EXPERIMENTAL TANKER USED TO STUDY

TRANSPORTATION OF JUVENILE SALMONIDS

by

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Since 1968, the National Marine Fisheries Service (NMFS), in cooperation with the U.S. Army Corps of Engineers, has been conducting research involving the collection of juvenile (smolting) Pacific salmon *Oncorhynchus* spp. and steelhead *Salmo gairdneri* at several dams on the lower Snake River in southeastern Washington and the transportation of these fish by trucks and barges around the remaining dams to a release site below Bonneville Dam, the most downstream dam on the Columbia River (Trefethen and Ebel 1973; Ebel et al. 1973; Ebel 1980). Transportation provides protection for the juvenile salmonids from turbines at dams, predation, and gas bubble disease (Ebel et al. 1973).

In 1981, a research project was undertaken by the NMFS to identify potential areas of stress in the collection and transport system at Lower Granite Dam on the Snake River and McNary Dam on the Columbia River. Stress of fish while in transport trucks was identified as a potential problem which led to consideration of load density and species interaction as contributing stressors. To test the effects of these potential stresses, a small experimental tanker was used that simulated conditions in the large (18,900-L capacity) tankers, while minimizing numbers of fish required per test.

The experimental tanker (Figs. 1 and 2) is divided into eight isolated 75-L (20-gallon) compartments and constructed of 0.63-cm (1/4-inch) welded aluminum plate. It is double-walled and insulated with a 7.6-cm (3-inch) layer of Styrofoam[1/] between the inner and outer walls. Common to all compartments are: a 10.2-cm (4-inch) diameter hinged release gate in the floor of the tank; two recessed air stones covered by a perforated aluminum

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[1/]Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

plate; a 5.1-cm (2-inch) diameter screened polyvinyl chloride (PVC) overflow standpipe; and a compartment lid equipped with a small surface agitator, powered by a 12V battery, and a vent for escapement of excess or waste gases. A 5-ohm - 25W resistor was wired in series with the d.c. motor of the agitator to reduce rpm. There are two, 10.2-cm (4-inch) diameter parallel aluminum pipe release lines, each draining four compartments.

The life support system contains two high pressure oxygen bottles, each attached to a separate bank of four medical oxygen flow meters connected in series with four 61-cm (24-inch) long carbon graphite air stones. By supplying oxygen in each compartment through two air stones, continued oxygen flow is ensured if a problem occurs in one of the two systems.

Total cost for the experimental tanker was about $4,000; approximately $1,500 for materials and $2,500 for fabrication. The small surface agitators were purchased from the Boat Cycle Co. of Henderson, Texas; the carbon graphite airstones were obtained from Airco Speer Co. of St. Marys, Pennsylvania. Additional information on engineering design and materials can be obtained by contacting the authors.

Advantages of using the small experimental tanker in this study were: desired transport densities were achieved using comparatively few fish; the multi-chambered tank enabled simultaneous experimentation or replication of several test conditions; and, being very compact, the tank could fit in the bed of a heavy-duty pickup truck. The tanker can be used to simulate actual transport conditions at a test site without moving the fish to a release site.

The experimental tanker was used successfully in research activities at Lower Granite Dam in the spring of 1982. During testing, six trips were made from Lower Granite to Bonneville Dam, a distance of 395 km and a duration of 8 h.

Acknowledgements

Special thanks to Wallace Iceberg and Phillip Weitz for their time and expertise in constructing the experimental tanker.

References

Ebel, W. J., 1980. Transportation of chinook salmon, *Oncorhynchus tshawytscha*, and steelhead, *Salmo gairdneri*, smolts in the Columbia River and effects on adult returns. Fish. Bull., U.S. 78:491-505.

Ebel, W. J., D. L. Park, and R. C. Johnson. 1973. Effects of transportation on survival and homing of Snake River chinook salmon and steelhead trout. Fish. Bull., U.S. 71:549-563.

Trefethen, P. S., and W. J. Ebel, 1973. Collection and transportation system of juvenile salmonids evaluated at Little Goose Dam. Mar. Fish. Rev. 35(8):33-36.

