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Council Staff

COMPILATION OF INFORMATION ON SALMON AND STEELHEAD LOSSES IN THE COLUMBIA RIVER BASIN

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FOREWORD

The draft Compilation of Information on Salmon and Steelhead Losses in the Columbia River Basin was released initially in September 1985. Because of the extensive public interest in the initial draft, as indicated from the volume of oral and written comments received, the draft was revised and released for further comment in December 1985.

Many individuals and groups worked to produce this compilation. For the initial draft, preliminary portions of Chapters 3-5 were prepared by Council contractors Randall Schalk (Chapter 3) and Environmental Research and Technology, Inc. (Chapters 4 and 5). Information found in Appendix D also was prepared in draft form by Environmental Research and Technology, Inc. Council staff compiled and prepared Chapters 1, 2, and 6, and prepared Chapters 3-5 from information substantially provided in contractor reports. The Council's Losses and Goals Advisory Committee, comprised of individuals associated with fish and wildlife agencies, Indian tribes, utilities, Bonneville Power Administration, and the general public, provided information on data sources and reviewed chapter drafts. The revised draft was prepared by Council staff using information found in the initial draft as a basis and incorporating further information from comments received in the initial review period. The format of the revised draft is substantially different from the initial draft.

Copies of most reference materials discussed in this compilation are available for public review and copying in the Council's public reading room at its central office, 850 S.W. Broadway, Suite 1100, Portland, Oregon, weekdays between 8 a.m. and 5 p.m. Minimal copying charges may be levied.

Chapter 1
INTRODUCTION

1.0 THE NORTHWEST POWER PLANNING COUNCIL

The Northwest Power Planning Council (the "Council") was established pursuant to the Pacific Northwest Electric Power Planning and Conservation Act of 1980 (16 U.S.C. 839 et seq., the "Act"). The Council was directed by the Act to develop a Columbia River Basin fish and wildlife program to protect, mitigate, and enhance fish and wildlife "affected by the development, operation and management" of hydroelectric facilities in the basin. (See Figure 1 -- Northwest Power Planning Council's Four-state Planning Area.)

Responding to Congressional direction to emphasize action over prolonged study, the Council's 1982 Fish and Wildlife Program included more than 200 action items calling for prompt implementation of fish and wildlife projects. However, the Council recognized that long-term program planning would require further definition of the scope of the Fish and Wildlife Program and establishment of program goals. Essential to these overall statements of purpose would be an understanding of the extent to which salmon and steelhead have been affected by the development and operation of the hydroelectric system and facilities. To serve these ends, the Council adopted program Section 201, which provides for a process leading to the development of goals:

> The Council will assess salmon and steelhead losses attributable to hydropower development and operations, state goals, adopt objectives, develop methods for measuring progress toward goals and objectives, and otherwise provide a systemwide framework for program measures and action items....

In April 1985 the Council adopted a work plan outlining a process for establishing this "systemwide framework," to be comprised of four principal elements: 1) a statement of losses, describing the salmon and steelhead production and production capability which have been diminished or destroyed

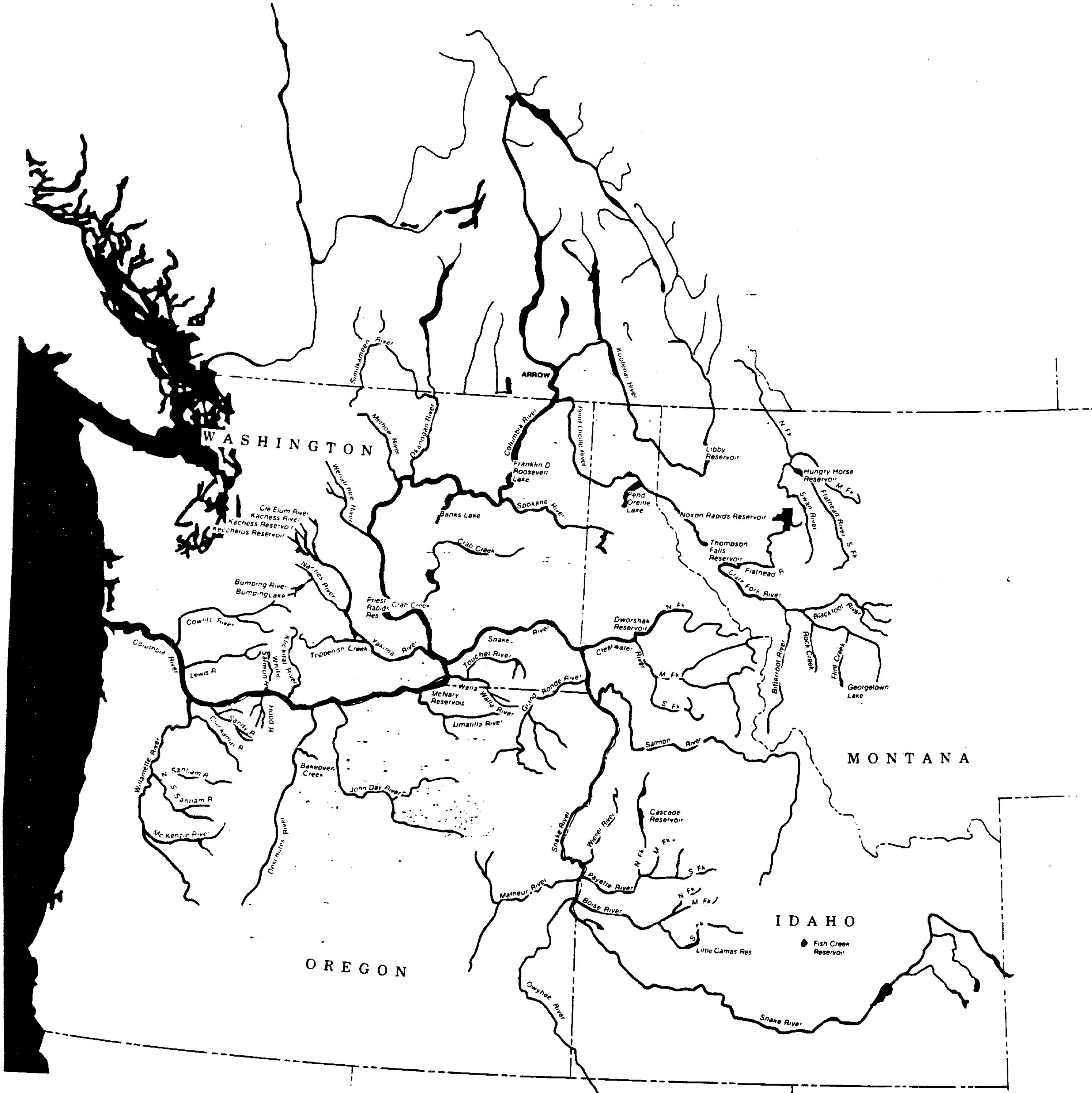

Figure 1. Northwest Power Planning Council's Four-State Planning Area.

by hydropower development and operations in the Columbia River Basin; 2) a statement of goals and systemwide objectives indicating the scope of fishing production to be funded under the Council's program and the major policies for determining the types and location of production to be emphasized; 3) production objectives, the series of short-term, geographically-specific and biologically-feasible production targets planned to lead together, over time, to achievement of long-term basinwide goals; and, 4) methods for measuring and accounting for progress toward goals and objectives.

