

Improved Bypass and Collection System for Protection of Juvenile Salmon and Steelhead Trout at Lower Granite Dam

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ABSTRACT—A new and improved system for diverting, bypassing, and collecting juvenile salmon, *Oncorhynchus sp.*, and steelhead trout, *Salmo Gairdneri*, at Lower Granite Dam on the lower Snake River is described. Major changes from previous systems of this type include a special fish screen slot for placement of the improved traveling screen, an open gallery bypass system for routing fish around the turbines, and a collection and holding area totally supplied by gravity-flow. The system is currently being evaluated by the National Marine Fisheries Service under contract to the U.S. Army Corps of Engineers.

INTRODUCTION

The National Marine Fisheries Service is conducting research on improving survival of juvenile Pacific salmon, genus *Oncorhynchus*, and steelhead trout, *Salmo gairdneri*, during their downstream migration. A major portion of the research emphasizes the development of safe diversion, bypass, and collection systems at dams on the Columbia and Snake Rivers in the Pacific Northwest (Fig. 1). Smith and Farr (1975) described a bypass and collection system for Little Goose Dam on the Snake River that utilized traveling screens in turbine intakes, submerged orifices in turbine intake gatewells, and an enclosed fish-transport pipe between the gatewells and the holding facility. This system was evaluated from 1971 through 1973, and the improvements were incorporated into the design of a similar facility at Lower Granite Dam (recently constructed 30 miles upstream from Little Goose Dam). This report describes further improvements and modifications, designed to provide

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safer and more efficient handling and movement of fish, at the Lower Granite Dam facility.

FACILITIES AND IMPROVEMENTS

Fish Screening Facilities

The turbine intakes and gatewells of Lower Granite Dam are basically identical to those of Little Goose Dam with one major exception. At Lower Granite Dam an additional slot, the special fish screen slot, was constructed upstream from each intake bulkhead slot—specifically for the placement of a traveling screen (Fig. 2). The fish screen slot differs from the bulkhead slot in the following features:

- 1) The fish slot is closer to the entrance of the turbine intake where the cross-sectional area is larger and the approach velocity is less.
- 2) The angle of flow passing the fish screen slot is more acute because the intake ceiling is steeper at this point.
- 3) The fish screen slot is isolated from other gate slots and considerably narrower (from front to back). Therefore, no vertical barrier screen is required to confine fingerlings.
- 4) A small screened opening (10 feet by 20 feet) is located approximately 15 feet below the water surface on the

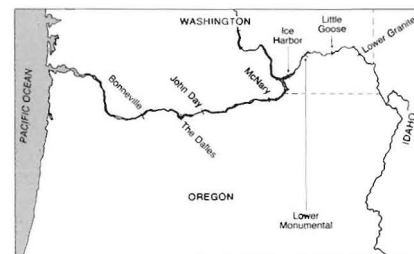


Figure 1.—Map of area showing the locations of dams on the lower Columbia and Snake Rivers.

downstream wall of the slot. Upwelling flows caused by a traveling screen in the fish screen slot are discharged through this screened opening and pass downward through three vertical shafts (approximately 3 feet in diameter), referred to as the Wagner horn (Fig. 2), and back into the turbine intake.

5) The ceiling of the turbine intake on the upstream side of the fish screen slot is cut off horizontally, creating a larger opening into the fish screen slot than into the bulkhead slot when a traveling screen is installed.

Standard traveling screens, such as those used at Little Goose Dam and described by Farr (1974) and by Smith and Farr (1975), are used at Lower Granite Dam without modification and operate satisfactorily in the bulkhead slot but not in the fish screen slot. When tested in the fish screen slot, descaling and injury of fingerlings increased while guiding efficiency decreased. The angle of the traveling screen in relation to the water flow in the intake was determined to be the main cause of the problem. The standard traveling screens operate at a fixed 45° angle from vertical, which results in the

