A Preliminary Estimate of the Value of Snake River Fish Runs

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by

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Introduction

Since 1938 anadromous fish have had to navigate past the dams on the Columbia and Snake Rivers. The U.S. Army Crops of Engineers has maintained fish ladders and counting facilities at these dams, and has provided an annual count of the numbers of fish by major species since 1938[1]. The U.S. Army Corps of Engineers has contracted with the Washington Department of Wildlife to do fish counting. The species of fish counted and included in this study include chinook and sockeye salmon, and steelhead trout. Over the years the number of fish counted annually has varied greatly. This variation is related to a number of factors such as the cycle of spawning, river and ocean conditions, and a number of other factors which are not well understood. Among these factors is the ability of particular species to respond to changing environmental conditions. These environmental conditions include both fresh water and salt water factors. In the fresh water situation, spawning habitat, downstream and upstream fish passage, and the mainstream predation environment, and the fresh water harvest are all factors to be considered. In the salt water environment the off shore ocean fishery, El Nin'o, and predation are factors. Additionally, some mature fish return to spawn after one year (jacks), some after two years, some after 3 years, some after four years, and some after 5 years. This variability is reflected in the fish counts and appears as the peaks and valleys on the charts which follow.

Fish Passage

Since 1938 fish passage for anadromous fish have been counted annually at each dam. A linear trend was computed for each species and dam from the year the reservoir was filled until 1993. The linear regression equations in some cases do not fit the data in a satisfactory manner. The regression coefficients that use time as an explanatory independent variable do not explain all of the variation in the data. This is evident in the great variability shown in the annual fish passage numbers. The regression coefficients tend to improve dramatically for the upstream dams. This occurs as the slopes of the trend lines become steeper. Specifically, the regression coefficients at Bonneville Dam were: 1) 0.03 for chinook salmon; 2) 0.50 for sockeye salmon; and 3) 0.38 for steelhead trout. At the Ice Harbor Dam the regression coefficients were: 1) 0.57 for chinook salmon; 2) 0.85 for sockeye salmon; and 3) 0.53 for steelhead trout. At Lower Granite Dam the regression coefficients were: 1) 0.04 for chinook salmon; 2) 0.83 for sockeye salmon; and 3) 0.70 for steelhead trout.

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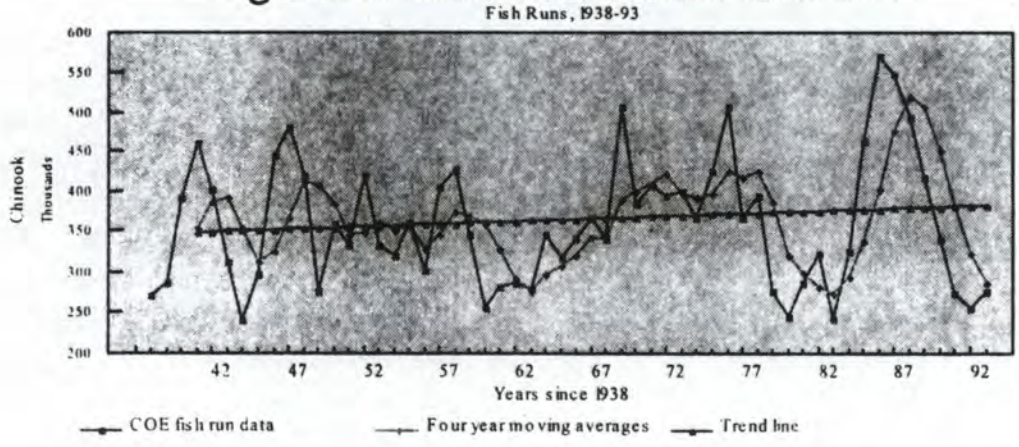
[1] U.S. Army Corps of Engineer District. "1990 Annual Fish Passage Report: Columbia and Snake Rivers for Salmon, Steelhead, and Shad." North Pacific Division Corps of Engineers, 1990.

The peaks and valleys of the graphs presented in figures 1 though 9 tend to decrease as one moves upstream, however on a relative basis the distance between the peaks and the valleys increases. Therefore, on the Snake River the variability is much greater than it is on the Columbia River. This variability is in some cases 6 or 7 times that of the lowest fish passage numbers reported. A great deal of this variability is also related to the spawning phenomenon discussed above. The chinook and steelhead fish runs passing the Columbia River dams have showed an upward trend since 1938. The fish runs for sockeye salmon show a downward trend over this same time period. At the Snake River dams the chinook and sockeye salmon both show a strong downward trends, while the steelhead trout show a strong upward trend. The sockeye and chinook salmon which showed a strong down trend on the Snake River had relatively higher regression coefficients. The steelhead trout showed increasing regression coefficients for all the dams evaluated in this study.