This document describes salmon and steelhead losses attributable to all causes. As such, it comprises only the first step in the Council's assessment of salmon and steelhead losses attributable to hydropower development and operations. It does not reach conclusions on relative responsibilities for losses or specifically identify hydropower's contribution to those losses. A Council staff issue paper entitled "Contributions" will discuss the extent of hydropower responsibility for losses.[1]

From the beginning the Council has been aware that its judgment on goals likely would be a prudential judgment, not a judgment dictated by data. Reliable data are scarce for the predevelopment era. Although more recent data are plentiful, even very recent data may not be expressed in a way that enables comparative judgments (e.g., among fishing effort, timber harvest and trends in fish runs).

It is the Council staff's judgment, however, that the data must be taken as they are, and that further investment of time and effort scouring historical records is unjustified. The process of preparing this compilation has demonstrated to the Council staff that almost every facet of the data could be debated without end, yet further debate over the data would not achieve precision. The Council intends to make its prudential judgments taking those uncertainties into account.

1/ Council staff issue papers related to goals are described in the Council's "Work Plan for Development of a Program Framework," April 1985. The "Contributions Issue Paper" is scheduled for release in March 1986.

It is the Council staff's judgment that the data permit several broad conclusions regarding anadromous fish losses, as follows:

1.1 CHANGES IN SALMON AND STEELHEAD RUN SIZES (Chapter 2)

The most dramatic conclusion is the drastic decline in the size of fish runs (numerical loss). Estimates of the average annual salmon runs before development of the basin range from about 10 to 16 million fish. In contrast, the estimated current average annual run size is about 2.5 million fish. These estimates yield a net basinwide loss of about 7 to 14 million fish.

1.2 EFFECTS ON TRIBES (Chapter 3)

Chapter 3 documents the extensive reliance of Indian tribes on salmon and steelhead. While this reliance has not been determined with precision either in the aggregate or with respect to specific groups, there is no doubt that it was a dominant fact in the lives of many tribes. The decline in numbers of fish, combined with the shift of fish from the upper to lower basin (see Section 1.4), has had a serious effect on those tribes.

1.3 HABITAT LOSS AND DEGRADATION GENERALLY (Chapter 4)

There have been significant losses and degradation of salmon and steelhead habitat in the Columbia River Basin. Particularly severe was permanent blockage of habitat by large mainstem dams such as Chief Joseph and Grand Coulee dams and the Hells Canyon complex. The harmful effects of such projects are irreversible because it is not feasible to provide fish passage facilities for them. Even if these areas were planted with non-native anadromous fish stocks, those stocks could not migrate and return to spawn. Even dams that permit fish passage have inundated habitat, destroying spawning and rearing areas and increasing downstream migration time. It is estimated that salmon and steelhead habitat in the entire basin has decreased from about 14,666 miles of stream before 1850 to 10,073 miles of stream presently, a 31 percent loss all due to water development. Salmon and steelhead habitat loss in the Columbia River above Bonneville Dam (incuding the Snake River) also has been intensive, decreasing from 11,741 miles of stream before 1850 to 7,582 miles of stream, about a 35 percent loss.

While the lower river area below Bonneville Dam has suffered significant losses of spring chinook habitat, there has been much less habitat loss compared to upriver areas. In the Willamette River, habitat has been opened to additional anadromous fish species (fall chinook, summer steelhead) due to the construction of the fishway at Willamette Falls. In the Columbia River system below Bonneville Dam, salmon and steelhead habitat has decreased from 2,925 miles of stream to 2,491 miles of stream, about a 15 percent loss.

Throughout the Columbia River Basin, additional salmon and steelhead habitat has been degraded by forest and farming practices, waste disposal, and other factors. In some areas such habitat degradation has been extensive; but its effects are largely reversible.

1.4 LOSSES OF UPRIVER FISH RUNS AND HABITAT (Chapter 5)

The greatest losses of fish runs and habitat have occurred in the upper Columbia and upper Snake areas. These losses are largely unmitigated. Three general factors are responsible for loss of upriver fish runs: 1) Loss of habitat. See Section 1.3. 2) Passage mortalities at dams. Passage mortality is estimated at about 15 to 30 percent per dam for dowmstream migrants and 5 to 10 percent for upstream migrants. Cumulative juvenile passage mortality for untransported fish passing nine dams on the way to the ocean is approximately 77 to 96 percent. Adult passage mortality for fish passing nine dams on the way to spawning areas is approximately 37 to 51 percent. 3) Mixed-stock ocean fishery. In a mixed-stock fishery, upriver and wild runs already weakened by habitat and passage losses, are fished at the same rate as lower river runs (heavily hatchery-supplemented). As a result weaker upriver runs may be overfished.

1.5 EFFECTS OF MITIGATION (Chapter 6)

Efforts have been made to mitigate the effects of development. Two of these efforts have had major implications for the salmon and steelhead fisheries. First was a series of fishing regulations that in addition to restraining harvest also contributed to a shift from inriver harvest to ocean harvest of some stocks. Columbia River chinook salmon caught in ocean fisheries (including Canada and Alaska) now account for about 73 percent of total harvest.

Second was the development of large-scale hatchery production of salmon and steelhead. In 1949, hatchery programs were developed under the Mitchell Act (16 U.S.C. § 755). Most Mitchell Act hatchery fish are raised and released in the lower river, supporting the expansion of the lower river and ocean commercial fisheries. By the late 1960s, hatchery production of fall chinook and coho salmon and steelhead far surpassed natural production. Extensive production of hatchery fish has, along with permanent blockage by dams which eliminated some stocks, changed the genetic character (biological loss) of Columbia River Basin stocks. In addition, availability of large numbers of lower river hatchery fish causes overfishing of wild and upriver stocks in the mixed-stock harvest.

Chapter 2
ESTIMATE OF TOTAL LOSSES:
A NUMERICAL RANGE

2.1 INTRODUCTION

To estimate the total quantity of salmon and steelhead lost, two variables are required. These are the numbers of salmon and steelhead produced by the Columbia River Basin prior to Euroamerican development of the basin and numbers of salmon and steelhead produced currently. Subtraction of current run sizes from predevelopment run sizes equals the total quantifiable loss as defined here. This chapter details estimates of predevelopment run sizes, current run sizes, and the resultant loss ranges. [Note that the portion of the total loss attributable to hydropower will be discussed in the Hydropower Responsibility Issue Paper to be released in April 1986.]