Figure 1.--Isometric view of the experimental tanker.

Isometric View of the Experimental Tanker

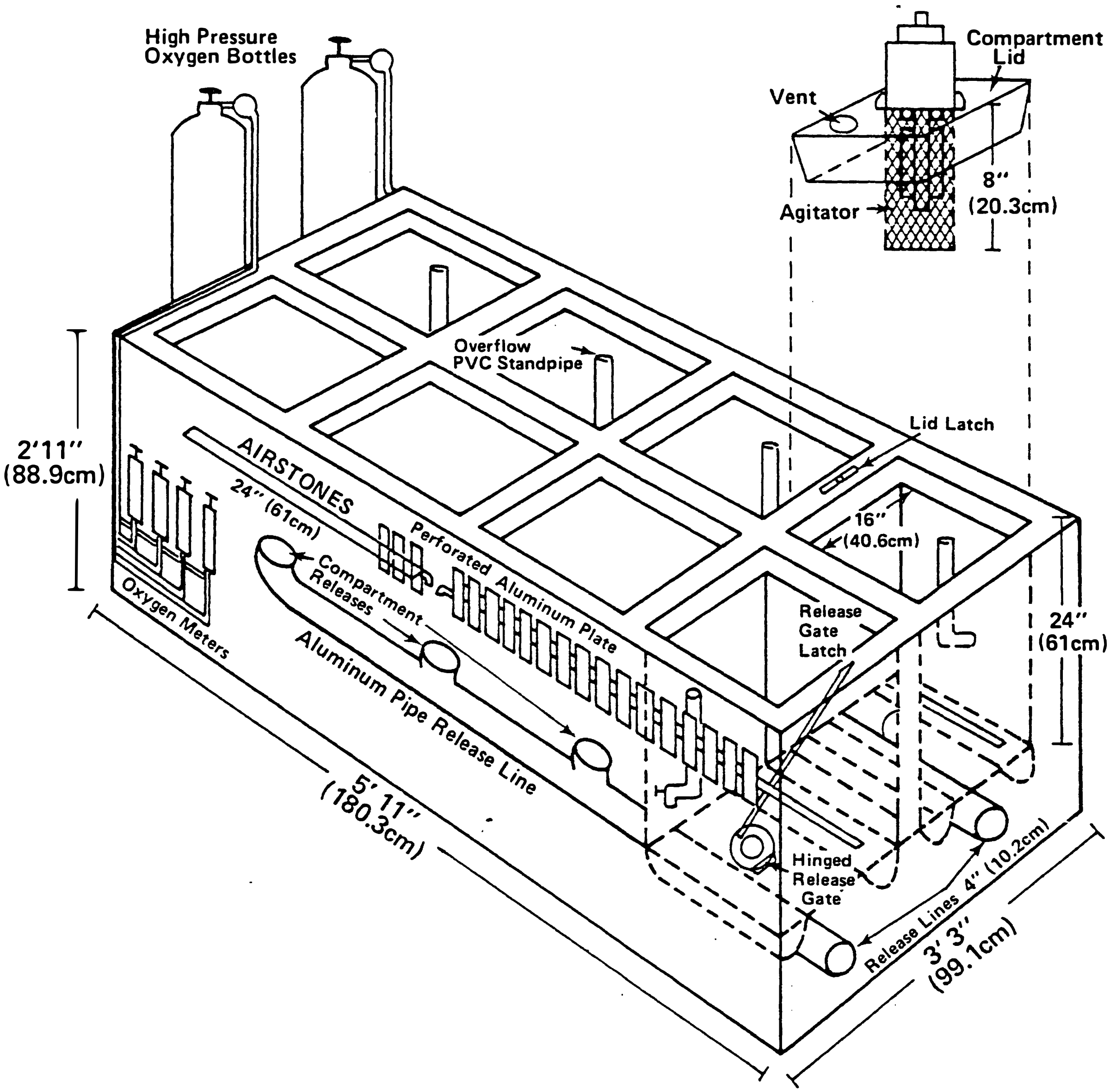
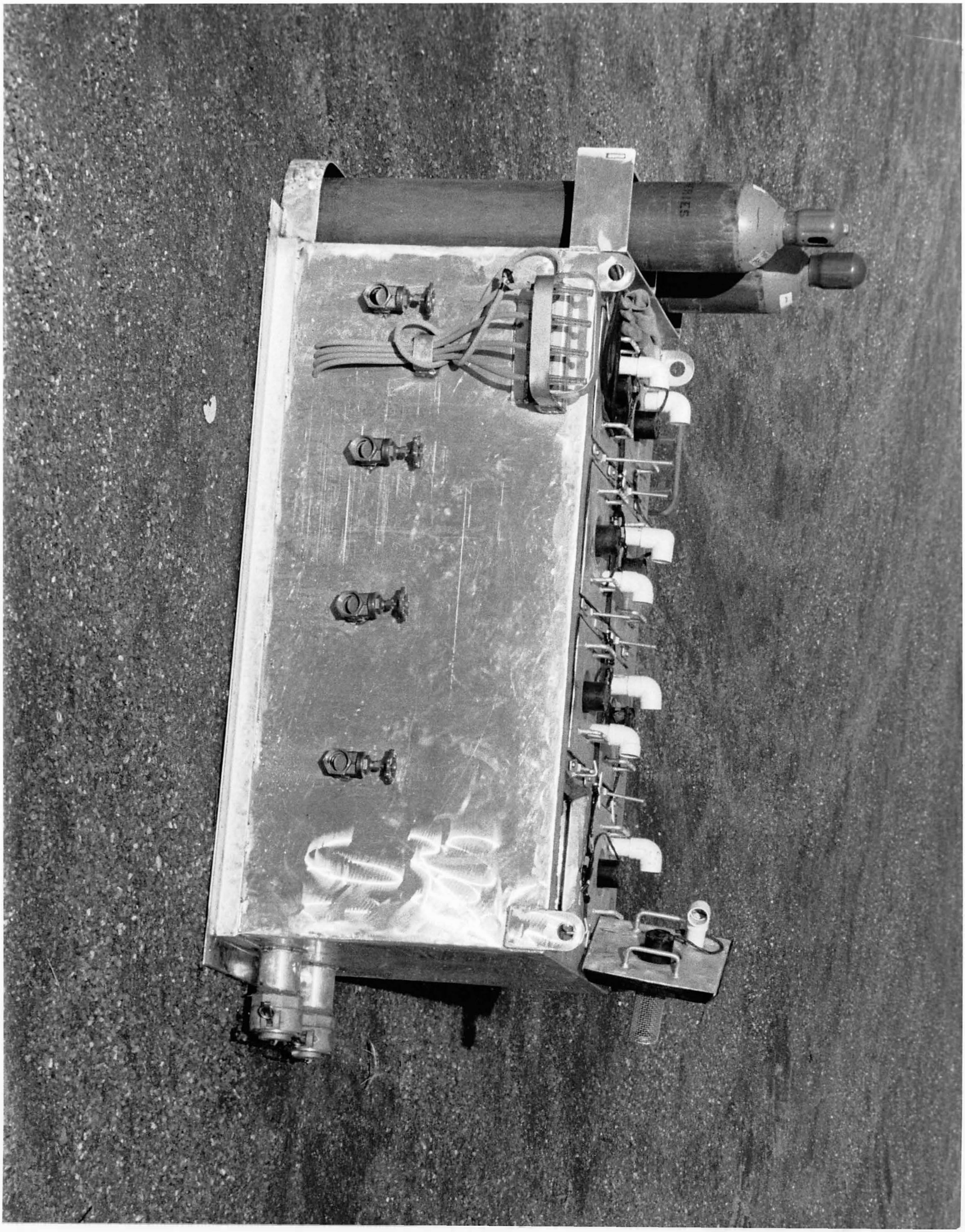