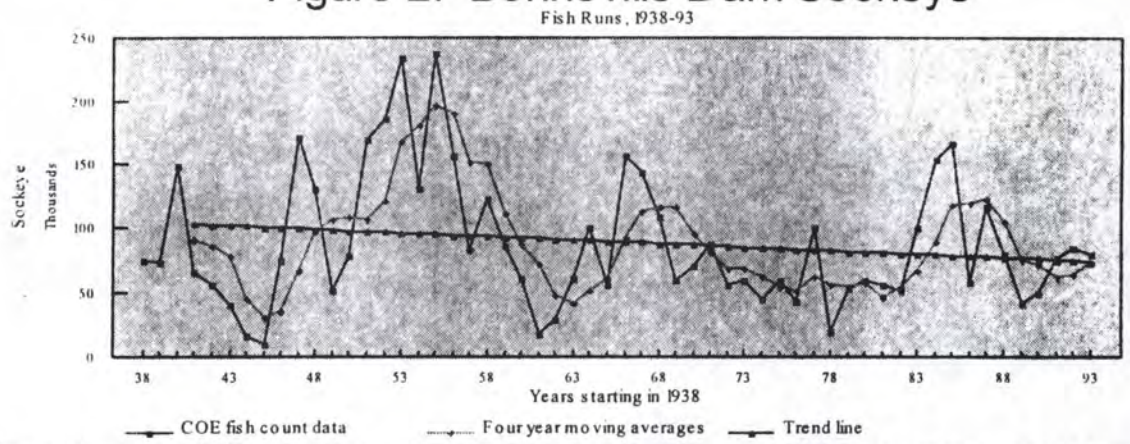
The run pattern for chinook salmon on the Columbia River over Bonneville Dam shows an slight increasing trend over the 55 year period that fish have been counted. Figure 1 shows both the Corps of Engineers annual fish run data, the four year moving average, and the trend line for the chinook fish runs since 1942. The year to year variability is great as evidenced by the peaks and valleys over the 55 year time period. The annual fish runs seem to have varied greatly over time with the amplitude of the peaks and valley's ranging from 240,000 to a high of 571,000 fish. The rate of increase over this period based on the trend line was 0.2 percent per year. The trend line analysis showed an increase from 347,764 to 381,044 chinook salmon over the 51 year time period. The obvious conclusion is that the upper Columbia River chinook fishery has held its own with the help of the hatcheries and improved fish passage over the years that the dams have been in place.

Figure 1. Bonneville Dam Chinook



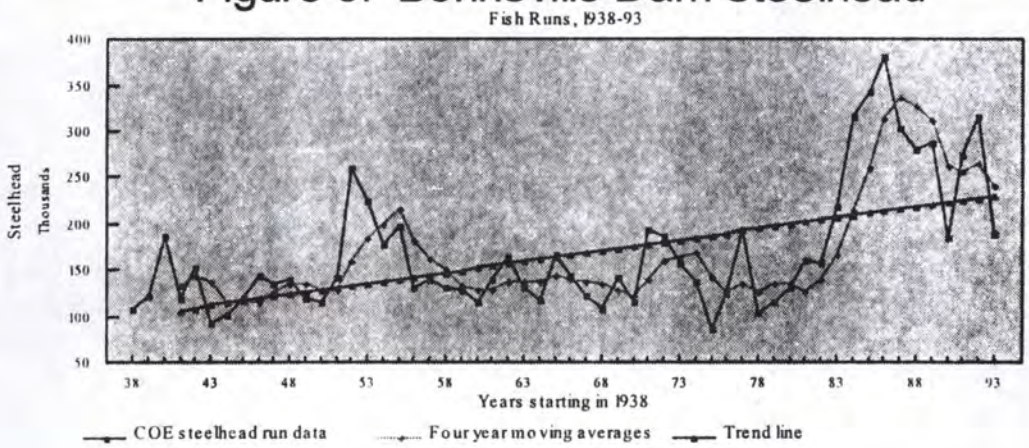
The run pattern for sockeye salmon on the Columbia River show a declining pattern since 1938, see figure 2. The decline as measured at Bonneville Dam is approximately 20 percent over the 55 year period. The variability in sockeye fish runs ranges from a low of 9,501 in 1945 to a high of 237,748 in 1955 and 235,215 1953.

Figure 2. Bonneville Dam Sockeye



Since the mid 1950's these runs have been in a long term decline. There have been short periods of highs and lows since then, but the range has been narrowed, and none of the recovery periods have exceeded 170,000 fish on an annual basis. The average rate of decline of the Sockeye as measured at Bonneville dam has been -0.6 percent according to the trend analysis.