2.2 ESTIMATES OF PREDEVELOPMENT RUN SIZES

2.2.1 Overview

Predevelopment run size has been estimated using different habitat-based and catch-based approaches. The various approaches are explained below.

2.2.2 Habitat-Based Approach

Run size can be estimated in terms of potential production of available habitat. In 1979 the Environmental Task Force of the Pacific Fishery Management Council estimated available habitat and potential production of each species for Columbia Basin salmon, but not for steelhead (Table 1). This estimate reflects conservative production estimates (PFMC 1985c) based on production "before water development blocked access to streams and before habitat was degraded." This is also the predevelopment (before 1850) definition used in this document.

Table 1 - Estimate of Columbia River Basin salmon and steelhead run sizes prior to 1850 based on estimates of available habitat.[1]

	Chinook[2]	Coho	Sockeye	Chum	Steelhead
Columbia River mainstem and tributaries downstream from Bonneville Dam	1,040,000	901,000		950,000	
Snake River	1,400,000	200,000	150,000		
Columbia River mainstem and tributaries upstream from Bonneville Dam not including the Snake River	1,000,000	100,000	500,000		
Total Columbia River Basin	3,440,000	1,201,000	650,000	950,000	2,042,000
Total salmon	6,241,000				
Total salmon and steelhead	8,283,000				

[1]Developed from Pacific Fishery Management Council (1979), Table 1.

[2]Spring, summer, and fall chinook.

Table 1 lists an estimated total potential production for salmon as over 6.2 million fish. Assuming that coho salmon production approximately equals that of steelhead for individuals produced per mile of habitat, steelhead potential production can be estimated using Fulton's (1970) work. Fulton estimated that there was a ratio of approximately 1.7 to 1 of steelhead to coho habitat in the Columbia Basin. Using this ratio, steelhead production equaled about 2,042,000 fish (1.7 x 1,201,000) prior to 1850. Salmon and steelhead production prior to development of the basin would be approximately 8.3 million (6.24 million plus 2.04 million) using this method.

2.2.3 Catch Approach

A less conservative estimate for calculating total run size prior to 1850 can be made using maximum catch records. Table A-1 (Appendix A) shows the maximum chinook catch as 2.3 million fish in 1883. The catch remained fairly consistent from 1880 to 1920 -- about 1.5 million chinook. However, in the 1880s the catch was mostly summer chinook stocks while from about 1890 through 1920 the catch was sustained by fishing on later runs, i.e., fall chinook (Figures 2 and 3). By 1920 the catch was estimated to be one-half fall chinook while in the 1880s it had been almost entirely summer chinook. Assuming that the ratio of summer chinook to fall chinook was the same in the 1880s as in 1920 (2 to 1), then it is reasonable to assume that the average catch of fall chinook was 1,150,000 fish (50 percent of the 2.3 million summer chinook catch from 1883). Also, assuming that there was a symmetric distribution of spring and fall chinook, then the spring chinook run was also approximately 1,150,000 fish. Thus, the total capability of the river can be estimated as 4.6 million chinook of all races.

Using these numbers and the maximum catch numbers for other species (Beiningen 1976a), a run size range can be computed (Table 2). In computing this range, catch efficiency figures assumed by some analysts of 50 percent (Junge 1980, Chapman 1982 for coho salmon, Henry 1953 for chum salmon), 67 percent (Koch 1976), and 85 percent (Chapman, 1985) are used. These computations estimate a total Columbia Basin predevelopment run size range of about 10 to 16 million salmon and steelhead.

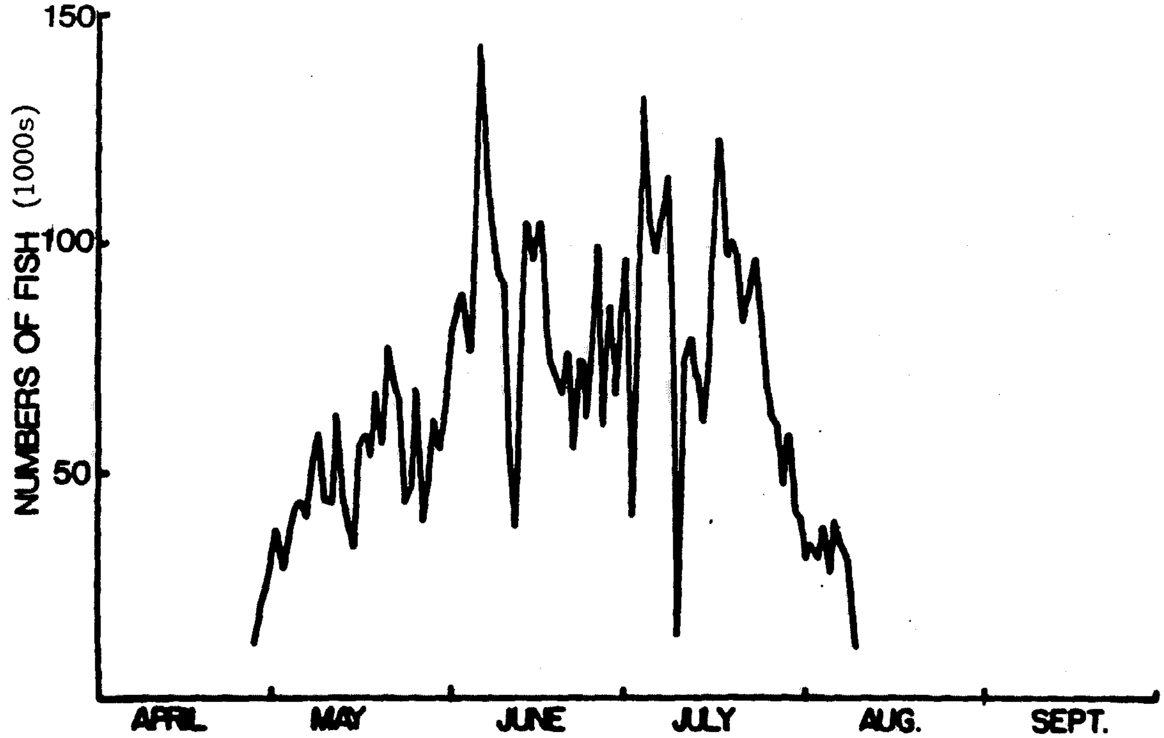

Figure 2. Timing of chinook runs in the Columbia River in 1878 showing dominant summer component at that time (Whitney and White 1984).

