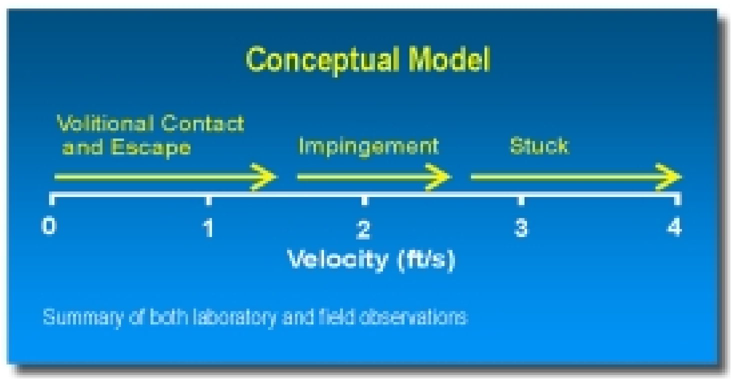
Response of Juvenile Pacific Lamprey to Turbine Passage

Columbia River Basin populations of Pacific lamprey (*Lampetra tridentata*) have severely declined in the past 30 years. It is thought that construction and operation of federal and private hydroelectric facilities may negatively impact juvenile lamprey because these declines occurred after the period of major hydroelectric development.

The lamprey's ability to survive hydroelectric turbine passage is not yet known. One concern, however, is that juvenile lamprey have a higher potential than other fish species for entrainment in turbines because they swim near the bottom of the river and are weak swimmers.



Caption Needed

To help determine the Pacific lamprey's ability to survive turbine passage, Pacific Northwest National Laboratory scientists conducted laboratory tests designed to simulate a fish's passage through the turbine environment. Juvenile Pacific lamprey were subjected to two of three aspects of passage: pressure drop and shear stress. The third aspect, blade strike, was not tested.

Pressure Drop

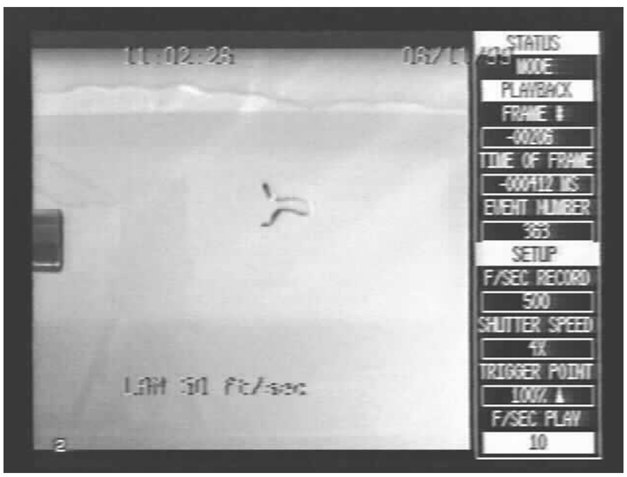
The absolute changes in pressure were designed to be similar to those a fish would experience during passage through a Kaplan turbine environment. We used a hyperbaric chamber to test a single worst-case scenario for lamprey: bottom-acclimated with a surface return. Juvenile lamprey were acclimated to an equivalent pressure of 60 ft depth for 24 h prior to passage. The entire pressure sequence lasted about 90 seconds.

Results from the simulated turbine passage tests showed no immediate external injuries or mortalities for lamprey exposed to rapid changes in pressure, i.e., ~400 kPa to ~5 kPa in 0.1 sec. That juvenile lamprey lack a swim bladder may be one reason for their resistance relative to bluegill sunfish, for example.

Shear Stress

Juvenile lamprey were subjected to a range of shear forces, such as those encountered as a fish passes through a turbine. Individual lamprey were placed directly into the shear zone using a tube located just above the jet nozzle. Three replicates with 10 fish per treatment were exposed to jet velocities ranging from 0 to ~15 m/s.

Lamprey did not suffer any ill effects at exposure to the high differential velocities (equivalent to rates of strain 1220 to 1830 cm/s/cm) that injured and/or killed juvenile salmon and shad. Possible reasons for the hardiness of juvenile lamprey may include their flexibility and the reduced size of vulnerable structures. For example, injuries to salmonids often involved the operculum—a structure absent in lamprey.



Caption Needed

These studies showed that at least two of the three main forces present in turbine passage (pressure and shear stress) were not harmful to juvenile Pacific lamprey. The effects of blade strike or sublethal effects, such as increased vulnerability to predation following turbine passage, are not known.

Results from these studies will assist the U.S. Army Corps of Engineers in their ongoing fisheries studies, particularly the effects of extended length bypass screens on juvenile Pacific lamprey. Results also will help the U.S. Department of Energy's Advanced Hydropower Turbine System Program make decisions in designing new "fish friendly" turbines.

This project has benefited from support by the U.S. Department of Energy's Advanced Hydropower Turbine System Program and the U.S. Army Corps of Engineers.

(www.inel.gov/national/hydropwer/turbine/turbine.htm).

For more information, contact
Dennis D. Dauble
Pacific Northwest National Laboratory
(509) 376-3631
or
Bob Mueller
Pacific Northwest National Laboratory
(509) 372-1344