Figure 3. Bonneville Dam Steelhead

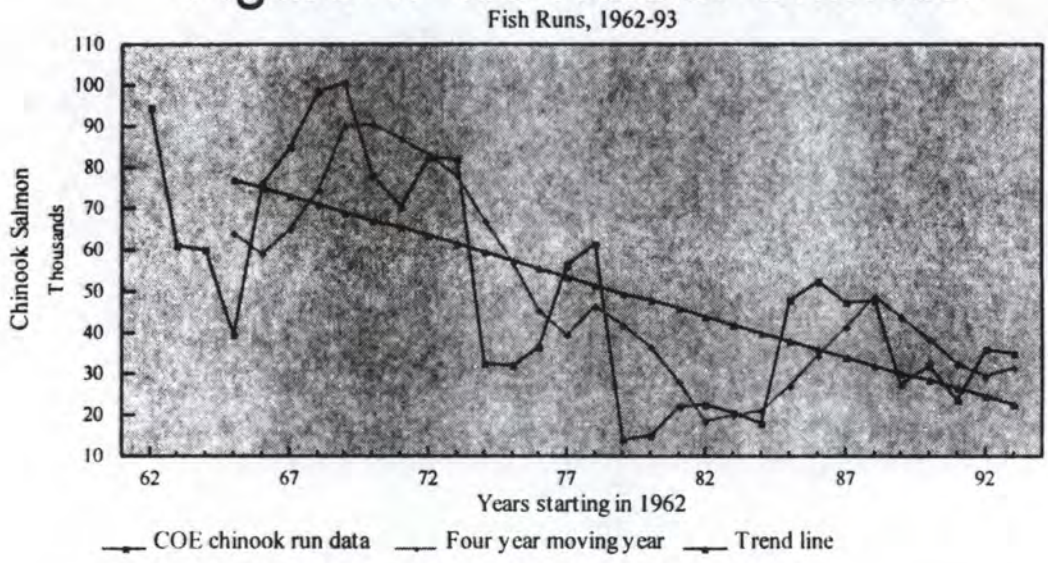


The annual tally for steelhead begins at slightly over 100,000 fish in 1938 at Bonneville Dam and increased to almost 230,000 fish in 1993. The average rate of increase at Bonneville Dam was 4.1 percent over the 51 year period. The variability in annual fish count numbers ranged from a low of approximately 80,000 fish in 1975 to a high of almost 380,000 fish in 1985. There appears to have been along term decline from 1938 to 1978, and a significant recovery after 1978 at Bonneville Dam. This recovery seems to correlate reasonably well with the time that the Ahsaka Fish Hatchery began producing fish.

The anadromous fish runs on the Snake River tend to be significantly different than those on the Columbia River based on the trend line estimates. At Ice Harbor Dam, the trend estimate was 76,899 for chinook salmon in 1962 and decreased to 22,355 fish

in 1993, this represents an average rate of decline in returning fish of -025 percent. Over all there has been approximately a 70 percent decline in chinook salmon runs over Ice Harbor Dam as estimated by the trend line between 1965 and 1993. This decline has occurred mainly on chinook stocks on the Tucannon River in eastern Washington.

Figure 4. Ice Harbor Chinook



The last Sockeye counted over Ice Harbor Dam was counted in 1989, and this was also true for the other upriver dams. The sockeye salmon appears to have disappeared from the Snake River, and may truly be an endangered species. The graph of fish run data speaks clearly as to what has happened to the sockeye salmon. The trend analysis indicated that there were only 710 fish returning to spawn and since 1988 the expectation is that none will return. The rate of decline at Ice Harbor dam was -4.0 percent over 28 years.

The same pattern set for sockeye salmon was followed at Lower Granite Dam (1975-1993) over the period of time that it has been in operation. The rate of fish loss at Lower Granite dam averaged -6.8 percent over the 15 year time period. It appears that the sockeye runs in Idaho are history . The last fish over Lower Granite Dam was counted in 1989.

The steelhead runs over Ice Harbor Dam have tended to increase over the period from 1962 until 1993 as show in figure 6. The trend line based on the four year moving averages begins with 39,131 fish in 1962 and increases to 98,939 fish in 1993.

Figure 5. Ice Harbor Dam Sockeye

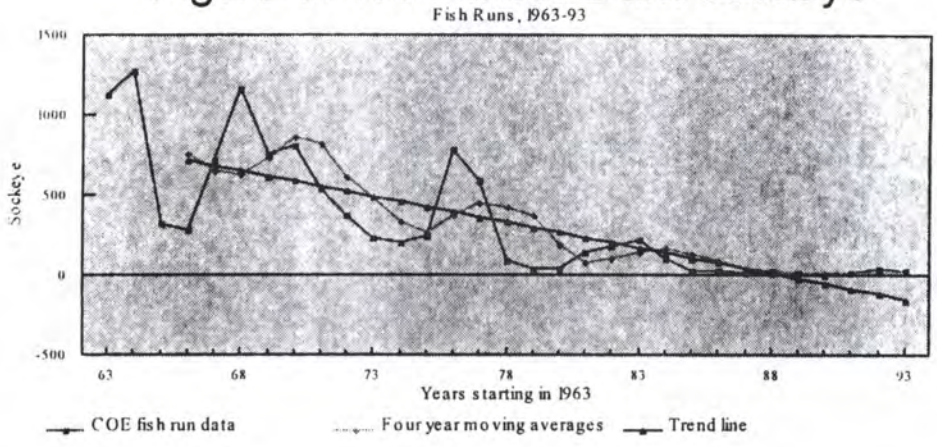
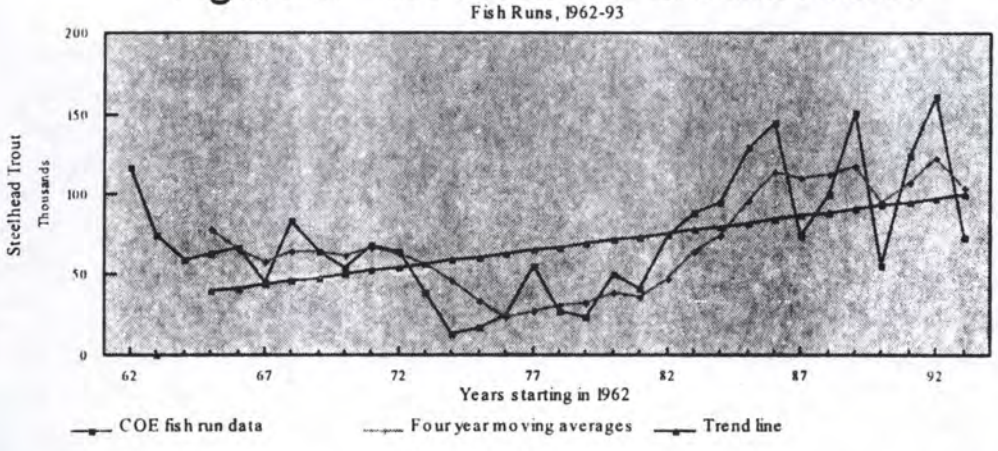