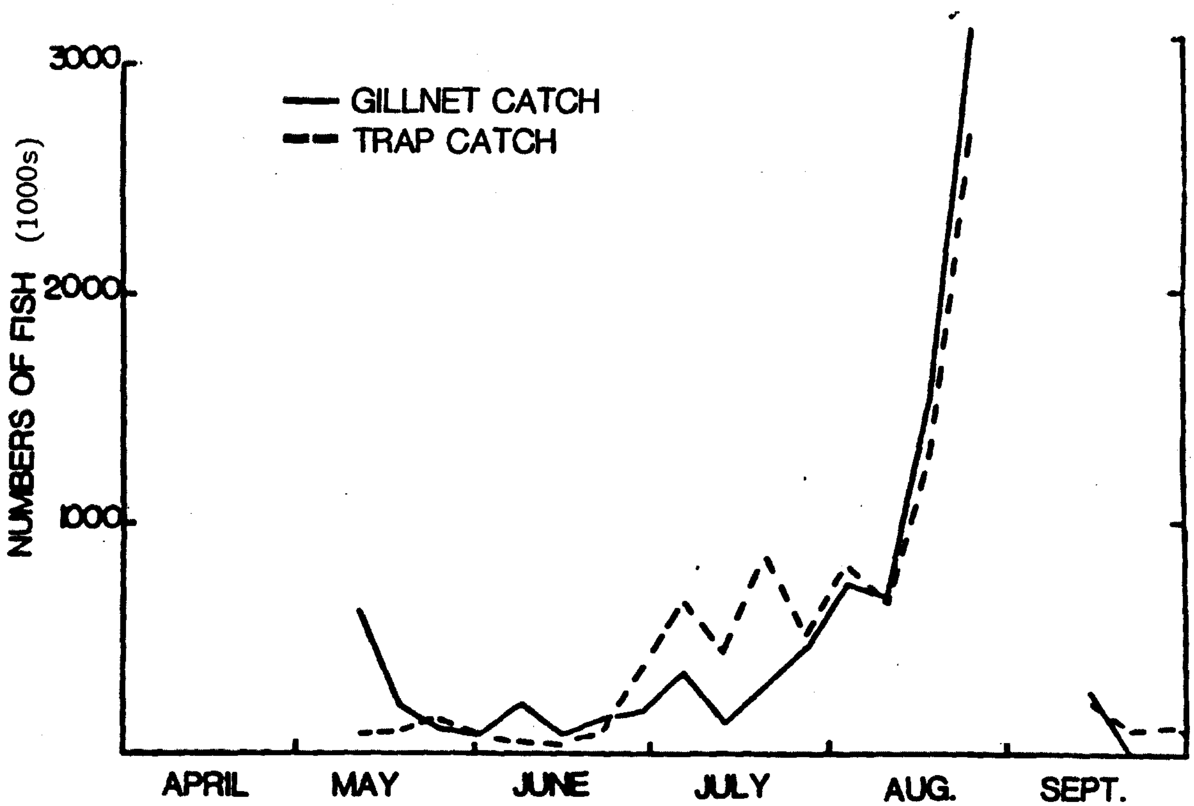

Figure 3. Timing of chinook runs in the Columbia River in 1919 showing decline of summer component (Whitney and White 1984).

Table 2 - Estimate of annual Columbia Basin run size based on maximum peak-year catch.

Species	Number of Fish Caught	Run Size Estimates[1] 85% Catch Efficiency Basis		67% Catch Efficiency Basis		50% Catch Efficiency Basis
Spring chinook	1,150,000	1,353,000	-	1,716,000	-	2,300,000
Summer chinook	2,300,000	2,706,000	-	3,433,000	-	4,600,000
Fall chinook	1,150,000	1,353,000	-	1,716,000	-	2,300,000
Sockeye	1,300,000	1,529,000	-	1,940,000	-	2,600,000
Coho	890,000	1,047,000	-	1,328,000	-	1,780,000
Chum	697,000	820,000	-	1,040,000	-	1,394,000
Steelhead	674,000	793,000	-	1,006,000	-	1,348,000
Total salmon and steelhead	8,161,000	9,601,000	-	12,179,000	-	16,322,000

[1]Estimate calculated by dividing number of fish caught by estimated catch efficiencies of 0.85, 0.67, or 0.50 (proportions of run caught).

Another method for estimating predevelopment run sizes in the Columbia Basin, similar to that detailed above, is outlined in Chapman (1985). Chapman estimates peak runs in the last half of the 1800s based on five-year mean peak harvest and mean weights (Table 3). Sockeye catches were calculated on the basis of ratios of fish wheel catches to total catch; spring chinook on the basis of catch timing and abundance relative to summer chinook; and coho on the basis of the first peak inriver catches. Optimum harvest rates are estimated by Chapman to be 77 percent for coho, 62 percent for sockeye, 68 percent for chinook, 69 percent for steelhead, and 30 percent for chum. However, Chapman estimates that an 80 to 85 percent harvest rate (catch efficiency) is probable, assuming that overfishing caused the declines in individual species of salmon and steelhead observed in the 1880s to 1920s period. He therefore estimates the predevelopment total Columbia Basin salmon and steelhead run to be about 8 to 10 million fish.

Table 3 - Estimate of annual Columbia Basin run size based on maximum five-year mean catch using Chapman (1985) catch efficiency numbers.

Species	Number of Fish Caught	Run Size Estimates: Optimum Harvest Rate		Run Size Estimates: 85% Catch Efficiency Basis
Spring chinook	400,000	588,000	(68%)	471,000
Summer chinook	1,700,000	2,500,000	(68%)	2,000,000
Fall chinook	1,100,000	1,618,000	(68%)	1,294,000
Sockeye	1,905,000	3,073,000	(62%)	2,241,000
Coho	605,000	786,000	(77%)	712,000
Chum	359,000	1,197,000	(30%)	422,000
Steelhead	382,000	554,000	(69%)	449,000
Total salmon and steelhead	6,451,000	10,316,000		7,589,000

Using Chapman's estimates of catch for each species and applying the 50 percent and 67 percent catch efficiencies used in addition to the 85 percent catch efficiency in the maximum peak-year catch method detailed previously (Table 2), the run size range can be estimated as about 10 to 13 million fish (Table 4).

Table 4 - Estimate of annual Columbia Basin run size based on maximum five-year mean catch using 67 and 50 percent catch efficiency numbers.

Species	Number of Fish Caught	Run Size Estimates: 67% Catch Efficiency Basis		Run Size Estimates: 50% Catch Efficiency Basis
Spring chinook	400,000	597,000	-	800,000
Summer chinook	1,700,000	2,537,000	-	3,400,000
Fall chinook	1,100,000	1,642,000	-	2,200,000
Sockeye	1,905,000	2,843,000	-	3,810,000
Coho	605,000	903,000	-	1,210,000
Chum	359,000	536,000	-	718,000
Steelhead	382,000	570,000	-	764,000
Total Salmon and Steelhead	6,451,000	9,628,000	-	12,902,000

A third method of estimating predevelopment salmon and steelhead run sizes for the Columbia Basin has been proposed by the Bonneville Power Administration (1984a) (hereinafter Bonneville). The source of the Bonneville estimate was a publication by Tollafson and Murrat (1959), with additional material from Rich (1922), and a rough calculation based on the total catch of salmon by fish wheels with the assumption that fish wheels took 5 percent of the total run (Donaldson and Cramer, 1971). Using this method, Bonneville estimated that the annual Columbia Basin salmon and steelhead run was as high as 350 million fish eight decades ago. This was apparently a misprint and the actual number computed was 35 million.