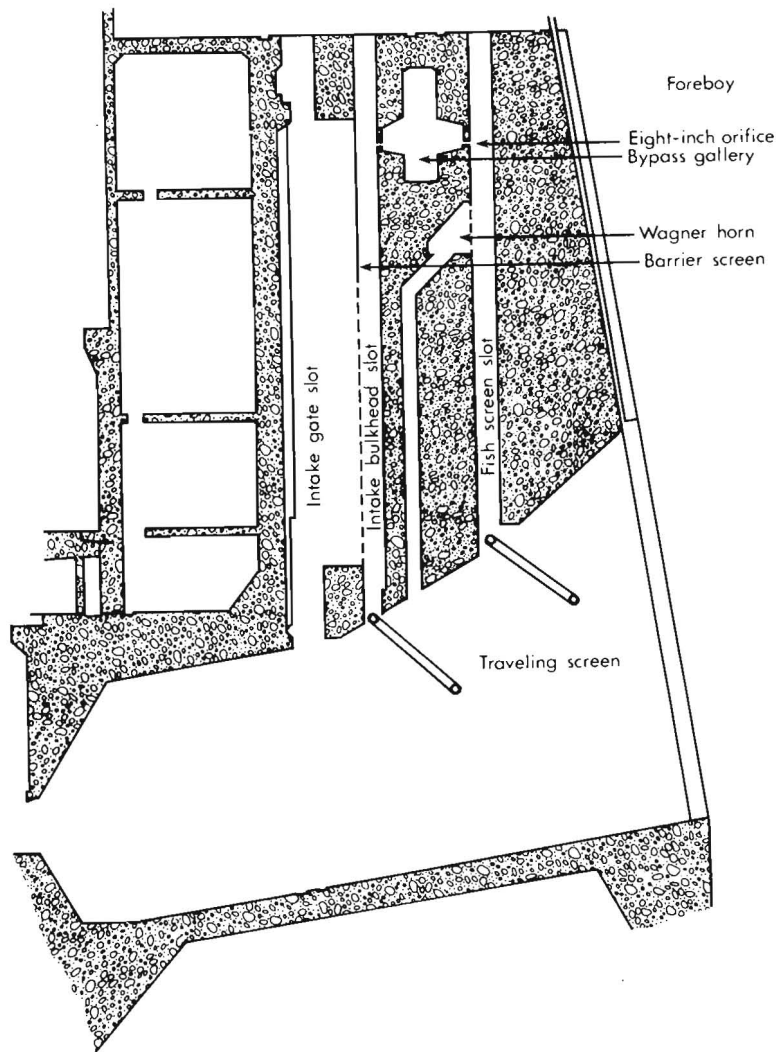


Figure 2.—Cross sectional view of turbine intake at Lower Granite Dam indicating principal features of the bypass system. Note that traveling screen is shown in the bulkhead slot but it can be placed in the fish screen slot.

screen being nearly perpendicular to the water flow when placed in the fish screen slot. The angle of the screen needed to be increased from 45° to an angle more closely approximating the angle to flow achieved in the bulkhead slot.

As a result of the deficiencies of the standard traveling screen, an experimental traveling screen (Fig. 3) is being developed by the U.S. Army Corps of Engineers for use in either the fish screen slot or the bulkhead slot. The unit is undergoing extensive testing by NMFS. The most prominent feature of the new screen is an adjustable angle of

extension which can be adjusted in 5° increments from 45° to 65°. Other features include the following:

1) It has two rotating woven monofilament mesh belts instead of four rotating wire mesh belts.

2) The new traveling screen does not require a bottom support structure as was used with some of the earlier standard screens. It is lowered by gantry crane to the operating level where it hangs in the turbine intake with the top of the support structure wedged in the narrowing lower area of the bulkhead or fish screen slots. The picking beam is disconnected and retrieved, eliminating

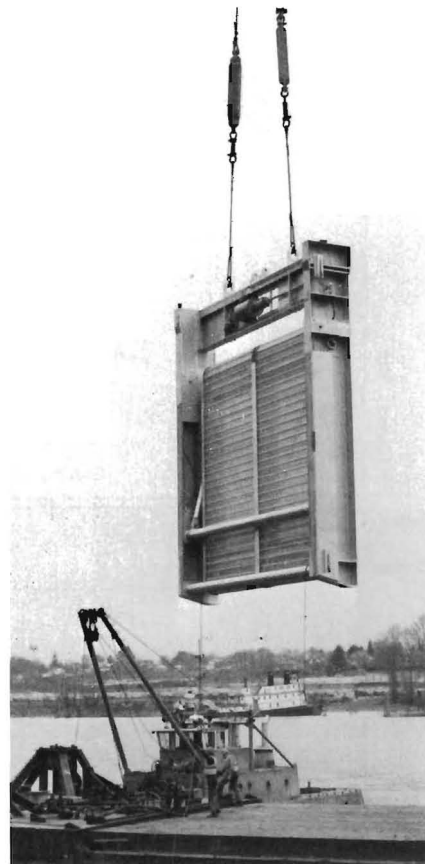


Figure 3.—New, adjustable angle, traveling screen currently being tested at Lower Granite Dam.

the need for pendant support cables in the gatewells while the traveling screen is down and operating.