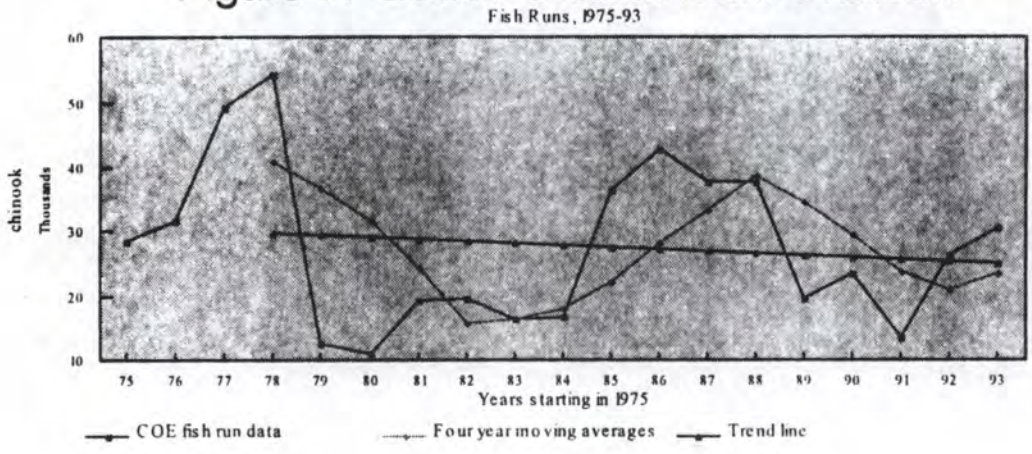
Figure 6. Ice Harbor Dam Steelhead



The rate of increase in steelhead trout averaged 10.6 percent over the 28 year period. The actual fish counts declined from 1962 to a low of 12,528 fish in 1974, but since 1974 the number of fish returning to spawn has been on an increasing trend. The maximum number of steelhead counted over Ice Harbor Dam occurred in 1992 with over 160,000 fish passing the dam.

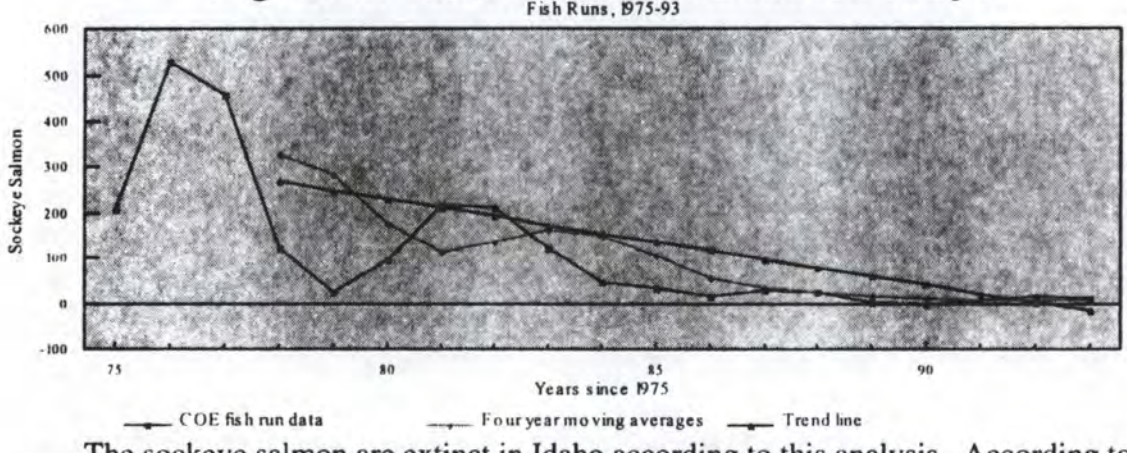
The pattern of chinook salmon counts at Lower Granite Dam follow those at Ice Harbor Dam, however, the trend in fish numbers is down, but at a much lower rate than at Ice Harbor. The trend estimate was 29,749 chinook in 1978, and had declined to 24,964 in 1993. The downward slope of the trend line indicates that there has been a problem with fish passage between Lower Granite Dam and Ice Harbor Dam. In addition to the Lower Granite Dam the chinook salmon also have to pass two other dams down stream besides Ice Harbor Dam on the lower Snake River. These are Lower Monumental Dam and Little Goose Dam. The chinook salmon (and all other anadromous fish passing Lower Granite Dam) have to pass eight dams total to get to their spawning reds, or to the fish hatcheries.

