A P P E N D I X

to Special Report on the

LOWER SNAKE RIVER DAMS

Ice Harbor
Lower Monumental
Little Goose
Lower Granite

Prepared by Fish Commission of Oregon as supplement
to report of National Marine Fisheries Service and
Bureau of Sport Fisheries and Wildlife, September 1972

Portland, Oregon

March 1973

APPENDIX B

Appendix to Special Report on Lower Snake River Dams

INTRODUCTION

The report entitled "Special Report on the Lower Snake River Dams, Ice Harbor, Lower Monumental, Little Goose, and Lower Granite" was submitted by the fisheries agencies to the Corps of Engineers in September 1972. The report concerns fish and wildlife compensation for the effects of these dams. It was prepared in response to Colonel Frank McElwee's April 11, 1966, letter to former Regional Director Paul T. Quick of the Bureau of Sport Fisheries and Wildlife.

We recognize that the report is difficult to follow for those not intimately connected with Columbia and Snake River fisheries problems. Consequently, we are supplementing the report with this appendix. In this appendix we shall demonstrate that use of the concept of "maximum" dam count to assess liability is justifiable. We shall show the levels of runs which should be maintained in the Columbia River system in order to counter the effects of dams constructed in recent years. This will be related to compensation being requested for the lower Snake River dams. We shall also give evidence of mortalities to adult salmonids resulting from the lower Snake projects which evidence was not available at the time the original report was prepared. We shall demonstrate that the dam counts which have seemingly held up favorably over the years are artifacts created by extensive curtailment of commercial fisheries to counter losses of adult fish passing dams. Finally, we shall demonstrate the serious impact of the main stem dams on our major fisheries.

ESTIMATE OF LOSSES DUE TO McNARY AND SUBSEQUENT DAMS IN COLUMBIA AND SNAKE RIVERS

In confining our attention to the more immediate effects of the four lower Snake River projects, we artificially fragment the broad picture and

tend to lose perspective. Dam construction occurring prior to the lower Snake projects has had a tremendous effect in depressing the Snake River runs. To base compensation at the four lower Snake River dams on these depressed levels is tantamount to ruining a man's business and then buying him out at a price far below its actual value. Most of this inequity and the resulting confusion in trying to measure it would not have occurred had it been possible to completely compensate for the effects of each dam at the time of completion. Prior to the current lower Snake River proposal, compensation for anadromous fish has been almost exclusively limited to restitution for runs completely blocked from spawning areas. Losses of adults and juveniles due to adverse passage conditions at and between dams have never been compensated for. That such losses do exist and are serious is well established by numerous studies by the fisheries agencies and the Corps.

In an effort to correct for these heretofore uncompensated losses in the entire Columbia River system, the fishery agencies early in 1971 requested an improved program to seek restitution. In a letter of February 22, 1971, General Roy S. Kelley (former Division Engineer of the North Pacific Division of the U. S. Army Corps of Engineers) suggested that a program for the mitigation of additional losses "should be initially formulated and recommended to us by the joint fishery agencies of the Northwest who possess expertise in these matters. We would then have a basis for documenting the severity of the problem, the justifiability of proposed measures, and should be in a sound position to make appropriate recommendations to higher authority in the Corps of Engineers and the Congress."

As a first step toward such a program, the Fish Commission of Oregon prepared what we include here as Appendix Tables 1 and 2. Appendix Table 1

demonstrates that following the completion of McNary Dam in 1953 and the ensuing construction of a series of major dams, adverse conditions severely reduced the productivity of the spawning escapement. To illustrate this, data on Columbia River salmon (spring chinook, summer chinook, and sockeye) and steelhead are tabulated for two periods:

(1) Pre-McNary-The Dalles brood years (1942-52) for which effects of Rock Island, Bonneville, and Grand Coulee dams were included.

(2) Post-McNary-The Dalles brood years (1957-67) which were additionally influenced to varying degrees by six dams on the Snake River and seven dams on the Columbia River (completed since 1957).

In Table 1, the measure of productivity for comparing the pre- and post-McNary periods is "return per spawner." To illustrate, if on the average one spawner produces one adult returning to the river 4 years later, the return per spawner is 1.0 and no harvest could be permitted if the run size were to be maintained. Moreover, if on the average each pair of spawners produces five adults returning to the river, the return per spawner would be 2.5, and three of each five fish or 60% of the run could be harvested and still maintain the run at the same level. We refer in the table to run size as a measure of "return" to the river and escapement as a measure of the "spawners."

