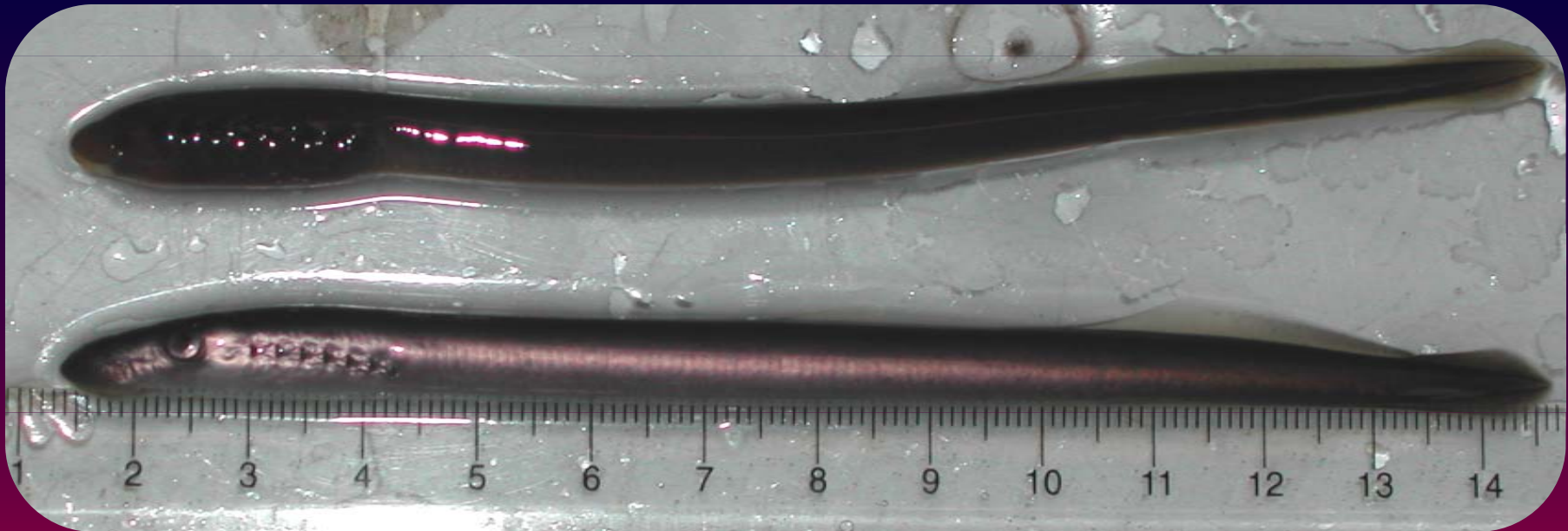


Considering Stone Lickers in Fish Screen & Passage Design



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Lacking paired fins, adults are weak swimmers using a “burst and attach” mode of movement to get through high velocity areas

Swim using lateral undulatory movements

PACIFIC LAMPREY LIFE CYCLE



Adults live in ocean 1-3 years and feed on host fish



Adults migrate to freshwater and hold over about a year



Adults develop teeth on sucking disk for parasitic feeding



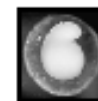
Adults spawn in gravel nest in stream riffles, then die



Larvae transform to juveniles (macrophthalmia) and migrate to the ocean



Ammocoetes live in silt/sand substrates as filter feeders for 3-7 years



Eggs hatch into larvae (ammocoetes) and drift downstream to slow velocity areas

Irrigation Diversions and Modifications

	Ammocoete	Macrothalmia	Adult
Dessication	X	X	X
Delay in migration		X	X
Impingement	X	X	X
Entrainment	X	X	X
High water temperature	X	X	X
Dessication of redd			X
Passage Barrier	X	X	X

What we know about Juveniles

- Volitional movement of lamprey mainly at night. Avoid daylight and burrow in fine substrate (ammocoetes)
- Average burst speed of juvenile lamprey 2.3 ft/s . Sustained swim speed in 5 minute tests ranged from 0 to 1.5 ft/s, median of 0.75 ft/s. (*approach velocity must not exceed 0.40 ft/s for active screens, or 0.20 ft/s for passive screens*)
- Juvenile lamprey became impinged on bar screens at velocities of 1.5 ft/s or higher during exposures in the swim chamber. Tail-first penetration behavior

