 and 1959, respectively. Counts have fluctuated between 1,078 and 3,870 fish since 1970 (Appendix A, Figure A-50). Cougar Dam, built in the 1960s, destroyed about one-third of the potential production area above Leaburg Dam (Willis et al. 1960).

Escapement of spring chinook over North Fork Dam on the Clackamas River, a major tributary to the Willamette, showed a dramatic increase in 1980 to 1983 from an annual average below 1,000 fish to an annual average of over 2,500 fish (Appendix A, Figure A-51). This has apparently been the result of returns from smolt releases at the Clackamas Hatchery (Bennett 1984). In general, increased hatchery production has increased returns of Willamette River drainage stocks (Beiningen 1976b).

Indications of pre-dam spring chinook run sizes in Washington lower Columbia tributaries include all time peak counts of 7,300 at Merwin Dam (1940) on the Lewis River, and 17,300 at Mayfield Dam (1965) on the Cowlitz River.

Estimated spring chinook run sizes for the Cowlitz, Kalama, and Lewis rivers since 1969 are shown in Appendix A, figures A-52 and A-53. Run sizes for these three basins have fluctuated with no apparent trend.

4.2.3.2 Summer Chinook

Summer chinook are not produced in this area of the basin.

4.2.3.3 Fall Chinook

Annual counts of fall chinook have been taken at Willamette Falls since 1955 (Appendix A, Figure A-54). Counts indicate an upward trend for Willamette River fall chinook.

Fall chinook fish and redd counts for the Sandy River (Trout and Gordon creeks) are shown in Appendix A, Figure A-55. There is no apparent trend over the years, but the 1981-83 counts dropped to 0 to 3 fish and 0 to 4 redds, possibly indicating the demise of this run.

Run sizes for naturally spawning fall chinook based on redd and peak fish count expansions for the North Lewis, East Lewis and Cowlitz rivers is shown in Appendix A, figures A-56, A-57, and A-58. Downward trends in abundance are indicated for the Cowlitz and East Lewis. No trends are apparent for the North Lewis.

4.2.3.4 Coho

Counts at Willamette Falls and North Fork Dam on the Clakamas River for coho salmon have fluctuated over the years (Appendix A, figures A-59 and A-60). Since 1977, counts at Willamette Falls have stabilized at under 2,000 from a high of 17,902 in 1970.

Spawning ground counts in lower Columbia River tributaries (Youngs River and Little, Willark, Carcus, Milton, Salmon, Sierkes, Raymond, Deep and Trickle creeks) indicate a declining trend in coho abundance (Appendix A, Figure A-61).

4.2.3.5 Sockeye

No counts are available for sockeye in this area of the basin.

4.2.3.6 Chum Salmon

Chum spawning ground counts in lower Columbia River tributaries have shown a relatively steady decline in numbers since the early 1960s counts of over 350 fish per mile to the record low of 14 fish per mile observed in 1981 (Appendix A, Figure A-62). Chum salmon counts are done for the Grays River and Hardy and Hamilton creeks (ODFW 1985b).

4.2.3.7 Steelhead

Counts of winter steelhead have been taken since 1950 at Willamette Falls (Appendix A, Figure A-63). These counts indicate a general upward trend in abundance. Counts at the Eagle Creek National Fish Hatchery rack and North Fork Dam on the Clackamas have fluctuated without an apparent trend (Appendix A, figures A-64 and A-65). Winter steelhead counts at Marmot Dam on the Sandy River have also fluctuated since 1966 without an apparent trend (Appendix A, Figure A-66).

Summer steelhead counts in the Willamette and Sandy basins have indicated an upward trend in abundance (Appendix A, Figures A-67).

4.2.4 Columbia River Between Bonneville Dam and Its Confluence with the Snake River

4.2.4.1 Spring Chinook

Minimum freshwater adult spring chinook run sizes have been estimated for the Klickitat, Little White Salmon, and Wind rivers since 1970 (Appendix A, figures A-68, A-69, and A-70). These estimates are computed by adding catch, hatchery returns, and expanded spawning ground counts of fish and redds (ODFW 1985b). These estimates fluctuate without any apparent trend.