Figure 7. Lower Granite Dam Chinook



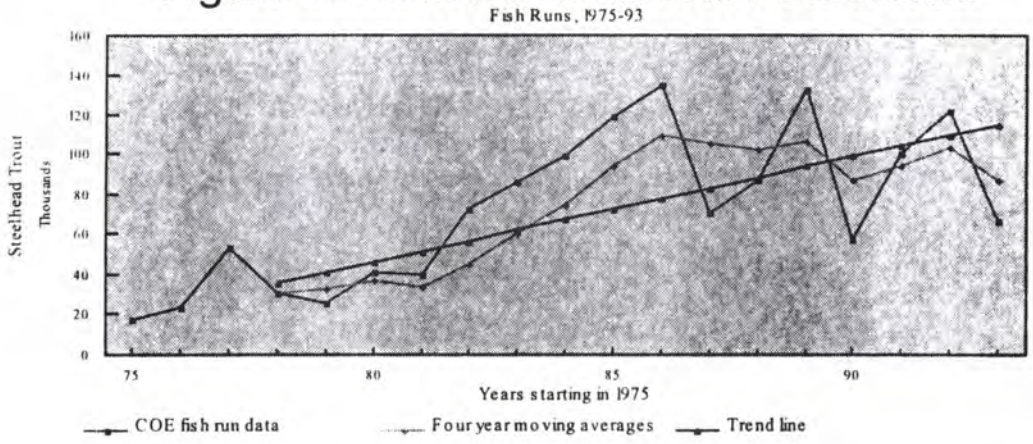
The rate of decline in chinook salmon at Lower Granite Dam has averaged -0.01 percent over the 15 year period for which the trend was measured. This rate of decline was considerably less than that experienced at Ice Harbor Dam. It indicates that the chinook salmon have been able to maintain their numbers upstream of Lower Granite in Idaho, Oregon, and Washington, than they have on the Tucannon River which is down stream from Lower Granite Dam.

Figure 8. Lower Granite Dam Sockeye



The sockeye salmon are extinct in Idaho according to this analysis. According to the trend line estimate, there were only 269 fish passing Lower Granite Dam in 1978, and this compares to 326 fish passing Ice Harbor Dam. The loss due to upstream fish passage amounts to over 17 percent or approximately 8 percent at each dam between Ice Harbor Dam and the Lower Granite Dam. The rate of decline for sockeye salmon passing Lower Granite Dam was estimated average -6.8 percent annually for the 15 years measured by the trend analysis.

Figure 9. Lower Granite Dam Steelhead



The case for the Lower Granite Steelhead is very different that that for either the chinook or sockeye salmon. The steelhead trout are obviously able to adapt to the changed river and fish passage conditions much better than the other species. The trend line estimate in 1978 was 35,416 fish and in 1993 that had increased to 114,736 fish. This amounts to a 324 percent increase in the number of steelhead over a 15 year period. The average annual rate of increase was estimated to be 24.2 percent, an impressive accomplishment. If one looks at the dispersion of data around the trend line it is also obvious that the over all trend has been upward over this time period. This time period also corresponds to the time when the Ashaka Fish Hatchery was brought into full production. In the case of steelhead it is evident that the hatchery process works very successfully.

The pattern of fish migration on the Columbia and Snake rivers needs to be interpreted in light of the many changes which have occurred over the 55 years or more that the river system has been operated. These changes include the development of irrigation, the addition of dams to the river system, population growth in the region, increased timber harvest levels, and the expansion of the river as a recreational resource. It also reflects an increasing reliance on fish hatcheries to supply fish to the river system to make up for the short fall of natural fish production. This is especially clear in the case of the chinook salmon and the steelhead trout. The development of fish hatcheries for these species has contributed more than half of the fish counted, and does indicate a severe decline in native wild fish stocks for these species. It is also evident that these fish stocks have been able to maintain themselves in spite of the environmental insults they have suffered over the 55 year period that the dams on the Columbia and Snake rivers have be constructed and operated.