The run size is the total number of adult fish returning to the Columbia River annually. It is estimated by adding the number of fish caught in the fisheries below Bonneville Dam to the Bonneville Dam count. Escapement is defined as the number of fish permitted to escape from the lower river fisheries, i.e., the numbers of fish passing over Bonneville Dam minus the commercial and Indian catches above Bonneville Dam. The term "escapement" used in this sense is meaningful since if upstream dams

Appendix Table I. Basic Columbia River Salmon and Steelhead Data for Estimating the Production Rates (return per spawner) for the 11 Brood Years Preceding the Completion of McNary Dam and the 11 Brood Years After the Completion of The Dalles Dam

Period	Parameter	Salmon: Spring Chinook	Salmon: Summer Chinook	Salmon: Sockeye	Summer Steelhead
Pre- McNary-The Dalles brood years (1942-52)	Avg escapement (1942-52)	52,400	37,900	49,100	95,600
	Avg run size (Salmon: 1946-56) (Steelhead: 1947-57)	187,300	105,100	195,900	259,600
	Return per spawner	3.57	2.77	3.99	2.72
Post-McNary-The Dalles 1/ brood years (1957-67)	Avg escapement (1957-67)	83,200	82,500	72,500	130,000
	Avg run size (Salmon: 1961-71) (Steelhead: 1962-72)	172,500	94,500	100,400	200,800
	Return per spawner	2.07	1.15	1.38	1.54

1/ *It should be noted that the production in these years was also influenced in varying degrees by other dams: Brownlee (1958), Priest Rapids (1960), Oxbow (1961), Rocky Reach (1961), Ice Harbor (1962), Wanapum (1963), Wells (1967), Hells Canyon (1967), John Day (1968), Lower Monumental (1969), and Little Goose (1970).*

kill a portion of the escapement (or a portion of the juvenile migrants) the return per spawner will measure this reduction.

Although there is some variation in the age of returning adult salmon and steelhead, we have used a return age of 4 years for salmon and 5 years for steelhead based on scale analyses. Under this set up, we have assumed that the salmon escapements from 1942 to 1952 produced the salmon runs returning from 1946 to 1956. Similarly for steelhead we relate the runs returning from 1947 to 1957 to brood year escapement from 1942 to 1952. Ocean catches for runs considered here are generally minor and are therefore not included. Ocean catches of Columbia River steelhead and sockeye are insignificant, and scale studies of ocean caught chinook indicate that the vast majority of these are fall chinook.

As already stated, our measure of productivity is "return per spawner" which is merely the run size ("return") divided by the escapement ("spawners"). The reduction in return-per-spawner values for recent years is rather dramatic for every species considered here. We might particularly draw attention to the "post" value for summer chinook of 1.15, recognizing that when the value drops below 1.0 the run is not even reproducing itself. Currently no direct fishery[1/] is permitted on this run although historically it was the single most important run in the Columbia.

To effectively regulate a fishery on anadromous species, it is important to determine the "optimum" or most desirable escapement needed to produce the greatest sustainable yield. By the late 1950's the accumulation of data from the fisheries and Bonneville counts supplied an excellent basis for estimating "optimum" escapement levels which were 80,000 each for spring

---

1/ *A few summer chinook are taken incidentally to the harvest of sockeye salmon.*

chinook, summer chinook, and sockeye salmon and 120,000 for summer steelhead (line 2, Appendix Table 2).

The optimum run (line 1 of Appendix Table 2) is estimated by multiplying the optimum escapements by the return per spawner for the pre-McNary period. These are the run sizes that could have been maintained if optimum escapement levels had been followed and if the series of dams starting with McNary had not been constructed. Optimum productions are maintained by harvesting the difference between run produced and escapement required. We refer to this harvest as the "optimum sustainable yield."

To estimate what our fisheries are now losing under current production we must estimate what yields can currently be maintained. As a starting point we have assumed in Table 2 (current period) that the magnitude of the runs maintained by the 1957-67 broods (Table 1) can still be maintained. It is not proper, however, to use the escapement values for this period, because increased adult losses particularly since the completion of John Day in 1968 required increased adult escapements from the fisheries to get the same number of adults to the spawning areas. Consequently average escapements for the years 1968 to 1972 have been used to represent the escapements in the current period in Table 2. As we have seen in studying the optimum condition, the current sustainable yield is the difference between the current run size and the current escapement.

