MFR PAPER 999

A new method has been devised by NMFS to increase the survival of juvenile salmon.

Collection and Transportation System of Juvenile Salmonids Evaluated at Little Goose Dam

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BACKGROUND AND OBJECTIVES

Survival of juvenile salmon—as well as steelhead trout—in the Snake River has declined significantly in recent years owing mainly to gas bubble disease, a condition caused by supersaturation of the river with nitrogen and other dissolved gases from spilling of water at dams. Before Lower Monumental and Little Goose Dams were built, over 90 percent of the young salmon managed to survive their seaward migration down the lower Snake River.

The term "nitrogen supersaturation" has fallen into common use (largely through convenience) to describe a condition known as excessive total dissolved gas pressure. Because air is nearly four-fifths nitrogen, references to the gas supersaturation problem have invariably highlighted nitrogen, even though the sum of all gas pressures is actually involved. Most of the Columbia River (and a major portion of the lower Snake River) is now a series of impoundments, or dams. The long succession of pools no longer provides the circulation necessary for rapid release of dissolved gases. Virtually all of the Columbia River below the U.S.-Canadian border and many miles of the lower Snake River are seasonally supersaturated to varying degrees, depending on river flows and amount of spill discharges at the dams. "Gas bubble disease" in fish is similar to the "bends" in deepsea divers. Fish, however, can contract the disease merely by remaining in supersaturated surface waters. An example of gas bubbles in a young fish is shown in Figure 1.

Reservoirs, or pools, delay the migration of juveniles by prolonging their exposure to high concentrations of dissolved gases, predation, and other adverse conditions. Such losses over a period of years could severely deplete the runs of salmon in a river. To offset this, the NMFS Northwest Fisheries Center's Division of Coastal Zone and Estuarine Studies designed a collection system at Little Goose, the uppermost dam in the lower Snake River. The collected fish are transported nearly 350 miles downstream around hazardous reaches of the river and released in the Columbia River below Bonneville Dam (Figure 2). Development and tests of the collection and transportation system were endorsed by State fishery agencies and financed by the U.S. Army Corps of Engineers. The system is now in the third year of a 6-year program.

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FISH PROTECTIVE SYSTEM AND FACILITIES

At Little Goose Dam the young fish are diverted from turbine intakes into intake gatewells by means of traveling screens (Figure 3). From the gatewells, the fish pass through a submerged orifice into a bypass pipe (Figure 4) and are routed around the dam to a collection area (Figure 5) below the powerhouse. At this point the fish are either released into the tailrace or transferred