2.2.4 Range

The methods identified above estimate a range of about 8 to 35 million salmon and steelhead produced annually in the Columbia Basin prior to development. It is important to identify the relative validity of the numbers estimated. The habitat-based estimate and the Bonneville estimate can be eliminated from the range. The habitat-based estimate is based on extremely conservative data and the PFMC reports that it doesn't reflect a realistic run size. The Bonneville estimate is based on an unrealistically high fish wheel catch of 1.75 million fish (5 percent of 35 million). The maximum catch that can be estimated for the lower river commercial fishery (this includes fish wheel catch) is 8.161 million fish (see Table 2). Fish wheels caught an average of about 7 percent of the total lower river commercial harvest according to Smith (1979). The maximum catch of the fish wheels was therefore about 7 percent of 8.161 million fish, or 571,270 fish. If fish wheels caught 5 percent of the total run, then the total run estimate using Bonneville's method should be about 11.4 million fish. This estimate is within the aboriginal run size range estimate of 8 to 16 million fish.

Considering the above, the range that is most reflective of the predevelopment run size is therefore about 8 to 16 million fish. Within this range, 10 to 16 million is probably the most reasonable considering that the 8 million estimate is based on lower river commercial catches that do not include any Indian, sport, ocean commercial, or upper river non-Indian commercial/subsistence harvest. Indian and upper river non-Indian commercial/subsistence harvest also occurred throughout the 1880 to 1920 period. In addition, a building sport and ocean commercial harvest occurred after the turn of the century. Therefore, even if there was an overall harvest rate of 85 percent, only a portion of this overall harvest occurred in the lower river commercial fishery and the 50 to 67 percent harvest rates (10-16 million fish) are probably more reflective of this portion of the total harvest than is the 85 percent figure (8-10 million fish). It should also be noted that the 1880 to 1920 lower river commercial catch and therefore estimated run size are based on a time when some environmental degradation had already occurred in the basin. Therefore the 50 to 67 percent harvest rates not only allow for the harvest that occurred in other than the lower river commercial fisheries, but also for a lowered basin productivity because of Euroamerican development of the basin prior to the 1880 to 1920 period.

2.3 ESTIMATES OF CURRENT RUN SIZE

The estimation of the current run size is complicated by both conceptual and data problems. For example, the run size estimates will differ depending on which stage of the life cycle the fish are counted. This conceptual problem is partially resolved by identifying where in the life cycle the current production is being estimated. However, the data problem never fully resolves itself since catch numbers and dam counts never give a complete picture of the population under study. For example, estimation of total current production from the Columbia River Basin by using counts of fish passing Bonneville Dam requires some understanding of the inriver and ocean harvest, tributary productivity below Bonneville Dam, ocean mortality, and other factors affecting the juveniles as they move from spawning grounds to the ocean. Recognizing these shortcomings and problems in estimation, it is still possible to estimate total current production in the basin with some degree of confidence. This has been done by the Washington Department of Fisheries, as displayed on Table 5.

Table 5 shows an estimate of total current production of salmon and steelhead for the Columbia Basin of about 2.5 million fish annually. This estimate includes the following assumptions. The ocean catch/inriver run factors represent estimates based primarily on coded-wire tag recoveries and from interpretation of inriver data from Pacific Fishery Management Council 1985 reports. The two sources are combined because tag recoveries are available for catch, but not for most escapement categories. These values were developed to be used with the 1977-81 averages. Since 1974-83 averages are similar, they may apply to the 10-year run size averages as well. For coho, the ocean catch rate has been significantly reduced in 1984-85 from 2:1 (2 caught for every 1 that escaped to spawn) to about 0.5:1, so it is not appropriate to use the latter expansion factor for the 1984 data.

Table 5 - Estimate of current run size (total adult production) for the Columbia River salmon and steelhead.

	Avg.[1] Ocean Catch 1974-83	Avg.[1] Ocean Catch 1977-81	Ocean Catch 1984	Ratio of[5] Ocean Catch/ Inriver Run	Estimated Total Current Run Size Using 5-Year Avg. (1977-81)
Below Bonneville Dam					
Lower river spring[2] chinook	94,700[3]	95,800	113,100	1.5[6]	239,500
Lower river fall hatchery chinook	138,600	131,600	109,900	1.4[9]	315,800
Lower river fall natural chinook	25,300	26,300	13,900	3.4[8]	115,700
Coho	268,700	237,900[4]	382,900	2.0	713,700
Chum[12]	2,000[15]	-	2,000[15]	0.0	2,000[13]
Winter steelhead[11]	67,500[15]	-	45,600[15]	0.0	67,500[13]
					1,454,200
Above Bonneville Dam					
Upper river spring chinook	81,900	83,600	47,400	0.1[7]	92,000
Summer chinook	27,700	28,400	22,400	1.7[14]	76,700
Upper river fall hatchery chinook	107,300	101,200	46,900	2.3[9]	334,000
Upper river fall natural chinook	89,500	81,900	133,100	3.4[9]	360,400
Sockeye[11]	58,200[15]	-	161,600[15]	0.0	58,200[13]
Summer steelhead[11]	143,400[15]	-	366,300[15]	0.0	143,400[13]
					1,064,700
Total Columbia River Basin					2,518,900

[1]PFMC, Appendix B, March 1985, for chinook and coho.

[2]Includes some jack salmon.

[3]Includes some spring chinook destined for upper Columbia River.

[4]1979-81.

[5]Comparable to 1977-82 average return year (1979-81 for coho).

[6]Calculated using data from agency reports on chinook stock status, U.S./Canada Technical Committee on chinook salmon.

[7]Calculated using coded-wire tag data from Klickitat, Carson and Leavenworth releases and PFMC (March 1985).

[8]Assumed equal to upper Columbia River fall natural, based on similarity in ocean distribution of coded-wire tag recoveries.

[9]Based on data from U.S./Canada Technical Committee on chinook salmon and inriver data from PFMC (March 1985).

[10]Calculated for unweighted average of late and early coho stocks using U.S./Canada Joint Technical Report (November 1975) and inriver data from PMFC (March 1985).

[11]Extracted from status report, Columbia River Runs and Fisheries (1960-1983), ODFW/WDF (1984).

[12]From Stock Assessment of Columbia River Salmonids, Volume II, Bonneville Power Administration (1985).

[13]Represents 10-year (1974-83) average. Five-year average not available.