Redd counts for the Warm Springs River, the major spring chinook natural production area left in the Deschutes Basin, are shown in Appendix A, Figure A-71). Average spring chinook redds per mile for the John Day River are shown in Appendix A, Figure A-72). The John Day spring chinook appear to be declining in abundance while the Deschutes data indicate no trend.

4.2.4.2 Summer Chinook

No summer chinook are produced in this area of the basin.

4.2.4.3 Fall Chinook

The Deschutes River fall chinook adult run size is shown in Appendix A, Figure A-73 for 1977 to 1983. Run size was estimated by adding escapement based on redd and fish counts to harvest (ODFW 1985b). The Deschutes fall chinook population appears to be stable according to this data.

4.2.4.4 Coho Salmon

The only counts of coho salmon found for this area of the Columbia Basin were for Powerdale Dam in the Hood Basin (Appendix A, Figure A-74). No trend is apparent from these counts.

4.2.4.5 Sockeye

Mainstem dam counts are the only counts available in this area of the basin (see 4.2.2).

4.2.4.6 Chum Salmon

No counts are available for chum in this area of the basin.

4.2.4.7 Steelhead

Counting of Umatilla summer steelhead has occurred at Three Mile Dam since 1966 (Appendix A, Figure A-75). A slight downward trend in abundance is apparent in this data.

Summer steelhead spawning ground data for the John Day Basin expressed in average redds per mile is shown in Appendix A, Figure A-76 for 1959 to 1984. A downward trend is apparent in this data also.

Summer steelhead counts at Sherars Falls in the Deschutes Basin occurred from 1977 to 1983 (Appendix A, Figure A-77). This data shows no trend in abundance.

Steelhead counts were taken at Powerdale Dam in the Hood Basin in 1955 and 1962 to 1970 (Appendix A, Figure A-78). These counts include both winter and summer steelhead and were taken from November through October (except 1955-February to July, 1962-April to October, 1964-November to April, 1969-no winter steelhead count). Note that the count extends over the end of the count year and into the beginning of the following year (ODFW 1985b).

Winter steelhead range extends east in the Columbia Basin to Fifteenmile Creek at The Dalles. Average redd counts per mile are shown in Appendix A, Figure A-79 for the basin. These counts have occurred intermittently since 1964 and indicate a drastic decline after the initial year count average of 17.4 per mile.

4.2.5 Columbia River Between Its Confluence with the Snake and Chief Joseph Dam

Fish counts are made at four dams on the mainstem Columbia River in this area: Priest Rapids, Rock Island, Rocky Reach, and Wells. Tables A-11 through A-14 (Appendix A) show counts of salmon and steelhead at these dams since their construction.

Fish counts over Rock Island Dam since 1933 provide the earliest indicators of the status of upriver populations of anadromous salmonids in this area of the Columbia River (Appendix A, Table A-12). There was a general increase in average numbers of salmon and steelhead counted at Rock Island Dam from the early 1940s until the late 1960s. Since then, a downward trend is apparent (Appendix A, figures A-80 and A-81). The coho salmon population increased dramatically during the late 1960s and early 1970s as a result of coho production from Leavenworth Hatchery. The Leavenworth Hatchery complex (Leavenworth, Naches, Methow federal hatcheries) sustained upriver runs of coho salmon until 1974. Production was then terminated because no sustaining population could be established in a local tributary stream. Since then, smaller releases have been made by Washington Department of Fisheries from the Rocky Reach mitigation rearing site on Turtle Rock (Mullan 1983).

4.2.5.1 Spring Chinook

Estimated spring chinook runs for 1970 to 1984 are shown for the Yakima, Wenatchee, Entiat, and Methow rivers in Appendix A, figure A-83, A-84, A-85, and A-86. Run sizes are estimated by adding catch, redd count expansions, and dam counts. An upward trend can be seen for the Yakima, Wenatchee, and Methow in the last several years. The Entiat spring chinook are declining in abundance.