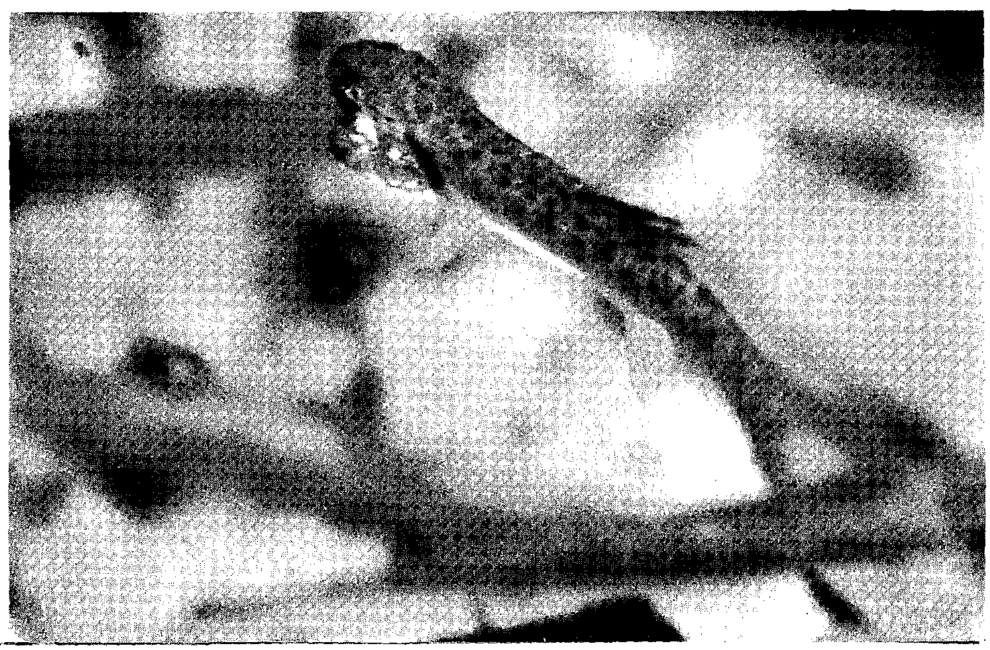


Figure 1. — Gas bubbles beneath skin on head of young chinook salmon. When bubbles burst, infections may set in and kill the fish. Gas absorbed into blood stream will cause emboli, which can block circulatory system and cause death.

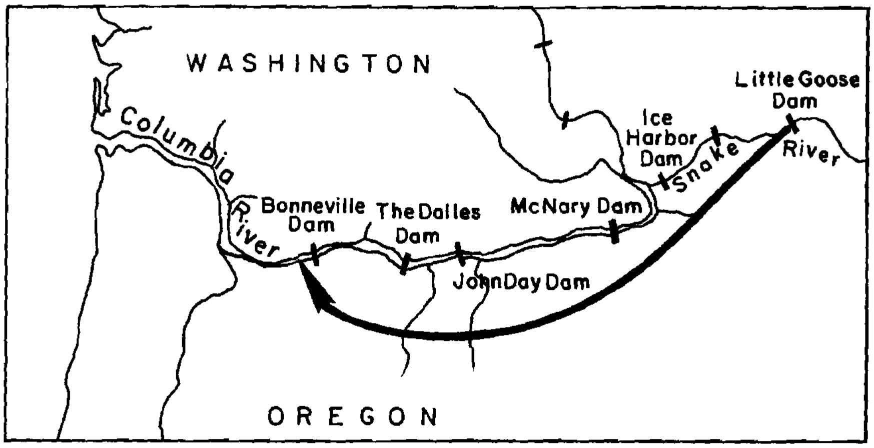


Figure 2.—Transportation route (heavy black arrow) from Little Goose Dam to Bonneville tailrace.

to a tank truck and transported downstream around hazardous areas.

Developmental studies by NMFS personnel at Ice Harbor Dam led to the design of the collection and transportation system. Tests had indicated that survival of truck-transported fish was about twice that of those migrating naturally downstream. Survival of fish transported during periods of heavy spills and high gas supersaturation was about three times that of non-transported fish.

EVALUATION OF THE SYSTEM

Returns of marked adult fish provide data on the effectiveness of the system. Juveniles are marked at the collection area (Figure 6) with a coded magnetic wire tag, a cryo-brand, and an adipose fin clip. Control groups are released

Figure 3.—Inclined traveling screen shown in operating position on deck of dam. Hydraulically operated arm is withdrawn to permit lowering of screen through gatewell slot.