[14]Assumed mid-Columbia and Snake portions of run are 50 percent each, and that ratio is average of these two (3.4 for mid-Columbia and 0.1 for Snake).

[15]These figures are for adult return to the river. Insignificant ocean harvest occurs on these stocks.

2.4 ESTIMATES OF TOTAL LOSSES

As stated in section 2.1, the total annual loss of Columbia Basin salmon and steelhead can be computed by subtracting the current run size from the predevelopment run size. By doing so, a range of loss of about 7 to 14 million salmon and steelhead can be computed (Table 6). This loss is attributable to all the developmental factors identified in this report (hydropower, fishing, logging, mining, irrigation, agriculture, grazing, urbanization/pollution, and miscellaneous impacts).

Table 6 - Estimated total loss of Columbia Basin salmon and steelhead.

Species	Predevelopment Run Size (Range)		Current Run Size	Loss (Range)	
	67% Catch Efficiency Basis[1]	50% Catch Efficiency Basis[2]		67% Catch Efficiency Basis	50% Catch Efficiency Basis
Spring chinook	597,000 -	2,300,000	331,000	266,000 -	1,969,000
Summer chinook	2,537,000 -	4,600,000	125,000	2,412,000 -	4,475,000
Fall chinook	1,642,000 -	2,300,000	1,126,000	516,000 -	1,174,000
Sockeye[2]	2,843,000 -	2,600,000	58,000	2,785,000 -	2,542,000
Coho	903,000 -	1,780,000	714,000	189,000 -	1,066,000
Chum	536,000 -	1,394,000	2,000	534,000 -	1,392,000
Steelhead	570,000 -	1,348,000	211,000	359,000 -	1,137,000
Total salmon and steelhead	9,628,000 -	16,322,000	2,567,000	7,061,000 -	13,755,000

[1]See Table 4, Column 2, maximum five-year mean catch.

[2]See Table 2, Column 4, maximum peak-year catch.

The loss can be broken down geographically into the areas above and below Bonneville Dam. Chapman (1985) identifies the percentage of the catch that was produced above and below Bonneville Dam. According to his estimates, based on stream miles, 18 percent of steelhead, 17 percent of spring chinook, 47 percent of fall chinook, and 52 percent of coho were produced below the point in the Columbia Basin where Bonneville Dam now stands. He states that all sockeye and summer chinook were produced above this point in predevelopment times. For the purposes of this compilation it will be assumed, based on habitat preference, that all of the chum and winter steelhead were produced below this point in predevelopment times and that all of the summer steelhead were produced above this point in predevelopment times. Although summer steelhead were present in lower river tributaries and chum and winter steelhead were found above Bonneville Dam, the amount of each species in these areas was very small and insignificant for purposes of these calculations. Using these percentages, the numbers of fish that once were produced above and below Bonneville Dam can be estimated. Components of the current run have been identified as "upper" or "lower" (Bonneville Dam being the dividing point) in Table 5. Once again, by subtracting predevelopment run sizes from current run sizes, the loss above and below Bonneville Dam can be computed (Table 7 and Table 8).

Table 7 - Estimated loss of salmon and steelhead produced above Bonneville Dam.

Species	Predevelopment Run Size (Range)		Current Run Size	Loss (Range)		
	67% Catch Efficiency Basis	50% Catch Efficiency Basis		67% Catch Efficiency Basis		50% Catch Efficiency Basis
Spring chinook	496,000 -	1,909,000	92,000	404,000	-	1,817,000
Summer chinook	2,537,000 -	4,600,000	62,000	2,475,000	-	4,538,000
Fall chinook	870,000 -	1,219,000	694,000	176,000	-	525,000
Sockeye	2,843,000 -	2,600,000	58,000	2,785,000	-	2,542,000
Coho	479,000 -	854,000	---	479,000	-	854,000
Chum	-----------		---	------------		
Summer steelhead	467,000 -	1,105,000	143,000	324,000	-	962,000
Total salmon and steelhead	7,692,000 -	12,287,000	1,049,000	6,643,000	-	11,238,000

Table 8 - Estimated loss of salmon and steelhead produced below Bonneville Dam.

Species	Predevelopment Run Size (Range)		Current Run Size	Loss (Range)	
	67% Catch Efficiency Basis	50% Catch Efficiency Basis		67% Catch Efficiency Basis	50% Catch Efficiency Basis
Spring chinook	101,000 -	391,000	240,000	(-139,000)[1] -	151,000
Summer chinook	-------- -	--------	-----	-------- -	-----
Fall chinook	772,000 -	1,081,000	431,000	344,000 -	650,000
Sockeye	-------- -	-------	-----	-------- -	-----
Coho	424,000 -	926,000	714,000	(-290,000)[1] -	212,000
Chum	536,000 -	1,392,000	2,000	534,000 -	1,392,000
Winter steelhead	103,000 -	243,000	68,000	35,000 -	175,000
Total salmon and steelhead	1,936,000 -	4,033,000	1,455,000	484,000 -	2,580,000

[1]Negative numbers reflect increases in production.

Table 7 displays the estimated loss of salmon and steelhead stocks above Bonneville Dam as between about 7 and 11 million fish annually. Table 8 displays the estimated loss of salmon and steelhead stocks below Bonneville Dam as between about 0.5 to 2.6 million fish annually. Although the difference in the the size of these numbers is large, this difference is reasonable considering the relative magnitude and severity of development above and below Bonneville Dam as detailed in Chapter 5. Because these estimates are not derived by the same range of methods used in estimating the overall basinwide loss figures, the two are not precisely comparable. Nevertheless, one can say that the upriver losses are substantial in relation to the lower river losses, and probably comprise significantly more than half of the total.

2.5 ALTERNATIVE ESTIMATE OF PREDEVELOPMENT RUN SIZE AND TOTAL LOSS

Data presented in the previous sections of this chapter can be combined in alternative methods to arrive at other estimates of predevelopment run size and total loss. The following represents one such alternative method. The results are shown in Table 9. The difference between this approach and the previous approach is in selection of a lower river commercial catch size, the addition of upriver Indian and settler catches, and the selection of catch efficiencies used to calculate spawning escapement.

Table 9 - Alternative estimate of predevelopment run size of Columbia Basin salmon and steelhead.

