# BRIEFING INFORMATION

# OTHER

# FISH PASSAGE RESEARCH HIGHLIGHTS

by

Wesley J. Ebel

Northwest Fisheries Center
National Marine Fisheries Service
Coastal Zone and Estuarine Studies Division
2725 Montlake Boulevard East
Seattle, Washington 98112

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# Fish Passage Research Highlights
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Studies funded under the Fisheries-Engineering Research Program since 1973 have been centered primarily on determining the effects of river regulation (peaking) on both juvenile and adult salmonids migrating in the Columbia and Snake Rivers. Other studies designed to evaluate the effect of new juvenile bypass systems and spillway deflectors are also in progress and considered high priority. Additional studies designed to improve adult fishways' collection efficiency are also being pursued. The National Marine Fisheries Service (NMFS), Oregon Department of Fish and Wildlife, Washington Department of Fisheries, Idaho Fish and Game Department, and the Corps of Engineers are participating jointly in this effort.

## Research on Juvenile Passage

Howard Raymond has discussed measurement of overall survival of juvenile populations of spring chinook and steelhead. Research results from several other studies bear on these survival estimates. These studies are centered mainly on:

A. Measuring effect of peaking on juvenile survival and timing.

B. Determining predator populations, their behavior and feeding habits.

C. Determining effect of peaking on stranding.

D. Determining effect of flow regulation on survival of resident fish.

E. Determining effect of spillway deflectors on juveniles passing over spillway.

F. Evaluation and improvement of fingerling bypass systems.

Most of these studies are currently underway and new data is continuously emerging. However, some studies are sufficiently complete to draw accurate conclusions and appropriate corrective actions can be taken.

Measurements to determine effect of peaking on survival of juvenile salmonids (particularly spring chinook and steelhead) have been difficult because it is difficult to isolate groups of fish that pass through a dam during periods of peaking from groups of fish passing through during periods of non-peaking. A general estimate of overall survival of a population, migrating during a year when water flow results in peaking operations such as in 1973, can be compared with overall survival in another year such as 74 and 75 when no peaking occurred during the migration because of high flows. These results have been discussed by Mr. Raymond.

Studies of diurnal movement through reservoirs and dams clearly show that fish move through the reservoirs during the daytime hours but hold up at the dam and do not pass through the turbine intakes until nighttime. This knowledge provides the potential to reduce turbine mortality. Flow control measures whereby some water is spilled at night might be implemented even during relatively low flow years to increase survival of juvenile migrants. The fisheries operations committee is currently considering this potential. Data regarding effects of peaking on survival and movement will continue to be pursued.

Data on effects of peaking on fall chinook stocks released from Priest Rapids indicates that survival of these stocks can be substantially improved if the fish are raised to a larger size (90-160 mm) rather than at 75-95 mm as they normally have been released. Fish released at the larger size passed

through the downstream reservoirs in record time in spite of the fact that peaking was occurring.

Predator populations (mainly squawfish) have been studied for the past two years in the Lower Columbia and Snake River. The purpose of these studies is to measure population size, areas of concentration, behavior, and predation rate. This knowledge is needed to provide information regarding decisions such as whether or not to collect and transport juveniles at a few selected upriver dams or to install traveling screens in all dams and divert and bypass fish around each dam.

Studies to date have shown that a substantial population of squawfish is present downstream from Little Goose Dam (over 17,000 captured in Merwin trap in 1974) whereas relatively small numbers have been found in the Lower Columbia in the area of John Day Dam. These studies show also that these fish feed actively throughout the juvenile migration period, particularly during periods when supersaturation of atmospheric gas is not a problem. Current data indicate that the population can be quite mobile and that population age class and concentration changes from year to year. We are particularly interested in determining, for example, whether a large population like that currently at Little Goose Dam will develop at Lower Granite Dam.

If it is determined ultimately that predator populations are concentrated and localized then some type of predator control may be possible.

