3.0 ESTIMATE OF THE CATCH AND TOTAL RUN-SIZE IN UPPER COLUMBIA BASIN.

3.1 CATCH ESTIMATE BASED ON HISTORICAL RECORDS OF CATCH.

Information from historical sources presented in sections 2.1 to 2.4 indicates that the minimum annual Indian catch was 150,000 salmon on the Spokane River and 90,000 salmon at Kettle Falls. Additionally, it is reasonable that a minimum of 60,000 salmon were taken at other locations above Grand Coulee for a combined total harvest of approximately 300,000 fish per year.

The addition of 60,000 fish to the Kettle Falls, Little Falls and Little Spokane counts (240,000 fish per year) is justified considering that this estimate did not include Spokane Falls and several other sites in the upper Columbia Basin where counts could not be obtained. These include the Pend Oreille River (where a count of approximately 4,000 additional fish was estimated -- see Section 2.3.1.1), the Kootenai River to Bonnington Falls (Section 2.4.1.2), Arrow Lakes (Section 2.4.1.2), the headwaters of the Columbia at Windermere and Columbia Lakes (Section 2.4.1.1), the Sanpoil River (see below), and at least 40 minor locations on the Spokane and mainstem Columbia (see below).

Several authenticated Indian fisheries in the Upper Columbia Basin, besides those mentioned previously, occurred in the mainstem Columbia and tributaries. These were principally in the San Poil and Colville Tribes territory. George Simpson in 1824 described the section of the mainstem Columbia between the Grand Coulee and Kettle Falls as being *"studded with Indian Lodges"* (Merk 1968). Winans (1870) wrote *"the Indians during salmon season build weirs across the Okanogan, Methow, San Poil, and the smaller streams catching a great many salmon, suckers and salmon trout (steelhead) earlier in the season and before they collect to catch their winter's supply at Kettle Falls."*

Ray (1932) reported that all of the streams flowing into the Columbia between Brewster, WA, i.e., near the mouth of the Okanogan River, and Kettle Falls were provided with traps. He identified 33 fishing sites between the San Poil River and Kettle Falls and on the Kettle River. Salmon could ascend only about 25 miles up the Kettle River (Fulton and Laird unpublished manuscript; Fulton 1968, 1970). Kennedy (1975) identified seven fishing sites on the mainstem Columbia between the mouth of the Spokane River and Kettle Falls but made no attempt to be exhaustive in her search. Larrabee and Kardas (1966) found a fishing site at Hawk Creek, a stream that flows directly into the Columbia about six miles downstream from the mouth of the Spokane River.

An important fishery was located at Rickey Rapids, about six miles downstream from Kettle Falls (see Section 2.1.1.4 and 2.1.1.6 for details). Another was at the mouth of the San Poil River about 14 miles above Grand Coulee Dam. The San Poil and other tribes belonging to the present day Colville Confederated Tribes fished salmon along the length of this river.

At the mouth of the San Poil River on July 4, 1811, David Thompson encountered "240 souls" fishing for salmon and gathering roots and berries

(Glover 1962). In an article published in the Spokesman Review (May 25, 1892), the reporter stated:

> *"About 200 Indians are encamped at the mouth of the San Poil River where they are engaged in fishing. They have put in a fish trap at that point and are securing a large number of salmon."*

Indian fishing activity on the Sanpoil continued into the twentieth century because L.R. Freeman (1920) at the San Poil Bar saw some Indians from the Colville Reservation fishing for salmon. Bryant and Parkhurst (1950) report that in the San Poil River a decline in the chinook salmon run was evident around 1890, but *"Dr. W.H. Rich observed a good run in 1918 and reported that Indians were catching salmon on the San Poil near the town of Republic, nearly 100 miles up from the confluence with the Columbia."*

The Davenport Times Tribune of May 28, 1925 noted *"the chinook salmon are reported to be running in the San Poil River in great numbers."* Dean Anderson, resident of Republic, stated that in the 1920's steelhead were more abundant in the San Poil River than chinook (Fulton and Laird, unpublished manuscript).

These reports, like those recorded elsewhere in the Upper Columbia Basin (see Sections 2.1.1.3, 2.1.1.6, and 2.4.4.1) indicate that the Upper Columbia Basin Indian Tribes continued to fish for salmon until the runs were blocked by hydroelectric projects.

These observations indicate that the estimate of 60,000 salmon, added to the 240,000 fish observed caught per annum, is an extremely conservative number and could justifiably be increased by a factor of 2 to 4. The count of 300,000 fish also did not include a fall fishery for coho and spent chinook, nor a large spring steelhead fishery (see Sections 2.1, 2.2, 2.3 and 2.4).