4.2.5.2 Summer Chinook

Natural spawning escapement for the summer chinook in the Wenatchee, Methow, Okanogan, and Similkameen rivers is shown in Appendix A, figures A-87, A-88, A-89, and A-90. These counts are computed by expanding redd counts to numbers of fish (ODFW 1985b). Trends in abundance are downward for these rivers except the Similkameen which had its second highest count in 1984.

Counts of summer chinook redds in mainstem Columbia River areas between Rocky Reach and Chief Joseph Dams show a drastic decline in 1967 (Appendix A, Figure A-91) due to inundation by Wells Dam (Horner and Bjornn 1981).

4.2.5.3 Fall Chinook Salmon

In the mainstem Columbia River, the only significant fall chinook spawning occurs in the Hanford Reach. Redd counts have been conducted there each fall since 1947 (Appendix A, Figure A-92). The number of redds in the

Hanford Reach increased to over 4,000 in the 1960s, after construction of Priest Rapids Dam. This increase was probably attributable to fish spawning in the Hanford Reach that would have otherwise spawned in the area inundated by Priest Rapids Dam. Redd numbers fluctuated during the 1970s and increased again in the early 1980s to more than 7,000 in 1985 (Watson 1976, Becker 1985).

4.2.5.4 Coho

Mainstem dam counts are the only counts available for this area of the basin (see 4.3.5.).

4.2.5.5 Sockeye Salmon

The two major production areas for sockeye left in the Columbia Basin are the Wenatchee and Okanogan basins. Peak fish counts for spawning grounds are displayed for these areas in Appendix A, figures A-93 and A-94. No apparent trends are obvious from this data.

4.2.5.6 Chum

Chum are not produced in this area of the basin.

4.2.5.7 Steelhead

Mainstem dam counts are the only counts available for this area of the basin (see 4.3.5).

4.2.6 Columbia River Above Chief Joseph Dam

There are few records of fish and redd counts for the area above Chief Joseph Dam. In a survey conducted in 1938, Chapman (1943) estimated there were 800 to 1,000 chinook spawning in the mainstream Columbia in the two miles below Kettle Falls. Scholz (1985) reports annual siting of 10-20 pairs of spawning chinook in a 1/8 mile section below Meyers Falls on the Colville River from 1925-1935.

4.2.7 Snake River Below Hells Canyon Dam

Fish counts at the four Corps of Engineers dam projects on the Snake River mainstem (Ice Harbor, Lower Monumental, Little Goose, Lower Granite) show a general decline in salmon numbers during the past 20 years (See Appendix A, figures A-33 through A-48 and tables A-7 through A-10). Steelhead numbers have recently increased dramatically at these dams, after low numbers during the 1970s.

4.2.7.1 Spring Chinook Salmon

Counts of spring chinook salmon over Lewiston Dam on the mainstem Clearwater River are shown in Appendix A, Figure A-95. This dam was removed in 1972. Note that the Lewiston and South Fork dams virtually eliminated spring chinook above this point before counts began at Lewiston Dam. The overall increase in abundance was the result or improved passage facilities and a reintroduction program initiated in 1961 (USFWS 1981).

Redd counts for the Tucannon, Grande Ronde, Imnaha, Middle Fork Salmon and Upper Salmon rivers are shown in Appendix A, figures A-96, A-97, A-98, A-99 and A-100. Generally, these data shown declining tends in abundance.

4.2.7.2 Summer Chinook Salmon

Redd counts for the upper mainstem an South Fork Salmon rivers are shown in Appendix A, figures A-101 and A-102. These data shown a downward trend in abundance.

4.2.7.3 Fall Chinook Salmon

Mainstem dam counts are the only counts available for this area of the basin (see 4.2.7).

4.2.7.4 Coho

Redd counts for coho salmon in the Wallowa River are shown in Appendix-A, Figure A-103. This information indicates that run has been decimated.

4.2.7.5 Sockeye

Adult sockeye counts were taken at the Redfish Lake weir in the Salmon River Basin from 1954 to 1966 (Appendix A, Figure A-104). This data indicates a downward trend in abundance.

4.2.7.6 Chum

Chum are not produced in this area of the basin.