Finally the average yearly loss to the fisheries from dams completed since 1953 may be estimated by subtracting the current yield from the optimum yield. It is of interest to compare these losses with estimated losses presented in the lower Snake River report, keeping in mind that the majority of the spring and summer chinook and summer steelhead runs considered in Tables 1 and 2 are produced by Snake River tributaries. Estimated

Appendix Table 2. Computation of Average Yearly Loss to Columbia River Fisheries Based on Difference between Optimum Yield 1/ and Current Yield

Period	Parameter	Salmon			
		Spring Chinook	Summer Chinook	Sockeye	Summer Steelhead
Pre McNary-The Dalles	Average optimum run	285,600	221,600	319,200	326,400
	Optimum escapement	80,000	80,000	80,000	120,000
	Optimum sustainable yield (difference)	205,600	141,600	239,200	206,400
Current	Average run >(Table 1)	172,500	94,500	100,400	200,800
	Average escapement >1968-72	115,400	74,800	68,700	129,800
	Average sustainable yield (difference)	57,100	19,700	31,700	71,000
Average yearly loss to fisheries (difference between yields)		148,500	121,900	207,500	135,400

1/ *Optimum yield is average yearly harvest that could have been taken by fisheries if McNary and subsequent dams had not been constructed.*

Snake River losses are 58,700 for spring and summer chinook combined while Columbia River losses are 270,400 (see Table 2, 148,500 spring chinook and 121,900 summer chinook). Estimated losses for Snake River summer steelhead are 55,100 compared to Columbia River losses of 135,400. Sockeye runs to the Snake River are small and no replacements have been requested for this species.

It is of interest to note that the average optimum run sizes (i.e., the run sizes that could have been maintained had McNary and subsequent dams not been built) given in Table 2 are reasonably close to the maximum run sizes since 1946 of 281,000 spring chinook (in 1955), 207,000 summer chinook (in 1957), 335,000 sockeye (in 1947) and 383,000 summer steelhead (in 1952). This illustrates why maximum rather than average run sizes during this period are representative of river potential. Average runs during this period were not representative. This largely resulted from an overharvest of the runs combined with a drastic translocation program following completion of Grand Coulee Dam.

In the Special Report on the Lower Snake River Dams, maximum counts since the completion of McNary Dam are used as estimates of representative runs in the pre-McNary period. For the Columbia River system we have seen that maximum runs are representative of potential river production. Consequently the use of "maximum" run does not subject the Corps to the responsibility for maintaining runs which nature would permit only on rare occasions. Rather the compensation program requested here in conjunction with compensation being requested for other projects in the Columbia basin will, if obtained, merely help us to approach yields of salmon and steelhead that could have been maintained on a sustained yield basis in the late 1940's and early 1950's and could still be maintained if these projects had not been constructed.