3.2 CATCH ESTIMATE BASED ON CALORIC AND PROTEIN REQUIREMENTS: POPULATION X PER CAPITA CONSUMPTION.

Craig and Hacker (1940) calculated an average per capita consumption of salmon at one pound per day during the entire year (or 365 annual lbs per capita). Given a population of 50,000 Indians (Carey 1922), their annual catch was about 18,000,000 pounds per year. Craig and Hacker concluded that, *"During 1933 the commercial catch of all species of salmon and steelhead on the Columbia River was approximately 26,000,000 pounds; therefore, it is evident that in primitive times the Indians may well have taken an annual catch which was a very significant proportion of the commercial catch of today."* Craig and Hacker's values are not particularly useful for the present problem--that of calculating the upriver catch--because; (1) they do not provide a breakdown of catch in different geographic regions of the basin, and (2) they are not based on a scientific approximation of caloric and protein requirements required to maintain an average man per day, i.e. it was not known if the amount of calories and protein contained in one pound of salmon flesh will meet these requirements.

Hewes (1947; 1973), making an assumption that salmon contributed an average of 50% to the total diet of Columbia Plateau Tribes, estimated salmon

consumption based on normal human caloric requirements of 2000 calories per day. The assumption that one-half of the food requirements were met by salmon was based on knowledge that other types of food collected by these hunting/fishing and gathering societies, e.g., tubers such as camas and bitterroot, are low in food value, so it is likely that salmon provided more than 50% of the annual food requirements except for some areas where the contribution of game was substantial. Therefore, the 50% figure is considered a minimum estimate. Based on the 2000 calories per day average consumption, and the fact that salmon flesh yields approximately 1000 calories/pound (Tressler 1923), this yields an average annual per capita consumption of 365 pounds. Hewes also obtained a figure of 300 pounds per capita based on protein requirements. These figures were in agreement with observed catches. For example, Swindell (1942) surveyed the Indian salmon fishermen in the Yakima, Umatilla and Warmsprings jurisdiction by interviewing the heads of 55 representative families out of a total of 795 families. The average per capita consumption was 322 pounds in 1941. Hewes then weighted the 365 pound annual per capita average for the Columbia Plateau tribes consumption to estimate the per capita consumption for individual tribes by evaluating ethnographic data on the relative importance of salmon in different portions of the Columbia Basin. His values for each tribe are recorded in Table 3.1. Using Kroeber's (1939) estimates of the population for each tribe (also recorded in Table 3.1), Hewes was able to calculate the total consumption by each tribe. Hewes combined total estimate of consumption for the entire basin was 22,274,500 pounds.

Schalk (1985) pointed out that Hewes' figures required a waste loss adjustment factor of 0.8 to account for portions of fish not eaten and a caloric loss adjustment factor to account for deterioration of salmon flesh as they burn their energy stores, and lose an average of 75% of their caloric content, during their upstream migration (see Section 2.1.2). The caloric loss adjustment factor varies (i.e., is negatively correlated) with the length of the upstream migration. Schalk's figures for different portions of the basin are recorded on Table 3.1. Schalk's combined total estimate of Indian consumption for the entire Columbia Basin was 41,754,800 pounds.

Table 3.1 is based on Hewes' and Schalk's data except for:

(1) The population levels of Coeur d'Alene, Kalispel, Spokane and Kootenai Tribes were broken out of the larger groups that Kroeber had combined them with. Their population levels at about the time of contact were determined using counts reported by Carey (1923), Mooney (1928), Kroeber (1939), Stevens (1856), Parker (1840), and Anastasio (1972). The average value of the different estimates was used; and

(2) Hewes' original estimate grouped the Coeur d'Alene and Kalispel tribes together with the Pend Oreille and Flatheads and estimated 100 lbs per capita consumption for the group. Since the Pend Oreille and Flatheads depended on buffalo and other game the 100 lb per capita figure is reasonable. However, based on the historical and ethnographic information presented about the Coeur d'Alene and Kalispels in Sections 2.2 and 2.3, the 100 lb figure is unrealistic and low, so the per capita estimate was increased to 300 lbs, i.e., Hewes average based on protein requirements. This figure is still

Table 3.1 Estimates of population and salmonid consumption Columbia Basin Tribal groupings prior to arrival of Euroamericans (circa 1780).[1]