4.2.7.7 Steelhead

Adult summer steelhead counts for Lewiston Dam on the Clearwater River and the Washington Water and Power diversion dam on Asotin Creek are shown in Appendix A, Figure A-95 and A-105 respectively. The Lewiston Dam counts increased until the dam was removed in 1972. The Asotin Creek counts shown no different trend.

Return of summer steelhead to the Dworshak National Fish Hatchery on the Clearwater River is shown in Appendix A, Figure A-106. These data shown no trend.

Summer steelhead redd counts for the Grande Ronde River are shown in Appendix A, Figure A-107. These counts show a downward trend over time.

4.2.8 Snake River Above Hells Canyon Dam

Spring and fall chinook salmon and steelhead counts were taken at Brownlee-Oxbow dam complex from 1957 through 1963 (Appendix A, Figure A-108). During these years, wild runs produced above the dams were being eliminated. The counts of fish indicate natural production above the dams at the time of construction. Maximum counts were approximately 17,000 fall chinook in 1958, 2,600 spring chinook in 1960, and 4,500 steelhead in 1959 and 1960 (Haas 1965).

4.3 COLUMBIA BASIN SALMON AND STEELHEAD HABITAT

4.3.1 Overview

Salmon and steelhead have specific habitat requirements, including access to and from the sea; an adequate supply of clean, cool water; suitable gravel for spawning and egg incubation; and an ample supply of food and space for rearing juveniles. Salmon and steelhead habitat quantity and quality have changed dramatically in the Columbia River Basin since 1850. Table 15 shows habitat quantity in miles of stream available for spring, summer, and fall chinook, coho, and chum salmon and steelhead for predevelopment times and for 1975. This table also displays estimates of smolt outmigrants for 1985. Sockeye salmon production areas are displayed in Appendix B, Table B-2. Information on changes in the quality of habitat are discussed for each of the six areas identified in Table 13 in this section and in Sections 5.3-5.9.

Prior to development, over 163,000 square miles of salmon and steelhead habitat existed in the Columbia River Basin (Thompson 1976b). This habitat figure represents approximately 14,666 miles of stream; 11,741 miles above and 2,925 miles below Bonneville Dam respectively. In 1976, only 72,800 square miles of the basin or 10,073 miles of stream remained accessible to

Table 15 - Salmon and steelhead habitat in the Columbia River Basin.[1]

	Habitat Available (miles of stream)[2] Formerly[3]	1975	% Loss	Estimated Smolt Produced[4]
Columbia River below Bonneville Dam				
Spring chinook	1,835	1,191	35	
Summer chinook	0	0	0	
Fall chinook	861	1,047	(22)[5]	
Coho	1,319	2,124	(61)[5]	
Chum	309	194	37	
Steelhead	2,410	2,378	1	
All Species				
Columbia River between Bonneville Dam and its confluence with the Snake River				
Spring chinook	1,218	655	46	
Summer chinook	0	148	148	
Fall chinook	70	201	(187)	
Coho	231	344	(49)	
Chum	0	0	0	
Steelhead	1,834	1,479	19	
All Species				14,771,00
Columbia River above its confluence with the Snake River				
Spring chinook	1,801	758	58	
Summer chinook	909	286	69	
Fall chinook[6]	485	115	76	
Coho	523	361	31	
Chum	0	0	0	
Steelhead	1,485	938	37	
All Species				22,450,000
Snake River below Hells Canyon Dam				
Spring chinook	3,899	2,813	28	
Summer chinook	2,198	1,834	17	
Fall chinook	674	345	49	
Coho	481	379	21	
Chum	0	0	0	
Steelhead	5,156	4,120	20	
All Species				8,951,000
Snake River above Hells Canyon Dam				
Spring chinook[6]	1,865	0	100	
Summer chinook[6]	1,865	0	100	
Fall chinook	371	0	100	
Coho	0	0	0	
Chum	0	0	0	
Steelhead	2,050	0	100	
All Species				0

Source: Pacific Northwest Regional Commission (1976).

[1]Predevelopment and early 1960s sockeye salmon habitat is documented in Appendix B, Table B-2.

[2]Habitat refers to natural spawning and rearing areas.