Studies to determine effect of peaking on stranding of juvenile fish in The Dalles-Bonneville Dam areas indicate that stranding caused by water level fluctuations from peaking is not a serious problem. Small numbers of

recently emerged fall chinook and chum salmon were found stranded in some areas during the April to June sampling period but preliminary estimates indicate no significant loss. Numerous incidents of stranding caused by boat wash in the lower river (Vancouver area) were recorded. The overall loss from this stranding could be significant but estimates are not now available.

Some data is being collected to determine effects of flow regulation and peaking on resident fish, but these data are insufficient at this time to comment on.

Studies to determine effect of spillway deflectors on juvenile salmonids passing over these structures have been completed at Bonneville and Lower Monumental dams. These studies have included tests utilizing juvenile coho, steelhead and fall chinook. These studies have conclusively shown that spillway deflectors do not cause injury to these fish. No adverse effect was detected; in fact, steelhead survived at a significantly higher rate when passing over spillways equipped with deflectors than they did over conventional spillways.

Studies to evaluate and improve efficiency of juvenile bypass systems at dams have been underway for several years. Effort in the last two years has been centered on those systems at Lower Granite, Little Goose, and John Day dams.

To date these studies have shown that bypass systems like that in place at John Day and Little Goose dams must be modified to achieve satisfactory passage from the gatewell, where fish are concentrated, to the bypass pipe. NMFS determined that installation of vertical barrier screens and lighted orifice inserts was required to achieve satisfactory passage at these dams.

For example, a combination of vertical screens, increased attraction velocity, and lighted inserts increased passage efficiency by a factor of 18 to 1 over the original design. Current data on efficiency of the system installed at Lower Granite Dam indicates that this system is very efficient in passing fish from the gatewell to the collection corridor. We believe these studies are very important because the fishery agencies have proposed the installation of traveling screens at all dams as a solution to the turbine mortality problem. Traveling screens would divert thousands of fish into gatewells. If the bypass systems were not efficient, more fish could be killed by this solution than would be killed if the fish were allowed to pass through the turbines. We also believe that the area of the river where the fish are released from the bypass system is critical. A bypass system that dumps the fish in slack water inhabited by an abundance of predators would also be undesirable. The existing bypass-outfall areas should be examined and evaluated before traveling screens are installed for bypass purposes.

This covers the results of the main areas of study currently underway regarding juvenile salmonids in the Columbia and Snake River. Future research will continue to be centered on these areas. We anticipate, however, that the focus of these studies will change as results emerge and solutions to problems are found.

## Research on Adult Passage

Information on adults has been obtained mainly by utilizing three main techniques; radio tracking, electronic tunnels, conventional tagging, and analysis of dam counts. The research has centered on:

A. Determining effects of peaking and flow regulation on migration and mortality rates and passage at Bonneville, The Dalles, and John Day dams.

B. Determining sources of unaccountable losses of fish between dams (nitrogen mortality, fallback, tributary turn-off, and Indian catch).

C. Improvement of fishway collection efficiency.

D. Determining effects of peaking and flow regulation at several dams on subsequent spawning success.

E. Measurement of effect of spillway deflectors on passage, survival and behavior.

The difficulties encountered in determining effect of peaking per se on adult migration rates and survival were similar to those encountered with juveniles. It was difficult to achieve the test conditions required and to adequately isolate fish that migrated only during periods of peaking operations. Nevertheless, many useful results and conclusions were obtained from these studies. The most important of these are:

1. Reduced flow through powerhouse at Bonneville Dam resulted in increased passage of adults.

2. Mortality of spring and summer chinook passing over Bonneville and John Day dams ranges from 10-25% depending on river conditions.

3. Spring and summer chinook mortality at The Dalles was considerably lower (10 to 15%) than at Bonneville or John Day dams.

4. Fallback of both spring and summer chinook ranged from 20-35% at Bonneville during 1974 and 1975.

5. In 1976 spring chinook were delayed about 4 days at Bonneville; summer chinook about 2 days. Various studies indicate delay is minimal at The Dalles. Spring and summer chinook were delayed from 2-5 days at John Day Dam in 1975.