Figure 2.--Photograph of experimental tanker.



Experimental Tanker Used to Study Transportation of Juvenile Salmonids

The National Marine Fisheries Service (NMFS), in cooperation with the U.S. Army Corps of Engineers, has been conducting research involving the collection of juvenile Pacific salmon (*Oncorhynchus spp.*) and steelhead trout (*Salmo gairdneri*) at several dams on the lower Snake River in southeastern Washington and the transportation of these fish by trucks and barges around the remaining dams to a release site below Bonneville Dam, the most downstream dam on the Columbia River (Trefethen and Ebel 1973; Ebel et al. 1973; Ebel 1980). Transportation provides protection for the juvenile salmonids from turbines at dams, predation, and gas bubble disease (Ebel et al. 1973).

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A research project was undertaken in 1981 by the NMFS to identify areas which could cause significant stress to fish in the collection and transport system at Lower Granite Dam on the Snake River and McNary Dam on the Columbia River. Stress of fish while in transport trucks was identified as a potential problem which led to consideration of load density and species interaction as contributing stressors. To test the effects of these potential stressors simultaneously in large fish tankers is impractical due to the large fish numbers and many compartments required; therefore, a small multi-compartmental experimental tanker was designed and built to simulate conditions in the large 18,900-L (5,000-gal) tankers, while minimizing numbers of fish required per test. This paper describes the experimental tanker in detail.

The experimental tanker (Figs. 1 and 2) is divided into eight isolated 75-L (20-gal) com-

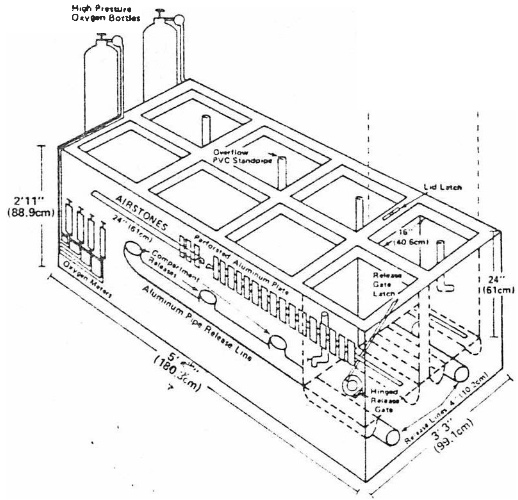

Fig. 1. Isometric view of the experimental tanker.

partments and constructed of 0.63 cm (1/4 inch) welded aluminum plate. It is double walled and insulated with a 7.6-cm (3-inch) layer of Styrofoam[1] between the inner and outer walls. Common to all compartments are: a 10.2-cm (4-inch) diameter hinged release gate in the floor of the tank; two recessed air stones in the bottom covered by a perforated aluminum plate; a 5.1 cm (2-inch) diameter screened polyvinyl chloride (PVC) overflow standpipe which exited through a gate valve on the outside of the tank; and a compartment lid equipped with a small surface agitator, powered by a 12-V battery, and a vent for escapement of excess or waste gases. A 5-ohm, 25-W resistor was wired in series with the d.c. motor of the agitator to reduce rpm. There are two 10.2-cm (4-inch) diameter parallel aluminum pipe release lines, each draining four compartments.

The life support system contains two high pressure oxygen bottles, each attached to a separate bank of four medical oxygen flow meters connected in series with four 61-cm