Native groups	Population	Hewes' per capita consumption (lbs)	Migration calorie loss factor	Waste loss factor	Estimated total annual consumption
Chinook	22,000	500	.94	0.8	14,630,000
Tlatskanai	1,600	365	.97	0.8	752,000
Kalapuya	3,000	100	.49	0.8	765,000
Cowlitz	1,200	250	.50	0.8	750,000
Klickitat Yakima, Wanapum, Palus	11,200	400	.58	0.8	9,665,600
Tenino, Umatilla, Walla Walla	2,900	500	.84	0.8	2,157,600
Cayuse	500	365	.81	0.8	282,000
Colville Confederated Tribes: San Poil, Colville, Wenatchi, Sinkiuse, Peskwaus, Methow, Nespelem,	4,500	500	.64	0.8	4,392,000
Spokane	1,400	500	.66	0.8	1,353,000
Kalispel	1,200	300	.57	0.8	789,600
Coeur d' Alene	1,200	300	.57	0.8	789,600
Kootenai	1,200	300	.39	0.8	1,154,500
Pend Oreille	900	100	.57	0.8	197,000
Flathead					
Okanogan, Lakes	2,200	400	.40	0.8	2,750,000
Nez Perce	4,000	300	.58	0.8	537,000
Paiute, Shoshone					
Total					44,126,900

1. Adapted from Hewes (1947;1973), Walker (1967), and Schalk (1985).

below Hewes 365 lb per capita based on caloric requirements.

With the changes noted above the total catch was estimated at 44.1 million pounds (Table 3.1).

It should be noted that Walker (1967) improved upon Hewes' estimate by computing per capita consumption from historical records of catch and ethnographic fieldwork data. Walker (1967) estimated that the average annual per capita consumption for the Columbia Basin Tribes was 584 pounds. We deliberately used Hewes' figures to maintain a conservative bias in developing our estimation of consumption, even though Walker's figures are likely more accurate.

Chance (1973) reported that salmon constituted about 50 to 90% of the meat purchased by the Hudson's Bay Company at the Colville post. For example, in 1827, 16,050 lbs of salmon were purchased compared to 2,964 lbs of all other types of meat combined (Table 3.2). This total divided by the approximately 30 Hudson's Bay Company employees occupying the post (Oliphant 1925) amounts to about 535 lbs per person per year or very close to the 584 lb figure that Walker (1967) derived for per capita consumption. That the Hudson's Bay Company personnel in the Upper Columbia (e.g., at Fort Colville) depended principally on salmon is found in their grousing about it in their diaries. For example, Francis Ermatinger wrote a letter to his brother Edward on 14 March 1826 in which he states, *"To counterbalance the misery of Damned Dried Salmon -- with which we are obliged to sustain a miserable existence -- we can . . . obtain a wife in every port we come to for a moderate charge"* [1] (cited in McDonald 1980).

Walker (1985) has recently improved his estimate based on additional source material. Gordon Hewe's (1985) has checked Walker's new figures for populations and per capita consumption and agrees with Walker's revisions. Hewes (1985) stated, *"The old population estimate of Mooney, used by A.L. Kroeber with only minor revision's in his "Cultural and Natural Areas of Native North America" (1939) was the best source available to me over forty years ago. I realized then that detailed archival research into old Hudson Bay Company records, accounts of various mission outposts, and the journals of explorers and travellers would be required to fine-tune the figures I employed for my estimate of fish consumption per capita. Since 1947 there has been more ethnographic fieldwork, more historical research, and more examination, especially for the Indian Claims cases, of the resource bases [of many of the Columbia Basin Tribes]."* The historical information included in this report also tends to support Walker's new estimate of population and consumption as far as the upriver tribes are concerned. Walker's new population and per capita consumption figures are presented in Table 3.3 Walker's (1985) calculations provided an estimate of 54.5 million total pounds harvested. This is comparable to the 41.7 million pounds estimated by Schalk and 44.1 million pounds estimated in this report. Not only is the total harvest based on consumption reasonably close, but the per capita consumption estimated for individual tribes is also nearly uniform (see Table 3.4). The fact that two independent methodologies by

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1. Ermatinger is referring to a Hudson Bay Company regulation which forbid a HBC employee from "taking of a woman without binding himself to reasonable provision for the maintenance of the woman and children."

Table 3.2. Hudson's Bay Company records for Kettle Falls: 1827-1840.

	Conversion factor[1]	1827	1829	1830
Dry venison (lbs)		88	111	0
Fresh venison (lbs)		1,709	914	2,554
Fresh beaver (ea.)		10	5	30
Salmon	15 lb	16,050	10,480	18,180
Ducks	5 lb	210	330	310
Geese	15 lb	510	75	165
Cranes	15 lb	30	15	0
Dogs	30 lb	120	90	0
Swans	15 lb	15	0	0
Beaver tails	5 lb	40	45	0
Grouse	2 lb	32	110	8
Trout/Small fish	1 lb	80	46	0

Sources: for outfits 1825 through 1829, John Work (1830); for outfit 1830, Heron and Kittson (1831). One quarter pieces of salmon were converted from numbers to weights by dividing the total number of quarter pieces by four and multiplying by 15 lbs.