[3]"Formerly" refers to the time before water developments blocked access to streams and before habitat was degraded (pre-1850).

[4]Numbers of smolts estimated for 1985 outmigration by Mainstem Passage Advisory Committee of the Northwest Power Planning Council. Includes hatchery and naturally produced smolts.

[5]Fishway at Willamette Falls constructed in 1971 increased habitat in the Willamette Basin.

[6]Mainstem Columbia River spawning habitat has been added to the Pacific Northwest Regional Commission (1976) estimates.

anadromous fish; 7,582 miles above and 2491 miles below Bonneville Dam respectively (Pacific Northwest Regional Commission 1976). This is a decrease of 4,593 miles of habitat which represents about a 31 percent decrease from predevelopment times.

Figure 5 depicts the area formally available to salmon and steelhead in predevelopment times and area available presently. Maps that precisely delineate habitat by species were prepared by Fulton (1968, 1970) and are available for review in the Council public reading room. Present and former spawning areas for Columbia River Basin salmon and steelhead are summarized in Appendix B.

4.3.2 Columbia River Below Bonneville Dam

A major physical barrier to anadromous fish in the Willamette River occurs at Willamette Falls which is about 42 feet high (Willis, Collins, and Sams 1960). A fishway, completed in 1971, improved passage above the falls for spring chinook, winter steelhead and coho. The fishway made habitat above the falls accessible to fall chinook and summer steelhead (Bennett 1985). Numerous other natural falls in the Willamette drainage block fish passage to otherwise suitable spawning and rearing areas. Dams constructed on tributaries above Willamette Falls have blocked about 250 miles of stream to salmon since 1950. Reservoir operations have flooded or dredged spawning areas and raised water temperatures.

Water quality deteriorated in the Willamette River until the mid-1960s. Pollutants included fine sediments, sawmill and cannery wastes, raw sewage, and sulphite pulp liquor. At times, the river was so polluted by the time it reached Portland that salmon and steelhead would not migrate upstream. Since that time, the Willamette's water quality has been restored through treatment of industrial and municipal effluent and controlled release of reservoir storage capacity.

Virtually all of the spring chinook habitat below Bonneville Dam, outside of the Willamette River, has been destroyed or is now inaccessible. Major losses have occurred in the Lewis and Cowlitz Rivers as the result of hydro developments. In addition, the eruption of Mount St. Helens in 1980 removed much of the Toutle River watershed from fish production.