The slope of the trend lines for steelhead trout passing the upstream dams tends to reflect the impact of hatcheries, spills, and barging. It is interesting that the chinook returning to Idaho have declined less than 10 percent between 1978 and 1993 as measured by the trend line as shown in figure 9. This should be compared with the more

than 70 percent decline in chinook salmon counted at Ice Harbor dam. It the trend estimates for 1978 at both dams are compared for chinook salmon, the estimate was 51,575 at Ice Harbor Dam, and 29,749 at Lower Granite Dam. It is clear that most of the fish lost on the Snake River have been lost between Ice Harbor Dam and Lower Granite Dam. The major losses seem to have occurred on the Tucannon River in eastern Washington.

The ultimate question that needs a short term answer is, can these fish species continue to maintain themselves with the same level of support which has been historically provided? The answer to this question is not clear. What is clear is that without the supplemental support of fish hatcheries, barging, and improved fish passage facilities the current stocks of these fish would be much smaller. In fact it is most likely that the other species would have gone the way of the sockeye salmon on the Snake River.

Estimated Value of Columbia and Snake River Fisheries

The question arises as to the worth of these fish which are part of the natural environment, and which existed prior to the building of the dams on these rivers. This question has become even more pressing with the threat of naming some of these fish endangered species. Arguments are being made that the economic losses from the strategies being proposed far outweigh the value of these fish, but little evidence is presented on the side of the fish. The approach will be to estimate the value of the salmon and steelhead fisheries in the Snake River system. The approach used to estimate fishery value was based on the American Fisheries Society document entitled "Monetary Values of Freshwater Fish and Fish-Kill Counting Guidelines published in 1982. The "Monetary Values of Freshwater Fish Committee" and the "Pollution Committee" set forth procedures and estimated the value of each specie of freshwater

Table 1. Monetary Values of Colombia and Snake River Anadromous Fish, 1993.

Species	Weight lb.	Value* per lb. $	Value per fish $	Capitalized value $
Chinook Salmon	33	$4.96	$163.68	$4,092
Sockeye Salmon	10	$4.96	$49.60	$1,240
Steelhead trout	17	$4.96	$84.32	$2.108

Source: American Fisheries Society. "Monetary Values of Freshwater Fish and Fish-Kill Counting Guidelines." American Fisheries Society . Special Publication No. 13, 1982. These values were adjusted by the Producer Price Index to update the values from 1982 to 1993.

fish.[2] The values developed in the above study have been updated from 1982 to 1990using the producer price index. [3] The Value per fish are shown in Table 1 along with the average weight, the estimated value per fish, and the capitalized value per fish.

This latter value may be interpreted as that amount of money which would have to be set aside to generate the corresponding cash flow generated by the fish value. A four percent "social discount rate" was used to determine the capitalized value of these fishRecognizing that the choice of discount rate is arbitrary, and that one could argue for higher or lower discount rates, this discount rates should not be considered to be set in concrete, but rather as a first step in the process of determining the value of these fish.

The next step was to calculate the value of the fishery based on the numbers of fish shown in the Corps of Engineers fish count data. These values are shown in table 2 for Bonneville Dam. The values shown are based on the trend analysis for each species of fish over the time period covered by the fish counting procedure. The beginning and the ending values are shown in table 2 and the differences are were computed. At Bonneville Dam the trend for chinook salmon and steelhead trout was increasing, and that for the sockeye salmon was decreasing. The economic values were computed using the values in table 1. The changes in the fisheries over time have tended to be increasing in the aggregate. The total number of fish has increased from an estimated 567,865 fish in 1941 to 685,741 fish in 1993. This represents an overall increase of over 100,000 fish. Most of this increase can be credited to improvements in hatchery operation, and downstream fish passage operations.

The next point at which values were measured was at Ice Harbor Dam near the mouth of the Snake River. the whole Snake River Salmonoid fishery. The estimated annual value of the lower Snake river fishery in 1962/3 was $16.3 millions. The major contributors to this value were the chinook salmon and steelhead trout. The capitalized value of these fisheries in aggregate declined from $397.8 millions to $297.5 millions over the 30 year period. The major loss in value was that related to the decline in the number of chinook salmon in the river. The total number of chinook declined by 54,534 fish over this time period. What is interesting is because of the increase in the number of steelhead trout, the total number of fish has increased by over 4,500 in the same time period.

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[2] The Monetary Values of Freshwater Fish Committee and the Pollution Committee. "Monetary Values of Freshwater Fish and Fish-Kill Counting Guidelines." American Fisheries Society, Special Publication No. 13. 1982.

[3] USDA. "Agricultural Outlook." March 1992/AO-183.

Table 2. Estimated Value of Selected Columbia River Fisheries, 1941-93.

Dam / species	Year	The number of fish	Average value per fish	The annual value of fishery	The stock value of fishery*
			$	mil. $	mil. $
Bonneville					
Chinook	1941	348,133	$163.68	$57.0	$1,425.0
	1993	381,881	(same)	$62.5	$1,562.5
	Difference	33,748	NA	$5.5	$137.5
Sockeye	1941	103,126	$46.90	$5.1	$127.5
	1993	74,058	(same)	$3.5	$87.5
	Difference	(29,068)	NA	($1.6)	($40.0)
Steelhead	1941	106,562	$84.32	$9.0	$225.0
	1993	229,802	(same)	$19.4	$485.0
	Difference	123,240	NA	$10.4	$260.0
Totals	1941	567,876	NA	$71.1	$1,777.5
	1993	685,741	NA	$85.4	$2,007.5
	Difference	114,865	NA	$14.3	$230.0

* A four percent discount rate was used in this study.