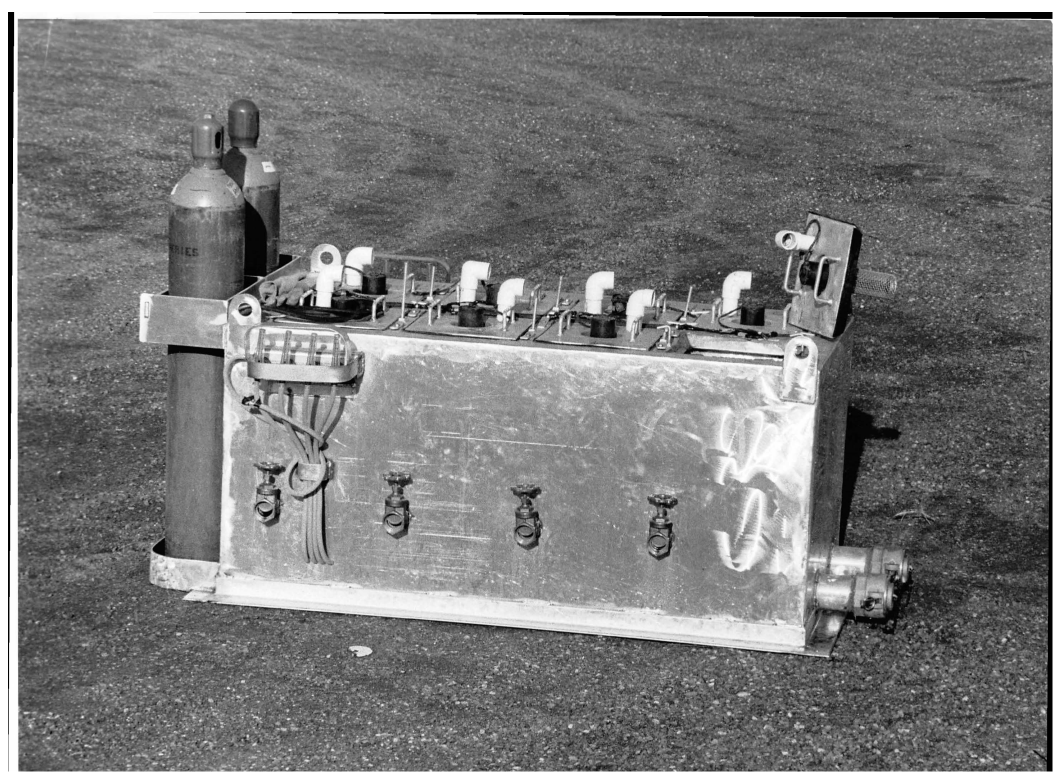

Fig. 2. Photograph of experimental tanker.

(24-inch) long carbon graphite air stones. By supplying oxygen in each compartment through two air stones, continued oxygen flow is ensured if a problem occurs in one of the two systems.

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Advantages of using the small experimental tanker in this study were: 1) desired transport densities were achieved using comparatively few fish; 2) the multi-chambered tank enabled simultaneous experimentation or replication of several test conditions; and 3) being very compact, the tank could fit in the bed of a heavy-duty pickup truck. The tanker can be used to simulate actual transport conditions at a test site without moving the fish to a release site.

The experimental tanker was used at Lower Granite Dam in the spring of 1982 to determine the relative difference in post-transport stress levels of three groups of fish: 1) chinook salmon only, 2) chinook salmon-steelhead trout mix, and 3) steelhead trout only. The three groups were transported at densities of 1.87, 3.75, 7.50, and 11.25 lbs/ft^3. During testing, six trips were made from Lower Granite Dam to Bonneville Dam, a distance of 395 km (245.4 miles) and a duration of 8 hours. Throughout the transport period oxygen levels remained at or above saturation and temperature fluctuated 1.11 C (2 F) or less in the tanker's compartments. Sampling protocol for the stress studies required minimal harassment of test fish; therefore, it was not practical to recover and record actual transport mortalities. Sample numbers obtained from the compartments for test purposes indicated mortality in all compartments was minimal; also, visual observation of the fish at the post-transport sample site revealed no apparent problems.

Acknowledgments

Special thanks to Wallace C. Iceberg and Phillip G. Weitz for their time and expertise in constructing the experimental tanker.

References Cited

Ebel, W. J., 1980. Transportation of chinook salmon, *Oncorhynchus tshawytscha*, and steelhead *Salmo gairdneri*, smolts in the Columbia River and effects on adult returns. Fish. Bull. 78:491–505.

Ebel, W. J., D. L. Park, and R. C. Johnsen. 1973. Effects of transportation on survival and homing of Snake River chinook salmon and steelhead trout. Fish. Bull. 71:549–563.

Trefethen, P. S., and W. J. Ebel, 1973. Collection and transportation system of juvenile salmonids evaluated at Little Goose Dam. Mar. Fish. Rev. 35(8)33–36.

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