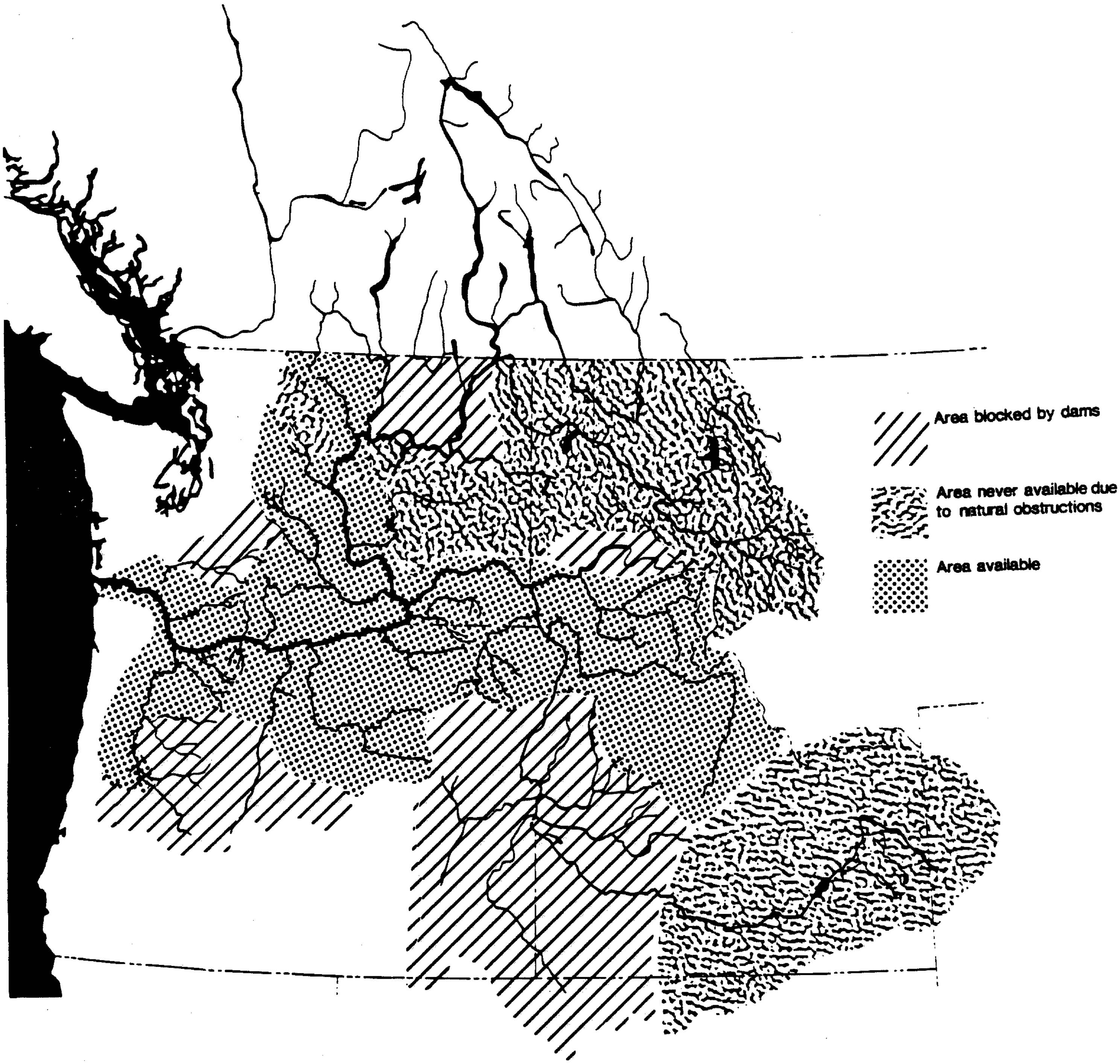

Figure 5. Columbia River Basin Anadromous Fish Areas (Northwest Power Planning Council 1984).

4.3.3 Columbia River Between Bonneville Dam and Its Confluence with the Snake River

The mainstem Columbia River behind where the John Day and McNary dam pools now stand was spawning habitat for fall chinook. Inundation by these dam backwaters eliminated production for fall chinook in this stretch of the mainstem.

The John Day River system provides spawning and rearing habitat for anadromous salmonids, principally steelhead. Steelhead are well distributed throughout the upper part of the basin (Oregon State Water Resources Board 1962). Spring chinook salmon are limited to the upper North and Middle Forks and to the mainstem of John Day River. Coho and fall chinook salmon are minor species in the drainage.

Habitat degradation, primarily water flow depletion, has limited salmonid productivity in the Umatilla and Walla Walla drainages.

4.3.4 Columbia River Between Its Confluence with the Snake River and Chief Joseph Dam

The mainstem Columbia River was formerly an important spawning area and an important migration route for salmon and steelhead. Aerial surveys conducted in 1946 showed that chinook salmon used gravel areas throughout the 210-mile reach from the confluence with the Snake and Okanogan rivers (Bryant and Parkhurst 1950). The only remaining fall chinook and steelhead spawning habitat in this stretch is a 50-mile portion known as the Hanford Reach that lies between Priest Rapids Dam and the upper extreme of the McNary Dam reservoir (PFMC 1979).

The Yakima River is one of the largest tributaries of the Columbia River. Prior to the initial development of the Yakima Valley in about 1860 (Davidson 1953), this river system provided extensive spawning and rearing areas for chinook, coho, and sockeye salmon (Bryant and Parkhurst 1950). The lower 29 miles of the Yakima River were seldom used for spawning. Most salmon tended to ascend farther upstream to the reach from Ellensburg to Easton Dam where most spawning still occurs. The system was formerly an important steelhead stream and still supports a small run (Bryant and Parkhurst 1950).

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