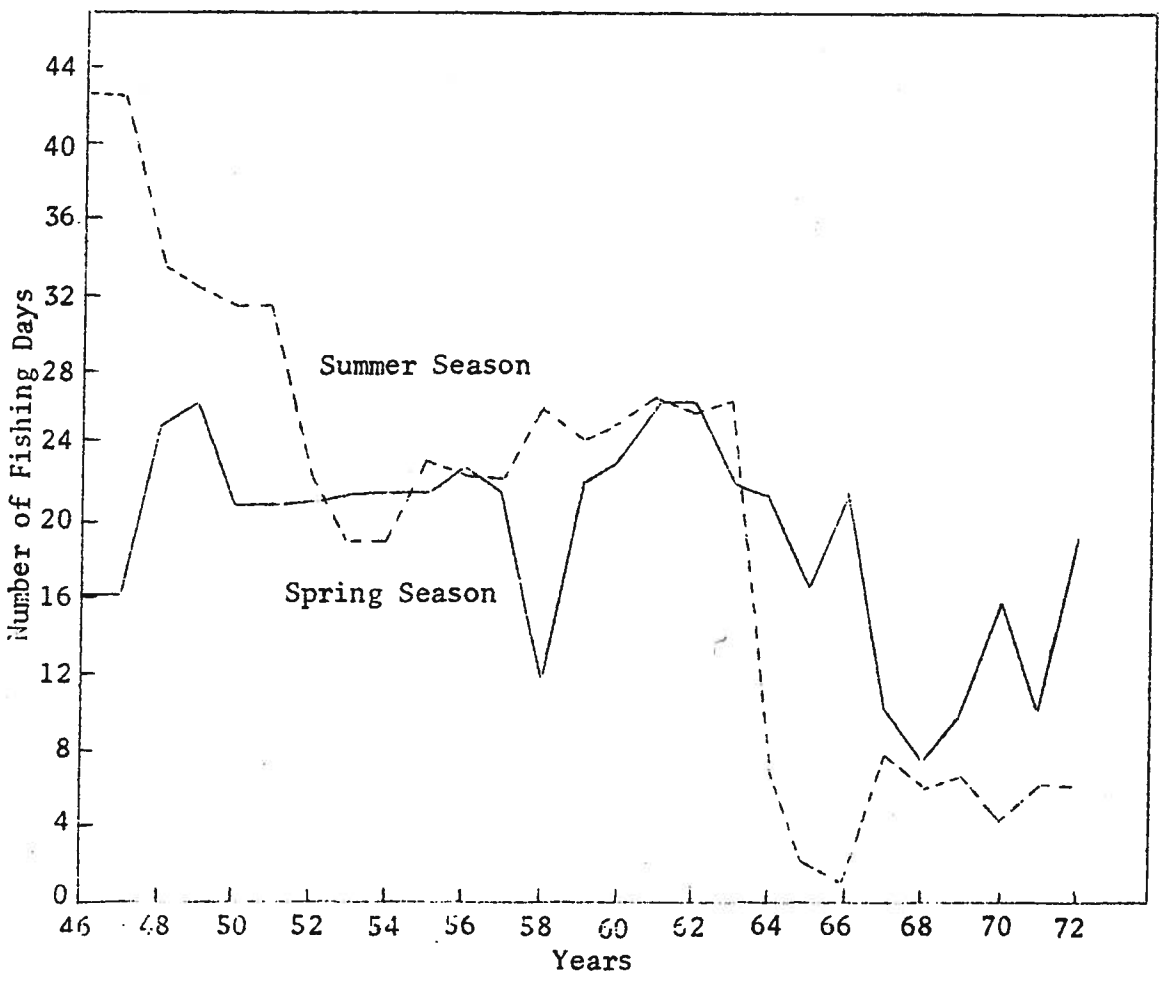
ACTUAL LOSSES TO FISHERY

The actual loss to the fishery in recent years is particularly distressing. In order to provide adequate escapement levels to spawning areas, increasing interdam losses of adult fish have been countered by severely curtailing the commercial fisheries. This has been accomplished both by reducing the number of fishing days allowed and by permitting fishing only during periods when fewer fish are present so that the resulting fishery is less efficient.

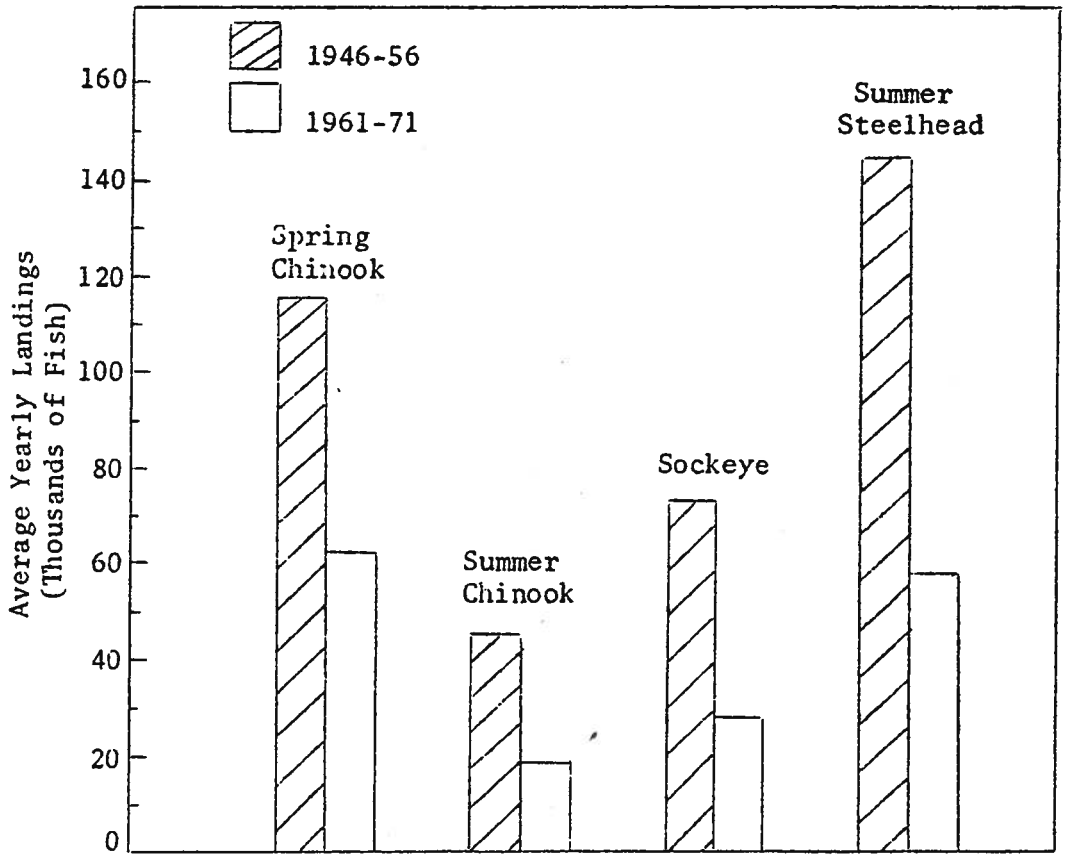
Appendix Figure 1 illustrates the decline in number of fishing days since 1946. Appendix Figure 2 shows the decline in the actual commercial landings of spring and summer chinook, sockeye, and summer steelhead for the same pre- and post-McNary years considered in Appendix Tables 1 and 2. It is clear that the landings of these species have been reduced to less than half their former levels.