3) The hydraulic power unit for driving the screen belt is watertight and located on the upper truss of the support structure, whereas the hydraulic power units for the standard traveling screens are located on the intake deck and connected to the traveling screen by about 90 feet of high-pressure hose.

Gatewell Orifices and Bypass System

Fingerlings diverted from the turbine intakes to either the bulkhead slot or the fish screen slot enter the bypass gallery by passing through one of two 8-inch illuminated orifices, about 6 feet below the water surface near the appropriate corners of the respective slots (Fig. 4). Orifices from the bulkhead slots empty into the gallery opposite those from the

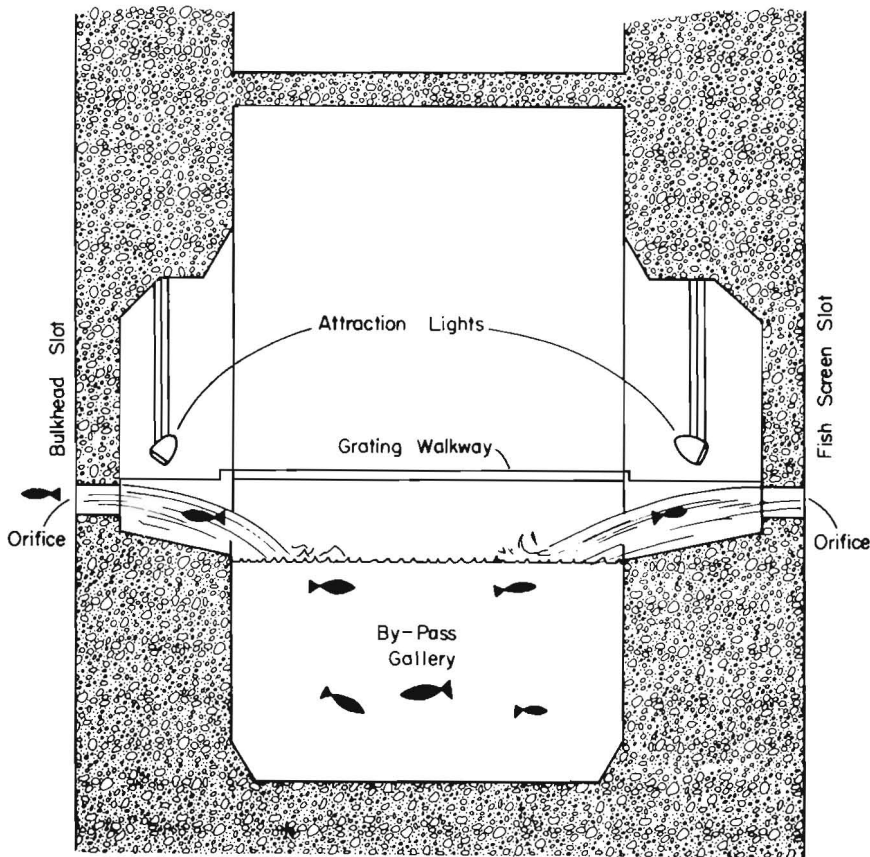


Figure 4.—Cross section of fingerling bypass gallery, showing orifices that pass fingerlings from bulkhead and fish screen slots.

fish screen slots. The opposing orifices are slightly staggered to prevent the two streams of water from contacting one another. A slide gate is installed on the gallery side of each orifice to allow them to be opened or closed quickly.