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1. Data presented in number of individuals was converted to pounds for purpose of comparison.

Table 3.3. Estimates of population and salmonid consumption of Columbia Basin Tribes circa 1780 based on Walker's (1985) estimates.

	Estimated aboriginal population	Estimated annual per capita consumption	% anadromous salmonids	Average per capita consumption of anadromous salmonids	Total consumption of anadromous salmonids
Lower Columbia Tribes[1]	27,600	1000[2]	.60[2]	600[2]	16,560,000
Yakima	7700	1200	.75	900	6,930,000
Umatilla	2500	1000	.75	750	1,875,000
Warm Springs	6200	1100	.80	880	5,456,000
Colville Tribes (excluding San Poil and Kettle Falls)	3250	1200	.90	1080	3,510,000
San Poil--Nespelem	750	1200	.90	1080	810,000
Colville (Kettle Falls)	2000	1200	.90	1080	2,160,000
Spokane[3]	2500	1200	.90	1080	2,700,000
Coeur d'Alene[3]	2000	1000	.75	750	1,500,000
Kalispel[3]	1500	1000	.75	750	1,125,000
Kutenai[3]	2500	1000	.90	90	2,250,000
Lakes	1500	1000	.75	750	1,125,000
Pend d'Oreille	1500	800	.50	400	600,000
Flathead	2500	800	.50	400	1,000,000
Nez Perce	5000	1000	.90	900	4,500,000
Shoshone Paiute	1000	400	.75	300	300,000
Shoshone Bannock	3500	800	.75	600	2,100,000
TOTAL					54,506,000

1. Data on the population of Lower Columbia Chinookian (22,000), Cowlitz (1,200), Tlatskanai (1,600), and Kalapuya (3,000) Tribes is from Hewes (1973) based on the Mooney/Kroeber estimates. Bob Boyd (1985) revised the estimates of the lower Columbia Tribes: Chinook (18,360), Cowlitz (4,320), Tlatskanai (1,890) and Kalapuya (16,200) for a total of 40,777. The Hewes numbers were used because Boyd indicated that there wer e some discrepencies in the lower river numbers caused by migratory movement of the tribes.

2. Per capita consumption estimate for the lower Columbia Tribes is our best guess.

3. Comparing Boyd's (1985) figures with Walker's (1985) figures for the four UCUT tribes. [Tribes (Walker's figure, Boyd's figure] yields = Spokane (W=2,500; B=3,055); Kalispel (W=1,500; B=1,650); Coeur d' Alene (W=2,000; B=1,920); Kootenai (W=2,500; B=1,492)].

Table 3.4. Comparison of the annual per capita consumption of anadromous salmon and steelhead by Upper Columbia United Tribes--Coeur d'Alene, Kalispel, Kootenai and Spokanes Tribes--estimated by various authors.

Tribe	Hewes (1947)[1]	Schalk (1985)[2]		Scholz (1985)[3]		Walker(1985)[4]	
		Base	Estimate	Base	Estimate	1967	1985
Coeur d' Alene	100	(100)	219	(300)	658	584	750
Kalispel	100	(100)	219	(300)	658	584	750
Kootenai	300	(100)	481	(300)	961	584	900
Spokane	500	(500)	948	(500)	948	965	1080

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1. Hewes' estimate was based on ethnographic data available in 1947 and an average per capita consumption of 300-365 lbs for the Columbia Plateau Tribes.

2. Schalk used Hewes numbers as a base and divided by migration los s and waste loss adjustment factors to arrive at an estimate of per capita co nsumption. Schalk arbitrarily reduced Hewes estimate of Kootenai per capita consumption from 300 to 100 lbs without providing any rationale for doing so.

3. Scholz et al. (1985)--this report--used Hewes average numbers as a base and Schalk's migration loss and waste loss adjustment factors to provide an estimate of per capita consumption. Scholz et al. provided rational (ethnographic and historical data) for using Hewes' original base for the Kootenai and increasing the Coeur d'Alene and Kalispel to 300 lb, i.e., Hewes average for the Plateau.