The last dam to be considered is the Lower Granite Dam on the Snake River. Lower Granite dam is the gateway to Idaho and the upriver Oregon and Washington

Table 3. Estimated value of Selected Lower Snake River Fisheries, 1962-93.

Dam /species	Year	Average number of fish	Value per fish	The annual value of fishery	Stock value of fishery*
			$	Mil $	Mil. $
Ice Harbor					
	1962	76,889	$163.68	$12.6	$315.0
Chinook	1993	22,355	(same)	$3.6	$90.0
	Difference	(54,534)	NA	($9.0)	($225.0)
Sockeye	1963	710	$49.60	$0.4	$0.8
	1993	(0)	(same)	$0.0	$0.0
	Difference	(710)	NA	($0.4)	($0.8)
Steelhead	1962	39,131	$84.32	$3.3	$82.0
	1993	98,939	(same)	$8.3	$207.5
	Difference	59,808	NA	$5.0	$125.5
Totals	1962-3	116,730	NA	$16.3	$397.8
	1993	121,294	NA	$11.9	$297.5
	Difference	4,564	NA	$4.4	($100.3)

* A four percent discount rate was used in this study.

fisheries. The results of this analysis are interesting in that the chinook salmon runs over Lower Granite although declining over time are not nearly as reduced as those over Ice Harbor Dam. The value of the upstream Idaho, Oregon, and Washington fisheries are shown in table 4. In terms of stock value the chinook salmon have declined by about 20

Table 4. Estimated Value of Selected Upper Snake River Fisheries, 1978-93.

Dam /species	Year	The number of fish	Average value per fish	The annual value of the fishery	Stock value of the fishery*
			$	Mil. $	Mil. $
Lower Granite					
Chinook	1975	29,794	$163.68	$4.9	$122.5
	1993	24,964	(same)	$4.1	$102.5
	Difference	(4,830)	NA	($0.8)	($20.0)
Sockeye	1975	134	$49.60	$0.007	$0.2
	1993	(0)	(same)	$0.0	$0.0
	Difference	(134)	NA	($0.007)	($0.2)
Steelhead	1975	35,416	$84.32	$3.0	$75.0
	1993	114,736	(same)	$9.7	$242.5
	Difference	79,320	NA	$6.7	$167.5
Totals	1975	65,344	NA	$7.9	$236.6
	1993	139,700	NA	$13.8	$345.0

* A four percent discount rate was used in this study.

percent, from a high of $122.5 millions in 1978 to $102.5 millions in 1993. The annual value of the chinook fishery has declined from $4.9 millions to $4.1 millions. This should be compared to the loss at Ice Harbor dam which was approximately 70 percent.

In the case of the sockeye salmon the results are quite similar to those at Ice Harbor Dam. The number of sockeye passing Lower Granite Dam was even smaller that that for Ice Harbor Dam. The last sockeye passing Lower Granite Dam was counted in 1989. The loss in term of stock value was estimated at $0.2 millions, and in terms of annual value approximately $70,000.

The steelhead trout follow the pattern established at Ice Harbor Dam. The number of fish has increased over 300 percent. The net increase in stock value for steelhead was $167.5 millions, from $75 millions in 1978 to $242.5 millions in 1993. The annual value increased from $3.0 millions in 1978 to $9.7 millions in 1993. The main factor behind this increase is the Ashaka steelhead hatchery on the Clearwater River.

The situation for the Upper Snake River fish runs is markedly different that that for the Lower Snake River fish runs. In this case the changes are not as dramatic as they were for the lower Snake River fish runs. The chinook salmon runs are declining, but at a much slower rate than for the Lower Snake River. The loss of chinook between 1978 and 1993 amount to just under 5,000 fish during the 15 year period. The loss of sockeye was the same as that which occurred at Ice Harbor Dam because the final destination of the sockeye would have been in the upper reaches of the Salmon River drainage in central Idaho lakes. However, for the steelhead trout, an even more rapid increase was shown than that at the Ice Harbor Dam. Steelhead trout numbers increased by almost 80,000 fish during this period.

Washington upriver chinook, sockeye salmon, and steelhead trout pass this dam. The value of the Idaho fishery is shown in table 3. The estimated value of the Idaho fisheries was $236.6 millions in terms of its stock value, and it generates an annual flow of $9.5 millions. Again, the valuation of the and Sockeye runs is flawed in that the average estimated runs do not reflect these runs potential under alternative management scenarios.

Conclusions and Observations

The purpose of this paper was to attempt to develop a methodology for estimating the value of the Columbia River fisheries. The important conclusions to be drawn are: 1) that the aggregate fish runs on the Columbia River as counted at Bonneville Dam have tended to increase since 1941; 2) the fish hatcheries, spills, and transport systems which have been used to maintain the up river fish populations have worked reasonably well to maintain and enhance steelhead trout populations on the Snake River; 3) that the greatest loss of fish has occurred on the lower Snake River; and 4) that the sockeye salmon have virtually disappeared from the Snake River.