	Lower River Commercial Catch		Other Catch		Total Catch		Estimated Predevelopment Run Size	
Species	Maximum Peak Year	Maximum Five-Year Mean	Indian Catch in 1880 to 1920	Settler Catch in 1880 to 1920	Maximum Peak Year	Maximum Five-Year Mean	Maximum Peak Year (80% Catch Efficiency)	Maximum Five-Year Mean (67% Catch Efficiency)
Spring chinook	1,150,000	400,000	38,000	38,000	1,226,000	476,000	1,530,000	710,000
Summer chinook	2,300,000	1,700,000	98,000	98,000	2,496,000	1,896,000	3,120,000	2,830,000
Fall chinook	1,150,000	1,100,000	56,000	56,000	1,262,000	1,212,000	1,580,000	1,810,000
Sockeye	1,900,000	1,900,000	500,000	500,000	2,900,000	2,900,000	3,630,000	4,330,000
Coho	890,000	700,000	78,000	78,000	1,046,000	856,000	1,310,000	1,280,000
Chum	697,000	360,000	41,000	41,000	778,000	441,000	970,000	660,000
Steelhead	674,000	430,000	68,000	68,000	810,000	566,000	1,010,000	850,000
Total	8,761,000	6,590,000	879,000	879,000	10,518,000	8,347,000	13,150,000	12,470,000

"Maximum Peak Year" catch for the lower river used in this estimate is from Table 2 except that sockeye catch is increased from 1.3 million fish to 1.9 million fish because it seems reasonable that the "peak catch" must be at least as great at the "five year mean" which is 1.9 million fish. The "Maximum Five-year Mean" catch is from Table 3 except that coho and steelhead have been increased to 700,000 and 430,000 fish, respectively, to reflect all-time maximum five-year mean catch sizes (1925-29 and 1923-27 respectively) as opposed to Chapman's pre-1920s maximum five-year mean peak catches.

As discussed in Section 2.2.4, additional harvest should be added to lower river commercial catch to estimate run size, otherwise the estimate would be overly conservative. This can be accomplished for Indian catch as follows. Predevelopment Indian catch is estimated to be 4.5 to 5.6 million fish (see Chapter 3, Table 12). One commentor estimates that Indian populations were one-sixth of predevelopment in the 1880 to 1920 period when peak lower river commercial catches occurred (Chapman 1985). Using these figures, Indian catch in 1880 to 1920 is estimated as displayed in Column 4 of Table 9. It should be recognized that even though Indian populations had dropped to one-sixth of those in predevelopment times, the drop in catch was probably not proportional because only a small portion of tribal members ever fished for tribal subsistence and the tribes sold an ever increasing portion of their catch in the commercial market after the Euroamericans settled in the basin. These factors support the proposition that the catch of Indians fishing in the 1880 to 1920 period was greater than one-sixth of that in predevelopment times.

A settler catch equal to the Indian catch is included in Table 9. This is reasonable considering that in the late 1800s the Indian population was about 10,000 while the settler population was 750,000 (see Section 5.8 Urbanization/Pollution) and the Indian populations presumably relied on fishing more than the settler population. Catches of the settlers are referred to in sections 5.2.3.5 and 5.2.3.6, while the need to control settler catches by harvest regulation in the late 1800s is reflected in Tables 17 and 18. Rather than assume these population levels and activities did not exist, it is assumed that they had equal effect as the Indian effort.

Finally, the total calculated catch is converted to total run size by dividing by selected catch efficiencies. Another point that can arguably be made about the data involves reducing the range of commercial catch efficiencies that are used to estimate predevelopment run size. The five-year mean is an average catch; therefore, the 67 percent catch efficiency is probably most appropriate for expanding this number because this represents an average catch. The 80-85 percent catch efficiency is probably most realistically applied to the maximum peak year catch because this catch efficiency represents peak efficiency of harvest. The 80 percent catch efficiency is selected in this range to recognize that the decline in run sizes was not only due to overfishing but environmental degradation as well. As noted in Section 2.2.4, basin productivity was lower because of Euroamerican development in the 1880 to 1920 period than prior to 1850. It is assumed here that the 80 percent catch efficiency reflects this lowered productivity.

In Table 9 it is estimated that the total predevelopment run size was about 12.5 to 13 million fish. Because the current run size is about 2.5 million fish, the total loss due to all causes -- hydropower, fishing, logging, mining, irrigation, grazing, urbanization/pollution, and miscellaneous impacts -- can be estimated to be almost 10 million fish, which is within the 7 to 14 million range estimated in Section 2.4, above.

Chapter 3

PREDEVELOPMENT RESOURCE

3.1 INTRODUCTION

3.1.1 Overview

This chapter describes the culture that centered around the Columbia River Basin salmon and steelhead resource prior to major development. By describing that culture, the predevelopment use of salmon and steelhead is described. From that description, estimates of the predevelopment size of runs can be made. To evaluate the losses caused by development, it is necessary to have baseline information on how the fish are distributed, how they are used, and the peoples that relied on them before development and other factors adversely affected the runs. Such development includes hydroelectric, logging, mining, fishing, grazing, and irrigation. This chapter surveys anthropological information regarding the distribution of people and fish, as well as productivity of various stocks of salmon and steelhead in the Columbia Basin.

Although quantitative data are desirable in this effort, such data are increasingly scarce as one moves back in time. Because mainstem dams were not constructed until 1933, there are no pre-1933 data equivalent to modern fish passage records for dams. Similarly, the predevelopment fishery was largely for aboriginal subsistence and, therefore, there are no records comparable to cannery records or other quantitative measures of fish catches. The fact that the primary use of harvested fish was for subsistence of people within the basin does provide a basis for an estimate of aboriginal run size. Additional factors are the size and distribution of the human populations and their daily fish-consumption rate. This estimate can be compared to run sizes recorded after settlement and development of the Columbia River Basin.

To understand the magnitude of the aboriginal salmonid resource, attention must focus first on how these fish were used by the native peoples who once occupied large portions of what is now Washington, Oregon, Idaho, British Columbia, and Montana. Information used to complete the description of resources use includes ethnographic, ethnohistoric and archaeologic data (see 3.2). Using this information, one can determine roughly the magnitude of numerical and cultural losses that have occurred due to elimination or significant reduction of salmon and steelhead available to native peoples. In addition, numerical losses in some specific areas of the basin can be put into perspective. Lastly, by comparing the predevelopment record of aboriginal use of salmon and steelhead with current fish run information, it may be possible to obtain some perspective on the biological loss that has occurred. The predevelopment description of the resource is presented to allow the Council to consider such information in making equitable decisions on establishing goals.

3.1.2 <u>Summary</u>

Columbia Basin salmon and steelhead were relied upon not only for immediate consumption, but were stored for winter subsistence. Only in highly productive root collecting grounds or camas prairies were there good alternatives to salmonids as seasonally abundant resources that could be preserved efficiently in quantity. For some groups, fresh, smoked, or dried salmon apparently dominated the diet throughout the year. For other groups (e.g., Kalapuyans), salmon consumption was probably restricted mainly to immediate use while fresh. Owing to differences in humidity, precipitation, and possibly in the oil content of fish, smoking was the dominant storage technique west of the Cascade Range, while air-drying dominated in the east. In general, fish with high oil content were preferred for eating fresh while those with low oil content were favored for storage.