4. Walker's estimates are based on observed catches reported in historical and ethnographic literature and ethnographic fieldwork. The Walker (1967) figures were extrapolated from his report on Nez Perce fishing practices in which he estimated the average per capita consumption at 584 lbs. The Walker (1985) column is an improved estimate based on additional source material.

investigators trained in different fields of anthropology provided similar estimates increases our confidence about the reliability of these numbers. The only significant difference between Schalk and Walker's estimates lies in their population estimated for each tribe. In this connection it is interesting to note that Boyd (1985) has recently completed an analysis of the effect of disease on the aboriginal populations of the Plateau, in which he updated the population estimates for each tribe. Boyd's estimates are in close agreement with Walker's (1985) estimates in most cases. For example:

Tribes	Hewes, Mooney, Kroeber estimate	Walker (1985)	Boyd (1985)
Coeur d'Alene	1200	2000	1900
Kalispel	1200	1500	1650
Kootenai	1200	2500	1500
Spokane	1400	2500	3000

In view of Hewes (1985) caveat cited above, and the reasonably close agreement between Walker's and Boyd's estimates, it would seem appropriate to suggest that Walker's numbers are a more accurate reflection of aboriginal consumption than the revised estimate based on Hewes' and Schalks numbers contained in this report. Consequently, our calculations are a minimum estimate and may be unrealistically low.

Of the total Indian catch of approximately 44 million pounds, 6.8 million pounds were harvested by upriver tribes above Grand Coulee-- including the Coeur d'Alene Kalispel, Kootenai, Spokane, Colville, Sanpoil, Lakes, Pend Oreille and Flatheads-- if Schalk's estimate used Hewes numbers are used to provide a minimum estimate. If Walker's (1985) figures are used to provide a maximum estimate, 13.1 million pounds out of a total of 54.5 million pounds were harvested by the upriver Tribes.

In order to compare the catch estimate for the Upper Columbia Basin based on historical observations of the Indian catch with the catch estimate based on consumption, the consumption data had to be converted from pounds to numbers of fish. This was accomplished using Schalks modification of Hewe's numbers to provide a minimum estimate. Beiningen (1976) provided data on the percentage that each species contributes to the total production and average weight of each species, including:

Species	% of run	Ave wt (lbs)
Chinook	42	18.5
Coho	14	8.9
Sockeye	7	3.5
Chum	11	12.2
Steelhead	25	7.3

Assuming that the number of each species caught would be in proportion to their level of production; the total Indian catch was converted to numbers of each species of fish by multiplying total number of pounds caught (44,100,000) by the percentage of the run and then dividing by the average

weight for each species. The resulting catch is:

Species	No. harvested by Indians
Chinook	994,310
Coho	668,956
Sockeye	875,958
Chum	394,899
Steelhead	1,499,920
Total	4,434,051

To calculate the number of fish harvested for the Upper Columbia Basin required an adjustment of Beiningen's figures because no chum and few coho migrate into this area (Fulton 1968; 1970). The figures presented below are suggestions taking into account the observations of Craig and Hacker (1940), Bryant and Parkhurst (1950), Fulton (1968; 1970) and Fulton and Laird (unpublished manuscript), who conducted fish surveys in the upper Columbia Basin.

Species	% of Upper Columbia run	Ave. weight
Chinook	55	18.5 lbs
Coho	4	8.9 lbs
Sockeye	7	3.5 lbs
Steelhead	31	7.3 lbs

The Indian catch of each species was estimated by multiplying the total annual upriver consumption (6,879,500 lbs) by the decimal percentage and dividing the resultant number by the appropriate average weight. The catch was estimated:

Species	No. harvested by Upper Columbia Tribes
Chinook	205,523
Coho	129,462
Sockeye	131,110
Steelhead	278,384
Total	644,469

The figure of a total harvest of 644,000 salmonids calculated on the basis of protein and caloric requirements seems large compared to a total harvest of 300,000 salmonids estimated from historical observations of the catch. These figures can be reconciled according to the following line of reasoning:

(1) The catch estimate was based on available data from historical records at Kettle Falls and two sites on the Spokane River (Little Falls and the Little Spokane River). It did not include at least one additional important site on the Spokane River (at Spokane Falls), the San Poil River, and numerous other locations because no quantified estimates could be found for these locations. Therefore, the estimate of harvest based on historical records should be considered minimal; and

(2) The catch estimate was based on summer catch which consisted principally of chinook, coho, sockeye and a few steelhead. It did not include a late winter/spring fishery for steelhead which was known to occur. The consumption based estimate took this into account. The catch of chinook, coho, and sockeye estimated from protein and caloric requirements totalled 366,085 fish which compares very favorably with the 300,000 estimated from historical records of catch.