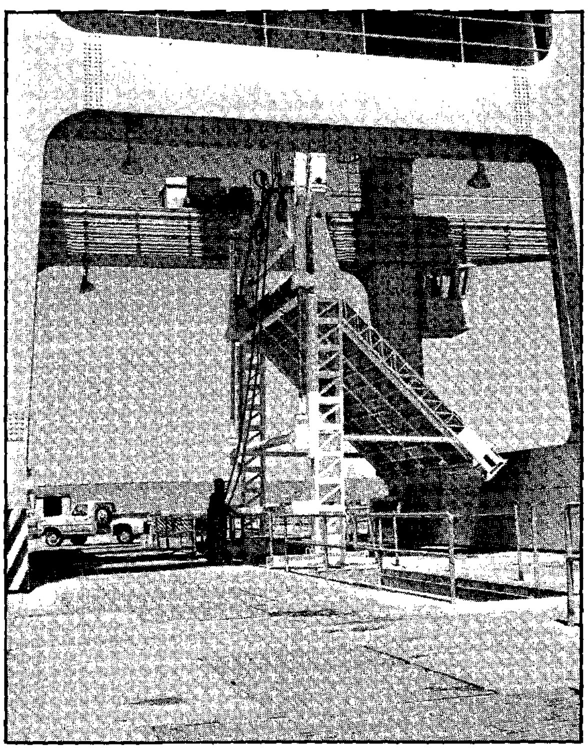
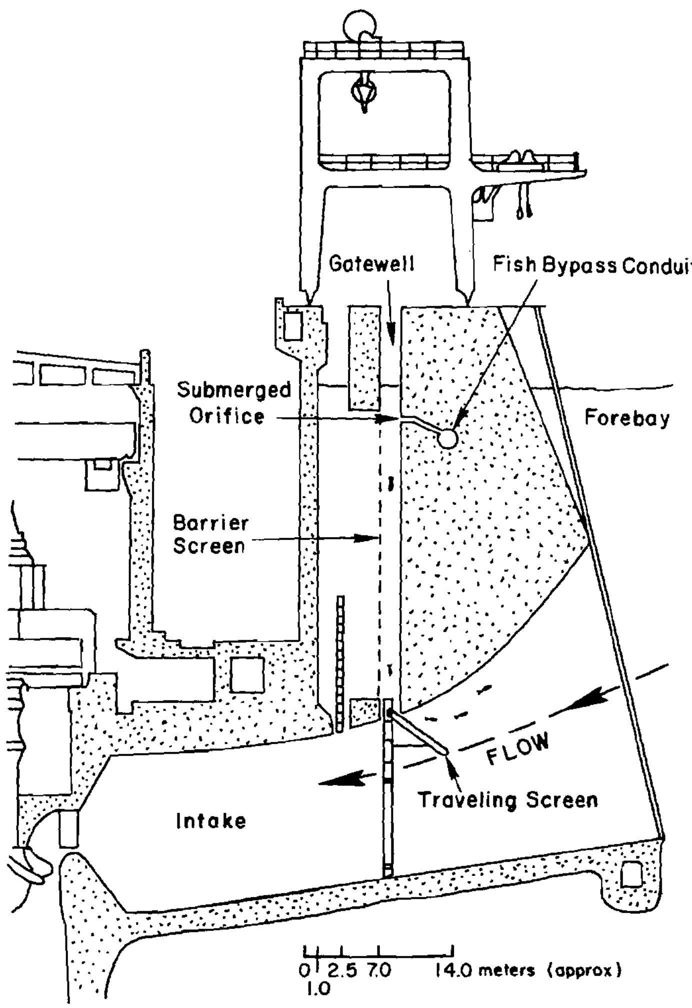


Figure 4.—Sectional view of powerhouse showing traveling screen in operating position within turbine intake.



