RECLAMATION Managing Water in the West

June 2012
Research and Development Office
Bulletin 2012-15

The Knowledge Stream
Research Update

Establishing Swimming Performance Criteria for Fish

Using fish swimming performance data to improve the design and operations at Reclamation facilities

Bottom Line

These studies provide data for improved design and operation of fish screens and fish passage structures.

Better, Faster, Cheaper

This field-based fish holding and experimental setup can be used for projects Reclamation-wide.

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Collaborators

Reclamation:

- **Montana Area Office**
- **Klamath Basin Area Office**
- **Tracy Area Office**
- **Pacific Northwest Region**

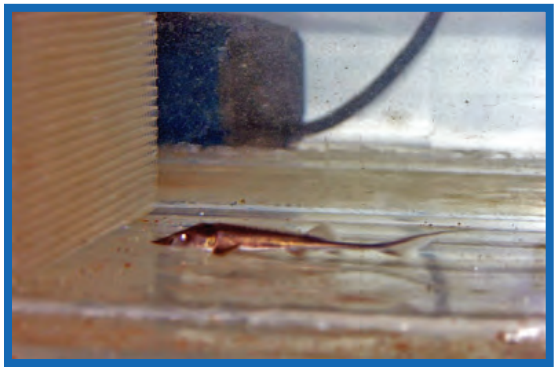
Confederated Tribes of the Umatilla

Problem

Understanding how well various species of fish swim under varying flow velocities is crucial for the design and operations of Reclamation's fish passage and fish screening facilities. For example, flow velocities near intake structures that are higher than a fish can handle could contribute to entrainment losses. However, if we know the swimming performances for particular life stages of a fish, we can identify appropriate locations to apply innovative fish barrier technologies such as non-physical barriers that use light, sound, and bubble curtains to limit potential entrainment loss. Moreover, by understanding swimming performances we can develop effective procedures, facility components, and equipment that will improve fish survivability. Similarly, experimental methodology, such as tagging or marking procedures used in mark and recapture studies, that affect the swimming performance of fish can contribute to biased test results (see Sutphin et al. 2007). Thus, a clear understanding of the effects of experimental methodology on fish swimming performance is also key to analyzing fish and potential effects on fish for Reclamation decisions related to operations, maintenance, new projects, and more.

Solution

To help provide these data for Reclamation analysts, engineers, and decisionmakers, this Science and Technology Program research project conducted multiple independent fish swimming studies on fish at Reclamation facilities. We worked with regional managers and biologists to identify the specific information about swimming performance needed to improve Reclamation's procedures or operations. The type of swimming performance evaluated was targeted to meet the demands of the particular species tested and regional science needs.



Late-larval pallid sturgeon in one of our fish swimming flumes.

Larval Pacific lamprey being inserted into our fish swimming flume for testing. The fish swimming flume is inside our mobile testing laboratory.

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Our three fish swimming chambers were designed, built, and calibrated by Reclamation's Technical Service Center's (TSC) Model Construction Group and Machine Shop. Some of these studies were conducted under laboratory conditions at the TSC.

However, most of species tested were species which are of special concern and/or are threatened and endangered (Pacific lamprey [*Lampetra tridentate*], Klamath River Basin suckers, and Chinook salmon [*Oncorhynchus tshawytscha*]). Tests on these species were undertaken at or near fish collection sites using Reclamation's Mobile Testing Laboratory. This new and innovative method minimizes fish handling and transportation; tests fish using their native waters with a natural temperature regime, photoperiod and water chemistry; and typically permits return of test fish to their natural system (thus minimizing mortality of threatened and endangered species). Field-based testing can also provide a cost savings to Reclamation, because it reduces the need to secure fish transportation permits and employee time necessary to transport fish.

More Information

Please see the more comprehensive discussion of our research results in the following reports.

Fin clipping, visual implant elastomer, and photonic marking solution, commonly used to mark fish for mark and recapture experiments, have no negative impact on a fish's ability to swim:

- Portz, D. and Z. Sutphin. In Draft. Effects of Fin Clipping for DNA Sampling on Physiological Stress, Swimming, and Survival of Chinook Salmon. Tracy Fish Collection Facility Studies. Volume X. Bureau of Reclamation, Mid-Pacific Region and Denver Technical Service Center.

The tested vacuum pump could be used at hatcheries and other Reclamation facilities to efficiently move fish into tanks:

- Portz, D. and Z. Sutphin. In Draft. Evaluation of Fish-Friendly Vacuum Pump Systems to Remove Salvaged Fish from Recessed Cylindrical Holding Tanks at the Tracy Fish Collection Facility. Tracy Fish Collection Facility Studies. Volume X. Bureau of Reclamation, Mid-Pacific Region and Denver Technical Service Center.

A mobile, field-based laboratory can be employed in an efficient manner to measure the swimming performance of fish:

- Sutphin, Z., C.A. Myrick, and M.M. Brandt. 2007. Swimming Performance of Sacramento Splittail Injected with Subcutaneous Marking Agents. North American Journal of Fisheries Management 27:1378–1382.

- Sutphin, Z. and C.D. Hueth. 2010. Swimming Performance of Larval Pacific Lamprey (*Lampetra tridentata*). Northwest Science, Vol. 84, No. 1, 2010.

- Sechrist, J. and Z. Sutphin. 2010. Effects of Non-Physical Modalities at Preventing Entrainment of Klamath Basin Suckers, 2010 Annual Progress Report.

- Mefford, B. In Draft. Intake Diversion Dam Fish Screens. Evaluation of Fish Screens for Protecting Early Life-Stages of Pallid Sturgeon. Hydraulic Laboratory Report HL-200X.

"Reclamation engineers can use these data, particularly the swimming endurance curves, when designing screens and barriers for fish. These curves, which define the burst, prolonged, and sustained swimming performance, can be used to predict the approach velocities at Reclamation structures and screens that are likely to result in impingement or entrainment."

Zachary Sutphin,
Principal Investigator

Future Development Plans

We have developed the mobile fish testing laboratory and multiple fish swimming chambers and have this equipment available for testing. However, there are no current studies identified that will use this equipment.