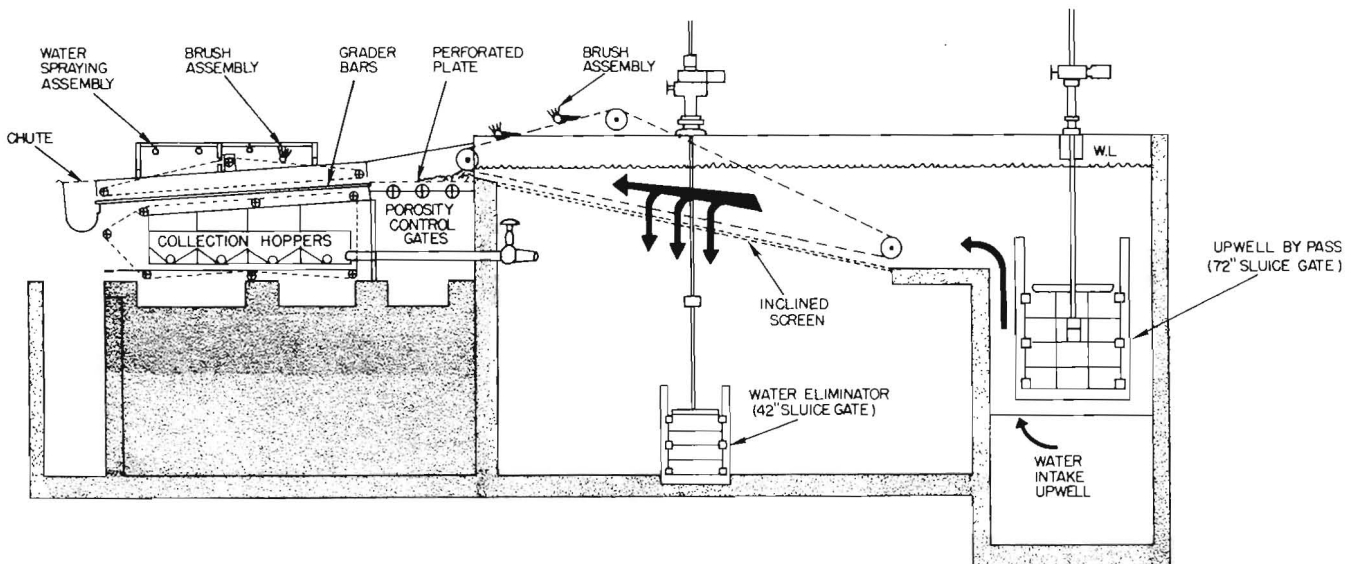
Ongoing research on orifice efficiency at Lower Granite Dam indicates that the 8-inch orifices will pass migrating fingerlings more readily than the 6-inch orifices in use at Little Goose Dam¹.

Once fingerlings pass through the orifices, they are carried in a flume-like channel or gallery (6 feet wide by 7 feet deep) to the south end of the powerhouse. At this point, they pass over a stop-log weir into a water-filled chamber that descends to the tailrace level (about 66 feet vertical), where they are carried to the collection facility (a distance of 400 yards) through a 42-inch diameter concrete pipe. The average water flow in the pipe is about 250 cubic feet per second at an approximate velocity of 25 feet per second.

The two 8-inch orifices per gatewell and the open flume or gallery at Lower Granite Dam are vast improvements over the single 6-inch orifice per

¹Richard F. Krcma, NMFS, Tri-Cities Airport, Bldg. 57, Pasco, WA 98301, pers. commun.

Figure 5.—Cross section of upwell and fish grader unit at Lower Granite Dam.



gatewell and closed pipe system in use at Little Goose, Lower Monumental, and John Day Dams. Egress from gatewells is facilitated because fingerlings have to pass through only 9 inches of straight pipe into a well-lit flume instead of several feet of elbowed pipe into a dark transport pipe. In addition, much of the debris that continually plugs the 6-inch orifices readily passes through 8-inch orifices. Further, the open flume permits ready access to any plugged orifice, whereas the closed systems require the use of scuba divers for debris removal.

Upwell and Fish Grader

As at Little Goose Dam, fish emerge from the upwell at the terminus of the transport pipe, are graded by size, and pass into the fish holding raceways. The design and operation of the upwell and fish grading systems at both dams are basically similar. Some modifications of the facility at Lower Granite Dam were necessary to handle the eightfold increase in water volume. Other modifications were incorporated to improve the overall system. Basic features of the system are shown in Figure 5. The following are the major differences from the system at Little Goose Dam:

- 1) A large inclined screen unit was installed in front of the perforated plate to offset the eightfold increase in water volume. The screen unit construction, including a sweeping mechanism to prevent plugging by debris and algae, was patterned after an earlier screen described in detail by Kupka (1966). Manual or automatic regulation of water over the screen is provided by a 42-inch sluice gate beneath the screen. The excess water is passed back to the river.