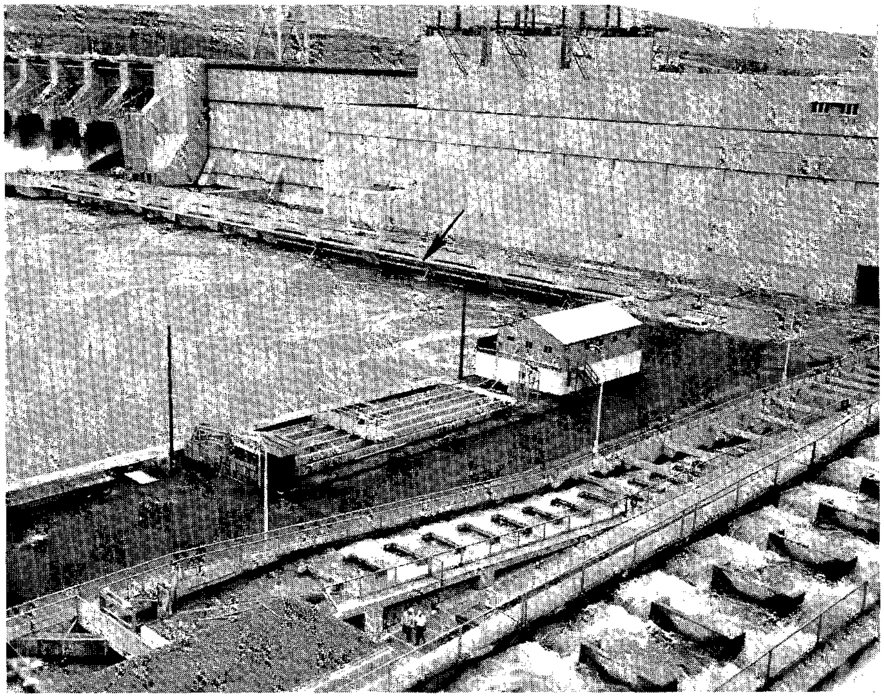


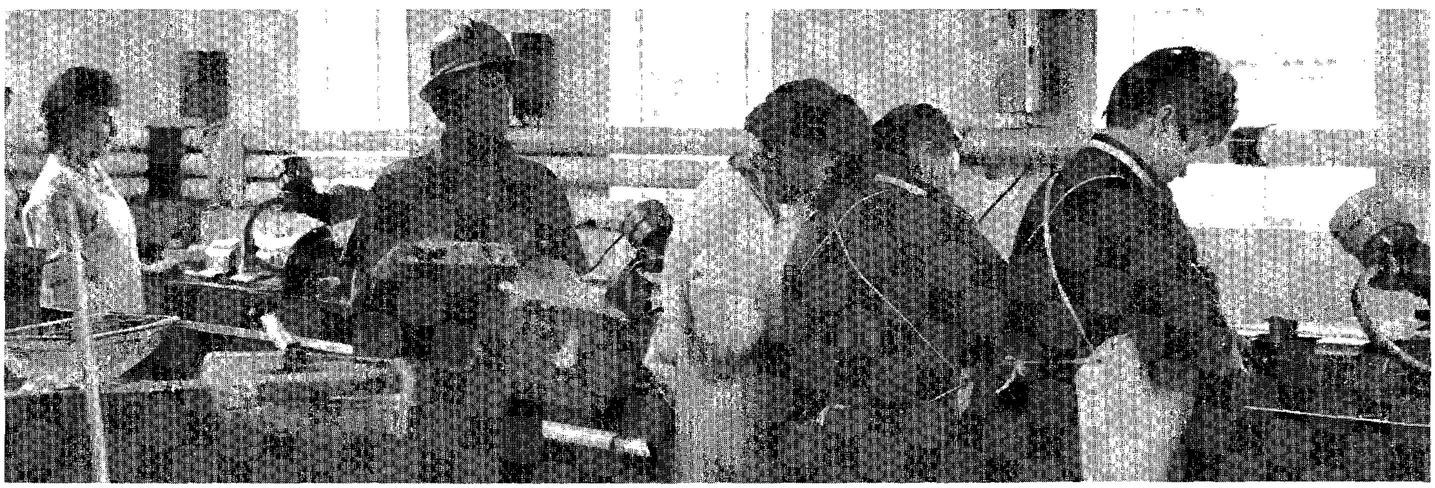
Figure 5. — Collection area into which fish are transferred through a pipe conduit (see arrow) from turbine intake gatewells. Here fish are graded by size and held in long raceways for inspection and marking.

above and below Little Goose Dam; test groups are transported by tank trucks and released below Bonneville Dam. Nearly 400,000 fish were handled in 1971 and about 900,000 in 1972.

When adult fish return to Little Goose Dam they pass through a special device in the fishway that detects those with a wire tag and diverts them into a holding area. Here the brand (Figure 7) is read and it is determined whether the fish had been transported and released downstream or had been released at the dam as a control. Identifiable fish are then released to continue their migration upstream. If the brand is not legible, the fish is held in a hatchery until spawned. The wire tag is then removed from the snout and the color code read for determination of the release site. Spawning ground surveys, conducted in cooperation with State fishery agencies, provide data on adults that pass Little Goose Dam undetected. Further data are obtained from recoveries in the commercial fishery in the lower Columbia River and from the sport fishery in the Snake and Columbia Rivers.