In addition to compensating for increasing losses of fish between dams additional escapement has been allowed to compensate for prespawning mortalities occurring to fish after they have passed the uppermost dam. We believe that many of these mortalities resulted from nitrogen gas bubble disease. However, prespawning mortality was observed during 1972 when nitrogen levels were relatively low because of river flow regulation by the Corps. Observations of fish on and below their spawning grounds indicated that delayed mortalities resulted from a high incidence of physical injury to fish passing dams. This prespawning mortality is illustrated by the declining number of spawning nests (redds) per 100 fish counted over the uppermost dam (Appendix Figure 3). 1/

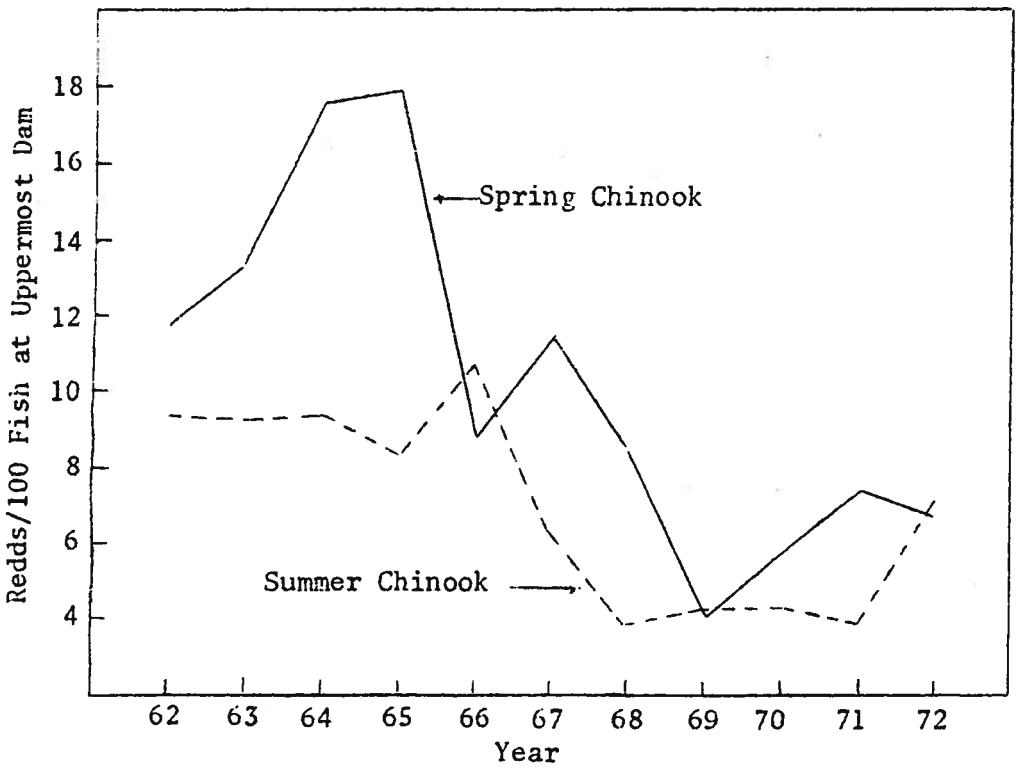
1/ *Redd counts supplied by Idaho Department of Fish and Game.*