Therefore, the consumption based estimate of catch of approximately 644,000 fish represents the most reasonable figure for the Upper Columbia Basin annual catch. It is important to recognize that this figure represents the loss to the tribes living above Grand Coulee Dam so, in a sense, it defines the minimum level of mitigation and compensation that should occur above Grand Coulee Dam. A similar calculation based on Walkers (1985) estimates yielded an annual catch of 1.1 million fish in the Upper Columbia River above Grand Coulee, so the 644,000 fish should be thought of as a conservative estimate.

3.3 ESTIMATE OF THE TOTAL RUN SIZE OF SALMON AND STEELHEAD IN THE COLUMBIA RIVER SYSTEM BEFORE MAJOR DEVELOPMENT OCCURED.

The total run size of salmon and steelhead in the Columbia River System, before being impacted by the hydroelectric power supply system and before major development occurred in the Columbia Basin has been estimated using a variety of techniques.

The "base run" estimates of Junge (1980) and Chapman et al. (1982) evaluated run losses by comparing run sizes for the period just before the onset of extensive hydropower development initiated by McNary Dam (i.e., 1938-1958) with the mid 1970's. They used catch (i.e., commercial landings) plus escapement (i.e., fish count at Bonneville Dam) data from 1938-1958 to develop stock-recruitment functions (Ricker 1975) that established a mean run size at an escapement leading to a maximum equilibrium yield. This method produced a "base run" estimate of 200,000 spring chinook, 160,000 summer chinook, 300,000 fall chinook, 260,000 steelhead, 28,200 coho, and 208,000 sockeye for a total of 1,167,500 adult fish.

These values are considerably less than the maximum reported catch of each of these species totalling 8.2 million adult fish (Craig and Hacker 1940; Columbia River Fisheries Project 1976) as indicated in the Table 3.5. Therefore, it is unlikely that "base run" estimates of Junge and Chapman are an accurate reflection of the magnitude of the historical total adult run size.

Moreover, the Northwest Power Act directs the Northwest Power Planning Council to address losses caused by *"the development and operation of any hydroelectric project on the Columbia River and its tributaries."* The methods of Junge and Chapman et al. do not address all losses because no accounting was made by Junge or Chapman et al. for losses for dams constructed before 1938; e.g., Rock Island, Bonneville and Grand Coulee Dams on the mainstem of the Columbia River and several hydropower dams located on the Spokane River that were constructed in the late 1800's and early 1900's.

Table 3.5. Comparison of Junge (1980) and Chapman et al. (1982) base run estimates with the maximum commercial catch reported for each species (NPPC 1985)

Species	"Base run estimate"	Maximum catch
Spring Chinook	200,000	1,150,000
Summer Chinook	160,000	2,300,000
Fall Chinook	300,000	1,150,000
Sockeye	208,000	1,300,000
Coho	28,200	890,000
Chum	No data	697,000
Steelhead	260,000	674,000
Total[1]	1,167,500	8,161,000

1. Covers period from 1938 to 1958.
2. Covers period from 1866 to 1940.

This was because stock/recruitment methodology of Junge and Chapman could not be employed before 1938 since required data were not available before 1938. It should also be emphasized that many fisheries biologists working for the state and federal fisheries agencies recognized that the "base-run" calculation probably underestimated the loss by a large amount because: (1) The Ricker model is unlikely to be the most appropriate model for chinook and steelhead (Hilborn 1984); (2) dam counts, the basis for constructing stock/recruitment curves, depend on the counter's ability to accurately identify the species and correctly assess the number of fish moving through a fish ladder. On numerous occasions where this type of counting has been evaluated it has been shown to be inaccurate (see Section 4.5.3). In a sense these counts are equivalent to historical information; and (3) dam counts also depend on the efficiency of the fish ladder for attracting fish into them. Many of the early fish ladders on the Columbia River system had problems and required modification, so we feel that many more fish may have been present than were actually counted, and that dam counts tend to be biased toward a lower number of fish.

Bonneville Power Administration (1984) indicated that *"historical estimates put the annual Columbia salmon and steelhead run as high as 350 million eight decades ago."* This number seemed to be unrealistically high. Subsequently, in attempting to locate the source of this number, BPA officials were contacted and they indicated that the published number was not accurate -- one too many zero's had been added, so the figure should actually be 35 million (Sharon Blair, pers. comm.). Ms. Blair indicated that the source of this figure was a publication by Tollefson and Murrat (1959), with additional material from Rich (1920), and a rough calculation based on the total catch of salmon in fish wheels, and the assumption that fish wheels took five percent of the total run (Donaldson and Cramer 1971). BPA has recently reprinted the above document and replaced the 350 million figure with a figure of 35 million.