Unlike the concentrated Euroamerican commercial fisheries that developed in the last half of the 19th century, the Indian fisheries prior to 1850 were dispersed over countless miles of rivers, streams, and creeks within the Columbia watershed. The quantitative importance of salmonids in aboriginal subsistence varied significantly from area to area within the Columbia drainage, but there was probably some dependence upon salmon in virtually all areas of the basin that provided accessible spawning habitat. When all the human populations scattered over the Columbia drainage are considered, estimates of the total yearly catch of anadromous salmonids are impressively high.

After the introduction of the horse in the early 1700s, increased mobility offered alternatives to fishing in and near a group's own territory. This was especially true in those areas east of the Cascades -- what anthropologists refer to as the Columbia Plateau. By traveling to prime fishing locations, natives could intercept fish where the runs were more reliable and the fish were in better condition. Groups that occupied areas beyond the range of anadromous fish could travel to fisheries in other groups' territories, either to fish for themselves or to trade for fish. Ownership of large herds of horses greatly expanded the capacity to transport bulk goods, such as dried fish, over considerable distances. Prior to the horse, similar capacities for transport were limited to those areas of the watershed where water transport could be used.

Fishing technology was diverse and sophisticated. The techniques natives used in various areas depended primarily on the nature of the stream channels. At points where the channel narrowed or natural waterfalls occurred, aggregations of fish allowed easy harvest with dip nets. On the lower Columbia, more complex fishing devices were required. Some, such as seines up to 600 feet long, required several men to operate.

Based upon the data examined, there do not appear to be any major discrepancies between the reports by Fulton on the general distribution of salmonid species within the Columbia Basin (1968; 1970) and the biological, ethnographic and historical data considered here. Salmon and steelhead generally inhabited the entire Columbia River Basin up to the Arrow Lakes in Canada and below the Shoshone Falls on the Snake. Any significant changes in range prior to 1850 probably would have resulted from hydrological changes caused by landslides or tectonic activity that could create or remove obstacles to salmonid migration.

Total catch estimates for Indians in the Columbia Basin have been calculated using aboriginal population estimates and salmonid consumption estimates per capita. Three different estimates of the total annual salmonid catch in the basin have been discussed and range from a low of 18 million pounds (Craig and Hacker 1940) to a high of nearly 42 million pounds (approximately 4.5 to 5.6 million fish). Hewes (1947) reports an intermediate figure of about 22 million pounds, based on assumptions very similar to those of Craig and Hacker. All of these estimates may be conservative because they exclude some other aboriginal uses of fish.

3.2 DATA SOURCES

Three kinds of data are useful in investigating the distribution and abundance of salmonids prior to major development in the Columbia drainage: 1) ethnographic data -- or the studies of living informants by anthropologists; 2) ethnohistoric data -- the accounts of early explorers, fur traders, and others untrained in anthropology; and 3) archaeological data -- the study of material remains.

Ethnographic data for this region were generally obtained from elderly Indian informants whose personal experiences extended back to the early 1800s. This type of information is often integrated with the written records of early Euroamerican observers of native cultures. Most of the ethnographic studies attempt to reconstruct aboriginal cultures as they existed immediately prior to major impacts resulting from Euroamerican contact, such as disease epidemics. The first major disease epidemic is thought to have passed through the Columbia Basin about 1775 (Boyd 1985).

The Northwest Indian groups referred to as "tribes" by ethnographers were distinguished mainly on the basis of linguistics. These tribes rarely possessed any political unity, but instead were collections of independently organized bands or local groups -- people who lived and subsisted together in the same village or camp during a portion of the yearly economic cycle. Because resource use often varied highly among bands within a tribe, the best ethnographic accounts are those that provide detail about individual bands rather than statements about typical behavior for all the bands in a tribe.

Ethnohistoric sources often amount to day-to-day descriptions by Euroamericans of particular events and behavior. These accounts can be quite valuable for their detail. Ethnohistoric descriptions of aboriginal life often tend to be more specific than ethnographies of this region and can be used to crosscheck the latter.

Archaeological data are uniquely valuable for extending the time scale of human resource use into the distant past -- in this instance, back 10,000 years or more. This data source is best suited to investigating how aboriginal cultures evolved and how various food resources changed in importance over time. The archaeological data offer a source of information on how long humans have been using salmonid resources and where. At present, detailed information that would permit identification of prehistoric distributions of the various fish species throughout the basin is very limited. While archaeological data would offer the most direct physical evidence of former salmonid distributions, the potential of these data generally has not been realized. Research currently in progress may overcome this obstacle by developing ways to discriminate salmonid bones commonly recovered, and by improving recovery procedures.

For the purposes of this compilation, we must rely primarily upon the ethnographic sources -- the native informants studied by anthropologists. The ethnohistoric sources are used on a more limited basis because comprehensive treatment of this very extensive literature would be impossible without spending considerably more time. Archaeological data are used mainly to provide a background for more recent data from ethnographic sources.

In focusing on the distribution and abundance of the salmon and steelhead resources prior to major development, this chapter uses anthropological data pertaining to specific areas and places. The aboriginal or "tribal" groupings referred to in this analysis cannot be directly equated with modern groupings or tribal organizations. How modern tribal organizations trace their ancestry back to the peoples observed in the early 19th century is a subject of considerable historical and social interest; it is not, however, essential to the use of anthropological sources for the biological purposes of this report.

Because most of the ethnographic studies aim at reconstructing traditional aboriginal culture prior to Euroamerican contact, these studies generally adopt a time reference of between 1780 and 1800. In the following section it will be suggested that, contrary to popular belief, Indian cultures of the Columbia Basin in the early 1800s had changed considerably over the previous centuries.

The Pacific Northwest includes three distinctive natural and cultural regions that anthropologists refer to as "culture areas:" the Northwest Coast, the Columbia-Fraser Plateau and the Great Basin. The Columbia River Basin encompasses portions of each of these three culture areas. West of the Cascades, the Columbia Basin lies within the Northwest Coast culture area, which was noted for the importance of both riverine and marine food resources in native subsistence. East of the Cascades, the Columbia flows through the Columbia-Fraser Plateau, a culture area distinguished by the economic importance of salmon, roots, and large game. The southeastern portion of the Columbia Basin cuts through the northern part of the Great Basin, a culture area known for the economic importance of seeds and small game.

Although culture areas can be broadly characterized in this way, the importance of different foods varied from group to group within each area. For example, some groups that lived on tributaries of the lower Columbia in the Northwest Coast area depended relatively little upon salmon or marine resources. Other tribes, such as the Shoshoni on the upper Snake River within the Great Basin, relied more on fishing, bison hunting, and root digging than on seed collecting or small game hunting.

Substantial variations in native subsistence occurred even between groups within the same tribe. These tribes often extended over thousands of square miles and included many individual groups, bands, or villages that were self-sufficient. Given the high relief of the mountainous Northwest, it is understandable that profound variations in food resources over relatively small distances contributed frequently to equally profound variations in aboriginal subsistence.

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