Appendix Figure 1. Columbia River Commercial Fishing Seasons for Salmon Below Bonneville Dam, 1946-72



Appendix Figure 2. A Comparison of Average Annual Commercial Landings in Zones 1-6 for the Years 1946-56 and 1961-71 of Spring Chinook, Summer Chinook, Sockeye, and Summer Steelhead



Appendix Figure 3. Number of Redds in Standard Spawning Ground Survey Units in Idaho per 100 Fish Counted Over Uppermost Dam for Spring and Summer Chinook, 1962-72 1/

1/ *Redd count data supplied by Idaho Department of Fish and Game.*

IMPLICATION OF COLUMBIA RIVER LOSSES TO LOWER SNAKE RIVER PROGRAM

What should be most clear from the foregoing material is the magnitude of the fish losses in the Columbia River due to dams constructed in the last 20 years, and the inordinate hardship on the resource and the fisheries if reasonable compensatory procedures are delayed further. Losses due to Snake River projects have been expanding since the completion of Ice Harbor Dam in 1962, and serious losses related to main-stem Columbia River dams jumped sharply in the late 1950's and have continued year after year since that time. It could be argued that some of these losses result from environmental changes in tributary streams. However, during the period studied here, extensive screening of water diversions, other stream improvements, and increased hatchery production of spring chinook and steelhead have countered most of the adverse effects occurring in these tributaries during this period. It should be made clear that the hatchery production referred to is in no way connected with compensation for fishery losses at main-stem Corps projects.

We have given evidence that it is valid to consider maximum runs as rough estimates of optimum production. We have also shown that the numbers of spring and summer chinook and summer steelhead requested to compensate for Snake River projects is small when compared to total Columbia River losses and have pointed out that Snake River tributaries are the major producers of these stocks.

Modifications of lower Snake River projects to reduce mortalities (particularly to juvenile migrants) are currently underway. These include the installation of slotted bulkheads in existing skeleton units, the installation of deflectors in spillway units, and the development of

travelling screens to divert juveniles from entering the turbines. For the most part, these modifications are related to the serious nitrogen problem which has been developing in recent years. These modifications have not been considered in the lower Snake River report for a number of reasons. In the first place, no compensation has been requested for nitrogen losses although fisheries agencies as well as pollution control agencies in the Northwest have requested that the above measures be taken to reduce levels of nitrogen supersaturation. Secondly, the measures taken to reduce nitrogen levels introduce other sources of mortality. Direct mortalities to juvenile salmon passing through bulkheads are so great that at present the bulkheads are not used when large numbers of downstream migrants are in the river. Spillway deflectors are a possible source of mortality to both juvenile and adult salmonids. Travelling screens which may divert more than 80% of migrants approaching turbine units also induce mortalities. Furthermore, in the lower Snake River report no compensation has been requested for mortalities to adult salmon although serious delayed mortalities have been demonstrated, and serious mortalities to adults have been established directly at lower Columbia River dams as well as at Ice Harbor Dam, one of the Snake River projects under consideration. Consequently the losses we have not considered should more than counter any improvements from project modifications.

The process of obtaining reasonable compensation for both Snake and Columbia River projects will take quite a few years even if plans for hatchery construction are initiated immediately. Periodic evaluations can adjust for any benefits from project modifications as well as any additional losses due to peaking and other operational procedures. Further delay of the compensatory process, however, could have a serious impact on the viability

of our fish runs and our fisheries. Because of the Columbia and Snake River dams, fishermen have already lost an accumulation of tens of millions of pounds of prime salmon and steelhead. The present compensation program is not addressed to these past losses but rather is aimed at reducing such losses in the future.

In conclusion we would urge that plans for major hatchery construction not be delayed. If all of the hatcheries requested as well as project modifications presently considered are realized, the lower Snake River projects will not be over compensated. Considering the additional losses due to lower Columbia River projects it is clear that it is the resource and fisheries that are on the short side of the ledger.

Fish Commission of Oregon

March 7, 1973