Preliminary analysis of data obtained at The Dalles on spring chinook indicated peaking had no dramatic effect on migration rate or survival, but again passage at the dam increased during periods of reduced flow through the powerhouse. Studies of summer chinook at John Day indicated no effect from reduced turbine flow in vicinity of fishway entrances.

Studies to determine sources of unaccountable loss were done in conjunction with peaking studies. One of the main factors resulting in "unaccountable losses" is fallback at Bonneville Dam. Spring chinook counts obviously have been inflated by about 35% the last two years. A second more serious source of loss is direct mortality measured at the dams. In 1975, a 17-21% loss of summer chinook was measured at John Day Dam and losses of spring and summer chinook ranging from 13 to about 26% have been measured at Bonneville Dam during several years. Losses between Bonneville and The Dalles and between John Day and McNary are directly correlated with flow; i.e., the higher the flow the greater the loss. This appears to hold true also for fallback. Losses at John Day are independent of flow.

We believe these two sources of unaccountable loss (i.e., Bonneville and John Day dams) are the most serious and the current effort is centered on reducing these losses. The area of the fallback at Bonneville Dam has been isolated by radio tracking but the causes of direct loss have not been determined. Certainly a part of the loss is related to delay in passage at the dams, and any improvement that can be made in fishway collection and passage systems should reduce direct mortality. Studies to improve fishway systems have therefore received considerable emphasis.

Information obtained on fishway collection systems has been obtained primarily by Corps biologists utilizing electronic tunnels in the collection systems to obtain accurate counts at various locations. Studies have been completed at The Dalles and John Day dams. Generally, it was learned that the collection system at The Dalles worked fairly well but passage could be improved during certain periods by making some changes in flow conditions in the vicinity of fishway entrances. For example, at The Dalles Dam fish approaching the collection system entrances can become disoriented if collection channel attraction flows become occluded by highly turbulent powerhouse discharge upwellings. This results in the fish moving to other, unobstructed entrances. Entrance to the fishway obviously could be improved by reducing turbine discharge on units adjacent to fishway entrances. Other adjustments to the powerhouse collection systems are possible; these will be investigated in future years.

Information on the effect of injury and gas bubble disease has been obtained by conventional and radio tagging studies. Earlier studies done before installation of spillway deflectors indicated that spawning success was substantially lower in high flow years when adults were delayed and subjected to long exposure to supersaturation of atmospheric gas.

Flow regimes and dam operating conditions obviously can influence spawning success, however, more data are needed to accurately assess the effect of peaking on spawning success.

Three radio tracking studies have been completed to determine whether spillway deflectors have any detrimental effect on adults migrating upstream. Fishery agencies were particularly concerned about delays in passage and whether injuries might occur to adults encountering shearplane forces present in the tailrace of the spillways. Studies done at Bonneville and Lower Monumental dams have shown that no substantial delay occurs due to spillway deflectors if the spillway and powerhouse are operated properly to provide suitable flow patterns. At Lower Granite Dam, however, with deflectors in all 8 bays there are some problems. No injuries were noted on any test fish entering the spillway area during these studies and generally it was concluded that spillway deflectors have no detrimental effect on adults migrating upstream.

Future studies regarding adults will be centered on isolating causes of losses and eliminating them. For example, studies conducted in the spring of 1976 will be focused on eliminating fallback, delay, and mortality at Bonneville Dam.

## Recommendations by Research Subcommittee

The present research program funded under the Fisheries Engineering Research Program of the U.S. Army Corps of Engineers was implemented and the monies secured on the basis of a need to determine what effects peaking might have on fish. The fishery agencies and the research subcommittee have recommended that the research focus more on mortality caused by development of the river for power purposes. Research centered on determining the effects of peaking would receive high priority, but would merely be a part of the overall research effort.