There is only one spawning stream between Ice Harbor Dam and Lower Granite Dam, the Tucannon River in Washington State, and the greatest loss of fish is undoubtedly related to the loss of habitat on this river. From an environmental point of view, it is clear that the loss of the Tucannon fishery has been a serious blow to the lower Snake River fishery. The loss of over 50,000 chinook salmon on their spawning journey between 1962 and 1993 needs further research.

This study concludes that the aggregate value of the Columbia River fisheries has increased since the Bonneville Dam was built. It is also true that most of this increase has resulted from the mitigation in terms of hatcheries, barging, and fish passage improvements that have been added to the systems since 1938. In terms of the individual species between 1941 and 1993: 1) the annual value of the chinook salmon increased from $57 millions to $62.5 millions, 2) the annual value of sockeye salmon declined from $5.1 millions to $3.5 millions, and 3) the annual value of steelhead trout increased

from $9.0 millions to $19.4 millions. The net gains were: 1) chinook salmon, $ 5.5 millions, 2) sockeye salmon, a negative $1.6 millions, and 3) steelhead trout, $10.4 millions. The stock value of the individual fisheries also changed between 1941 and 1993 as follows. Chinook salmon increased by $137.5 millions from $1.425 billions in 1941 to $1.562 billions in 1993. The sockeye salmon's stock value declined by $40 millions from $127.5 millions in 1941 to $87.5 millions in 1993. The steelhead trout which showed the largest gain increased by $260 millions from $225 millions to $485 millions in 1993. The aggregate stock value of these fish runs estimated at Bonneville dam in 1993 was just over $2.0 billions, and the annual value generated was estimated to be $85.4 millions.

The situation on the lower Snake River is mixed in terms of the economic value of the fisheries. The chinook and sockeye salmon are in decline, while the steelhead trout are increasing in a significant way. The value of the chinook salmon on the lower Snake river has declined dramatically since 1965. The stock value of this fishery declined $225 millions, and the annual value by $9 millions between 1965 and 1993. In the case of the sockeye salmon the loss of stock value decline $0.4 millions and an annual value loss of $70,000. The steelhead trout runs however were increasing, and the stock value of this resource increased from $82 millions to $207.5 millions. The annual value of the steelhead runs increased from $3.3 millions to $8.3 millions. The aggregate stock value of the lower Snake River fish runs was estimated to be $297.5 millions in 1993, and this was decline of $100.3 millions from the situation in 1965. The annual value of the lower Snake river fisheries was estimated to be $11.9 millions in 1993, down $4.4 millions from 1965.

The upper Snake River fish runs that feed the Idaho, eastern Oregon and Washington fisheries are being maintained in a better form that those of the lower Snake River. The chinook salmon although in decline have not suffered as much as the lower Snake River chinook salmon. The stock value of this resource has declined from $122.5 millions to $102.5 millions since 1978. The annual value declined from $4.9 millions to $4.1 millions. The fate of the sockeye salmon on the upper river is the same as that for the lower Snake River. In the case of steelhead trout, again the resource is increasing. The stock value of the steelhead trout on the upper river has increased from $75 millions in 1978 to $242.5 millions in 1993. The annual value of the fishery increased from $3 millions to $9.7 millions over the same period. The aggregate stock value of the upper Snake River fisheries was estimated to be $345 millions in 1993, which was up $108.4 millions over 1978. The annual value of the fishery was estimated to be $13.8 millions in 1993, which was up $5.9 millions.

The general conclusion is that the aggregate value of these fisheries has increased since Bonneville Dam was completed. It is also true that most of this increase has resulted from the mitigation in terms of hatcheries, barging, and fish passage improvements that have been added to the systems since 1938. However, it is also clear that some individual species have not fared very well during the 55 years since the first dam was built. The sockeye salmon have been in decline on both the Columbia and

Snake rivers, and the chinook salmon have been in serious decline on the Snake River. Steelhead trout however have been increasing significantly on both river systems. It is clearly evident that some of the fisheries on the Columbia and Snake rivers have been impacted negatively by the development of the dams on these rivers. This negative impact has been mitigated by hatcheries, improved downstream fish passage, improved spawning habitat, and downstream barging of chinook salmon and steelhead trout. In the case of the sockeye salmon, the only hope may be to build hatcheries for these fish, if society wants to ensure their survival in the current river system. Further, if it is true as some environmentalists and fishery people have stated in public hearing and other places that in the current situation that 80 percent of the chinook and steelhead returning from the sea are hatchery fish, then it appears that the only reasonable solution in the short run is to continue to expand the hatchery process. A further comment is that the short run in this case may turn out to be longer than anyone is currently contemplating. Finally, this is not be construed as saying that society should give up on the nataurally spawning fish, but rather that it may take a very long time to achieve the situation in which most of the fish are wild.

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