The Pacific Fishery Management Council (1979) estimated the total annual production of salmon and steelhead (NPPC 1985) in the Columbia Basin, based on the amount of available spawning and rearing habitat, at approximately 8.3 million adults:

Species	Estimated number of adults produced annually
Chinook	3,440,000
Coho	1,201,000
Sockeye	650,000
Chum	950,000
Steelhead	2,042,000
Total	8,283,000

This was considered to be a conservative estimate. For example, their total of 8,283,000 fish compares to a combined maximum catch of all species of 8,161,000. Since the total run size is equal to the catch plus spawning escapement, and since escapememt ranges between 1/3 and 2/3 of the total run size -- the habitat based figures appear to be too low. The catch component of the total run size has been variously estimated at 33 percent (Robinson 1957), 50% (Chapman et al. 1982) and 66% (Koch 1976). These numbers were used to compute the range in run size for each species as indicated in Table

3.6. Thus, an estimate of the total run size based on maximum catch provides an estimate of approximately 12 million to 24.7 million fish. The 33% catch rate seems unrealistically low given that these were maximum catches. A reasonable figure for the average total run would lie between the 12 million and 16.3 million figures.

Different estimates of the total adult run size of the Columbia River are summarized in Table 3.7. Since there is little overlap in the spawning areas of different species of Pacific salmon in the Columbia Basin (Craig and Hacker 1940; Chapman 1941; Rich 1948; Bryant 1949; Bryant and Parkhurst 1950; Bryant et al. 1950; Parkhurst 1950; Lavier 1976; Fulton 1968, 1970; Fulton and Laird, unpublished manuscript); and since the behavior of fry and fingerlings of each species is different (reviewed by Hoar 1976; Hasler and Scholz 1983) thereby minimizing overlap in rearing habitat, it seems reasonable to speculate that the habitat could have supported maximal numbers of each species in its pristine state. In this connection, since maximal catches reflect the actual potential of the habitat for producing salmon, it appears that the catch based estimate offers the best approximation of the total adult run size before significant developments occurred. The mean (14.2 million) of the range (12-16.3 million) is a reasonable estimate of the total adult run size.

3.4 ESTIMATE OF THE RUN SIZE INTO THE UPPER COLUMBIA BASIN BEFORE MAJOR DEVELOPMENT OCCURRED.

The run size into the Upper Columbia Basin was estimated by calculating the escapement for a computed catch of 644,000 fish. Using the catch rates for each species in the upper basin above Grand Coulee (See Section 3.2), and values of 33% (Robinson 1957), 50% (Chapman et al. 1982) and 66% (Koch 1976) to compute the catch proportion of the total run (See Section 3.3), the run size for each species into the Upper Columbia Basin is estimated and shown in Table 3.8.

This estimate of the run size above Grand Coulee Dam ranges between approximately one and two million fish. If the figure for the 33% catch rate is ignored to conform to the methodology used to estimate the total run size, the mean (1.1 million) of the range (976,00 - 1.3 million) is a reasonable estimate for the run size above Grand Coulee. Since passage of salmon is totally blocked by Grand Coulee and Chief Joseph Dams, the loss in the Upper Columbia is about 1.1 million fish. Note, however, that since the aboriginal catch was probably not reaching the maximal levels attained in the commercial fishery, the 33% catch to escapement ratio might provide a more accurate reflection of the run size (1.9 million fish). In this sense, the 1.1 million fish calculation should be considered a conservative estimate. Also, if Walkers (1985) figures for the catch are used, the run into the Upper Basin would be on the order of 1.6 million.

3.5 PERCENTAGE OF THE TOTAL RUN MIGRATING TO THE UPPER COLUMBIA BASIN ABOVE GRAND COULEE DAM.

The percentage of the total run migrating above Grand Coulee Dam was estimated by computing the ratio of the total run size (Section 3.3) to the

Table 3.6. Estimate of total run size based on maximum catch at three different catch/escapement ratios.

	Maximum catch	Run size range: Catch=66%	Catch=50%	Catch=33%
Chinook	4,600,000	6,969,000	9,200,000	13,939,000
Sockeye	1,300,000	1,969,000	2,600,000	3,939,000
Coho	890,000	1,328,000	1,728,000	2,696,000
Chum	697,000	1,004,000	1,394,000	2,112,000
Steelhead	674,000	1,006,000	1,348,000	2,042,000
Total	8,161,000	12,003,000	16,322,000	24,728,000

Table 3.7. Summary of different techniques used to estimate adult run size.