Returns in 1972 of early-maturing (1 year in the ocean, "jack") steelhead trout, released as juveniles in 1971 at Little Goose Dam (controls) and at Bonneville Dam (transported), are encouraging. Chinook salmon recovered this year have been too few for computation of benefit ratios due to transport, but preliminary estimates of benefit (based on recoveries of 327 fish) computed from trout returns indicate that survival of transported fish was 61 percent greater than that of nontransported fish. Should future returns of adult fish follow the same pattern as in past years at Ice Harbor Dam (confluence of Snake and Columbia Rivers), final estimates of increased survival of salmon and trout—attributable to transportation in 1971—should exceed 100 percent. This projection is predicted on evidence that transport/control ratios are higher for 2- and 3-ocean fish than for jacks.

Figure 6.—Interior of marking shed near collection area where young fish are branded and wire tagged in assembly line. The fish are pumped into holding tank from raceways, anesthetized, and diverted to fish marking stations. After processing, the fish are transferred by gravity flow through pipe into tank truck.



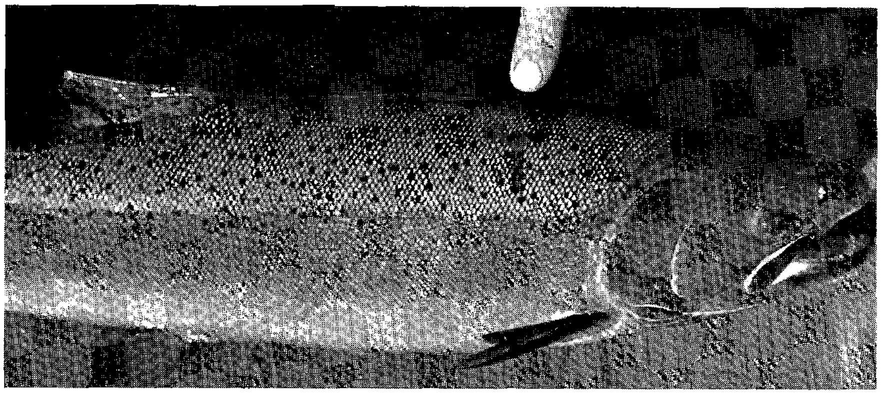


Figure 7.—Cryo-brand on adult steelhead trout. Fish had returned to Little Goose Dam after having been caught and branded at the dam during its juvenile stage and transported downstream below Bonneville Dam.

Fish losses during the collection and transport process appear mainly related to descaling and other physical injuries. To reduce losses during collection and transport, the staff is determining causes of injuries and stresses incurred by fish while they are being collected, marked, transported, or released. In areas where descaling occurred, their causes have been pinpointed and preventive steps are underway. Points of stress are identified through blood chemistry studies; so far there is little indication that increased stress seriously affects survival.

FUTURE PLANS

To increase the capability of the system for diverting fish from turbine intakes at Little Goose Dam, the Corps of Engineers is currently installing six additional traveling screens, completing the screening of the three turbines now operating at that project. With the increased screening capability, up to 90 percent of the migrants could be diverted from the river when no spilling occurs. In 1975, fish passage facilities similar to those at Little Goose Dam will commence operation at Lower Granite Dam about 45 miles upstream. Ultimate management decisions concerning the future extension and application of the transport concept must await the results of ongoing studies. For the present, only a minor fraction of the total migration is being used to evaluate the system. On occasion, additional fish have been transported on request of the managing State fishery agencies, principally during periods when dissolved gas concentrations in the river are at levels dangerous to fish.

The need to prevent losses of young fish will increase in the future as river flows are more controlled, spilling at dams decreases, and a greater proportion of the seaward migrants are forced through turbines. To prevent losses of fish from turbine passage, the Corps of Engineers proposes installation of screens in the intakes of a number of dams to bypass fish around each project. Implementation of these plans would again depend on the results of studies by NMFS to determine effectiveness of the traveling screens and bypass systems.

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