- 2) A 72-inch sluice gate in the upwell provides a means of returning the entire flow back to the river before it passes over the inclined screen and fish grader. The entire flow is normally diverted directly to the river when fish are not migrating or not needed for collection.

- 3) The length of the fish grader has been increased to 20 feet, and a fourth water-filled hopper was installed under

the grader bars. This modification provides a finer degree of size grading. Adult salmon and trout that fail to fall through the grader bars enter a chute at the end of the grader and are discharged back to the river.

- 4) A chain-driven trash sweeping device installed directly above the grader bars prevents the accumulation of water-borne debris. (This is in addition to the standard traveling debris collector between the grader bars and hoppers.) The new device consists of a bristle brush attached to an angle iron frame, suspended between two chains operating on guide bars and idler sprockets. Operation of this trash sweep can be controlled either manually (using a starter switch) or automatically (by means of an electric timer that regulates the operating interval). A limit switch ensures that the brush assembly will stop at the same point above the grader bars after each operation.

- 5) A water spraying assembly, consisting of evenly spaced yard-type sprinkler heads connected by pipe, is located above the grader bars. This assembly provides a constant film of water on the grader bars, allowing easier and faster movement of fish down them.

Fish Holding Area

The size and configuration of the fish holding raceways and the method of crowding are the same as previously described for Little Goose Dam, but some basic improvements have been incorporated. The raceways at Lower Granite Dam are above the level of the fish marking facility and the truck loading area, thereby providing complete movement of fish to these areas by gravity flow. This design provides easier movement of fish and eliminates injuries which may occur with pumping. The last 2 feet of the downstream end of each raceway floor has been lowered 1 foot to provide a basin near the outlet pipe. This modification provides easier removal of the last few fish in each raceway by allowing complete drainage of the raceways—thereby congregating the remaining fish closer to the outlet pipe.

Fish Marking and Laboratory Facilities

The fish marking and laboratory complex is immediately downstream from the fish holding raceways (Fig. 6). The complex consists of: 1) a marking and sorting facility—wooden building with a concrete floor (1,024 square feet) and 2) laboratory, office, and related facilities—two mobile homes (720 square feet each), connected to each other and the marking facility by an enclosed porch.

During the sorting and marking operation, fish are transferred from the raceways by means of a 6-inch diameter fiber glass pipe running underground to a 1,000-gallon holding tank in the marking facility. From there, fish are placed into a sorting trough containing a temperature-controlled recirculating anesthetic bath and examined for previous marks and condition. Previously marked and poor quality fish not used for the transportation experiments are sent through a 3-inch diameter polyvinyl chloride (PVC) pipe, either directly to the transport truck or to an outside holding tank to recover from the anesthetic before being returned to the river. Unmarked fish to be used for the transportation experiments are sent through one of four 3-inch diameter PVC pipes to a marking station for adipose fin removal, freeze branding, and injection of a magnetic coded wire tag into the cartilage of the snout. The freeze brand and wire tag identify each experimental group, whereas the adipose fin clip simply indicates the presence of a wire tag in the fish's snout. After completion of the marking process, the fish are sent through an electronic detector head that automatically rejects any untagged fish, thereby ensuring that only properly wire tagged fish are used in the transportation experiments. To inhibit fungal growth, properly tagged fish enter a 20-foot section of 3-inch diameter PVC pipe containing a recirculating, temperature-controlled solution of malachite green. At the end of this pipe, the fish pass over a screen device, that eliminates the malachite solution, and into a 6-inch diameter



Figure 6.—Overall view of fish holding and marking facility at Lower Granite Dam (shown from left to right are: shop, laboratory and office buildings, marking facility, fish holding facility, and upwell and grader units).

fiberglass pipe containing fresh running water that carries them to the truck.

SUMMARY

The improved fish diversion, bypass, and collection systems at Lower Granite Dam operated satisfactorily in 1975-76. The automatic

counting and gravity flow loading features make this facility ideally suited for mass-collection and transportation of large numbers of downstream migrating salmonids. This system is part of a continuing cooperative effort between NMFS and the U.S. Army Corps of Engineers to improve fish passage on the Columbia and Snake Rivers.

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