Source	Estimated adult run size (approximate)
Junge/Chapman Base Run Estimate (after 1938)	1.2 million
BPA	35 million
Habitat Based Estimate (PFMC + NPPC)	8.2 million
Catch Based Estimate	12 to 16.3 million
Average	14.5 million

Table 3.8. Estimates of total run size into the Upper Columbia Basin based on aboriginal catch rates.

Species	Estimated harvest	Run size range: Catch=66%	Catch=50%	Catch=33%
Chinook	205,523	311,398	411,046	622,796
Coho	29,462	44,639	58,924	89,278
Sockeye	131,110	198,636	262,222	397,303
Steelhead	278,384	421,793	556,768	843,587
Total	644,469	976,468	1,288,938	1,952,936

Upper Columbia run size (Section 3.4) for each species (Table 3.9). Eight percent of the total run was bound for the area above Grand Coulee. If Walker's (1985) figures are used about 14% of the total run migrated to the upper portions of the Columbia.

8-14% of total run.

This is a minimum estimate of the percentage of the total run that can be attributed to the Upper Columbia Basin for two reasons:

(1) The Upper Columbia run-size estimate did not include fish bound for the Upper Columbia that were caught below Grand Coulee. Inclusion of these fish would have increased the escapement to the upper river; and

(2) The total run size was based on a maximum catch in the commercial fishery whereas the upper Columbia run-size is based on a minimum estimate of consumption and, therefore, likely to underestimate the upriver catch by a wide margin.

Another way that the Upper Columbia run can be compared to the total run is to compute the ratio of the number of salmon harvested by the upriver tribes to the total harvested by the entire aboriginal fishery. This comparison has the advantage of treating catches throughout the Basin in a uniform fashion. However, it also makes the assumption that the Indian catch before development occurred in the Columbia Basin is an accurate reflection of the pattern of the run. The percentage of each species caught (by number and weight) in the Upper Columbia Basin (above Grand Coulee) compared to the entire Columbia and Snake River system are summarized in Tables 3.10 and 3.11.

These results, which indicate that about 14% of the entire catch was taken above Grand Coulee Dam, are consistent with what is known about the relative amounts of spawning and rearing habitat available in different reaches of the Columbia River System (Craig and Hacker 1940, Chapman 1941, Rich 1948, Bryant 1949, Bryant and Parkhurst 1950; Parkhurst 1950 a-c, Lavier 1976, Fulton 1968, 1970; Fulton and Laird unpublished manuscript). Overall the Upper Columbia River provided approximately ten to fourteen percent of the spawning and rearing areas for the anadromous fishery of the Columbia and Snake River drainages Craig and Hacker 1940; U.S. Bureau of Reclamation 1976; Koch 1976). Walkers (1985) figures for total aboriginal catch and upriver aboriginal catch indicate that approximately 24% of the entire catch was taken above Grand Coulee Dam.

14-24% of entire catch was @ GCD

Table 3.9. Comparison of the total run size to the Upper Columbia River run size.

Species	Total run size	Upper Columbia run size	Percentage migrating to Upper Columbia
Chinook	8.1 million	.4 million	5%
Sockeye	2.3 million	.2 million	8%
Coho	1.5 million	.05 million	3%
Steelhead	1.2 million	.5 million	41%
Total[1]	13.1 million	1.1 million	8%

1. Excludes chum.

Table 3.10 Percentage by number of total catch taken by tribes above Grand Coulee Dam.

Species	Total no. harvested by Indians in Columbia and Snake system	Total no. harvested in the Upper Columbia Basin (above Grand Coulee)	Percent harvested in Upper Columbia Basin (above Grand Coulee)
Chinook	994,310	205,523	20%
Coho	668,956	29,462	4%
Sockeye	875,958	131,110	14%
Chum	394,899	0	0%
Steelhead	1,499,920	278,384	18%
Total	4,434,051	644,469	14%

Table 3.11 Percentage by weight of total catch consumed by tribes occupying the territory above Grand Coulee Dam (values from Table 3.1).

Estimated total annual consumption by Columbia Basin Tribes:	44,126,900 lbs
Estimated annual consumption by Upper Columbia Tribes above Grand Coulee:	
Colville (Kettle Falls)/Sanpoil[1]	2,000,000 lbs
Coeur d'Alene	789,600 lbs
Kalispel	789,600 lbs
Kootenai	1,154,400 lbs
Lakes[1]	600,000 lbs
Pend Oreille/Flathead[1]	197,100 lbs
Spokane	1,353,800 lbs
Total	6,984,500 lbs
Percentage of fish consumed in the Upper Columbia Basin above Grand Coulee (based on pounds of fish consumed).	14%

1. These values represent best guesses from data provided in Hewes' table.