Dauble et al (2006)

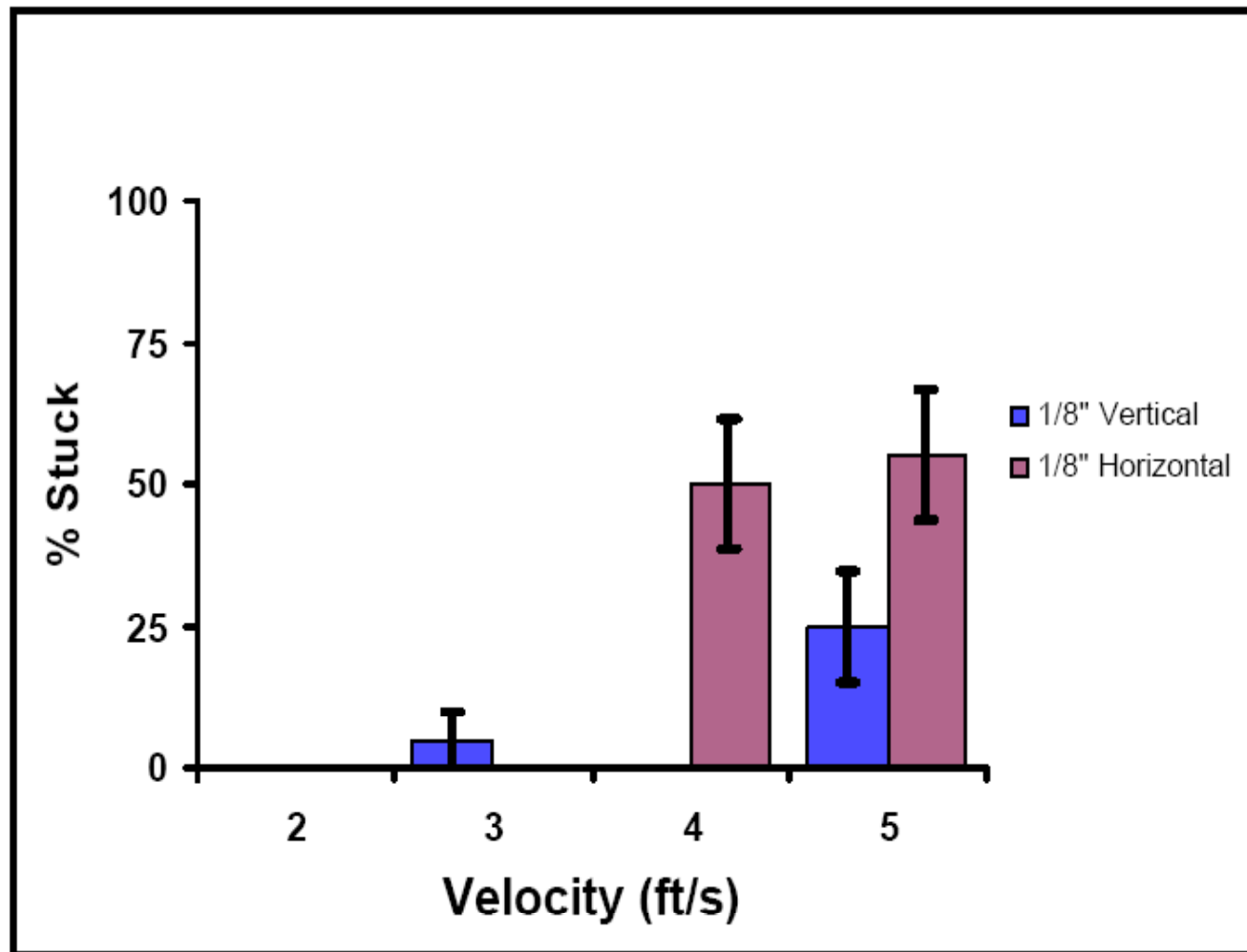


Figure 10. ESBS Screen Material Orientation Effects, Vertical and Horizontal, with a 10° Degree Tilt to Simulate Sweeping Flows (bars = \pm SE, n=10)

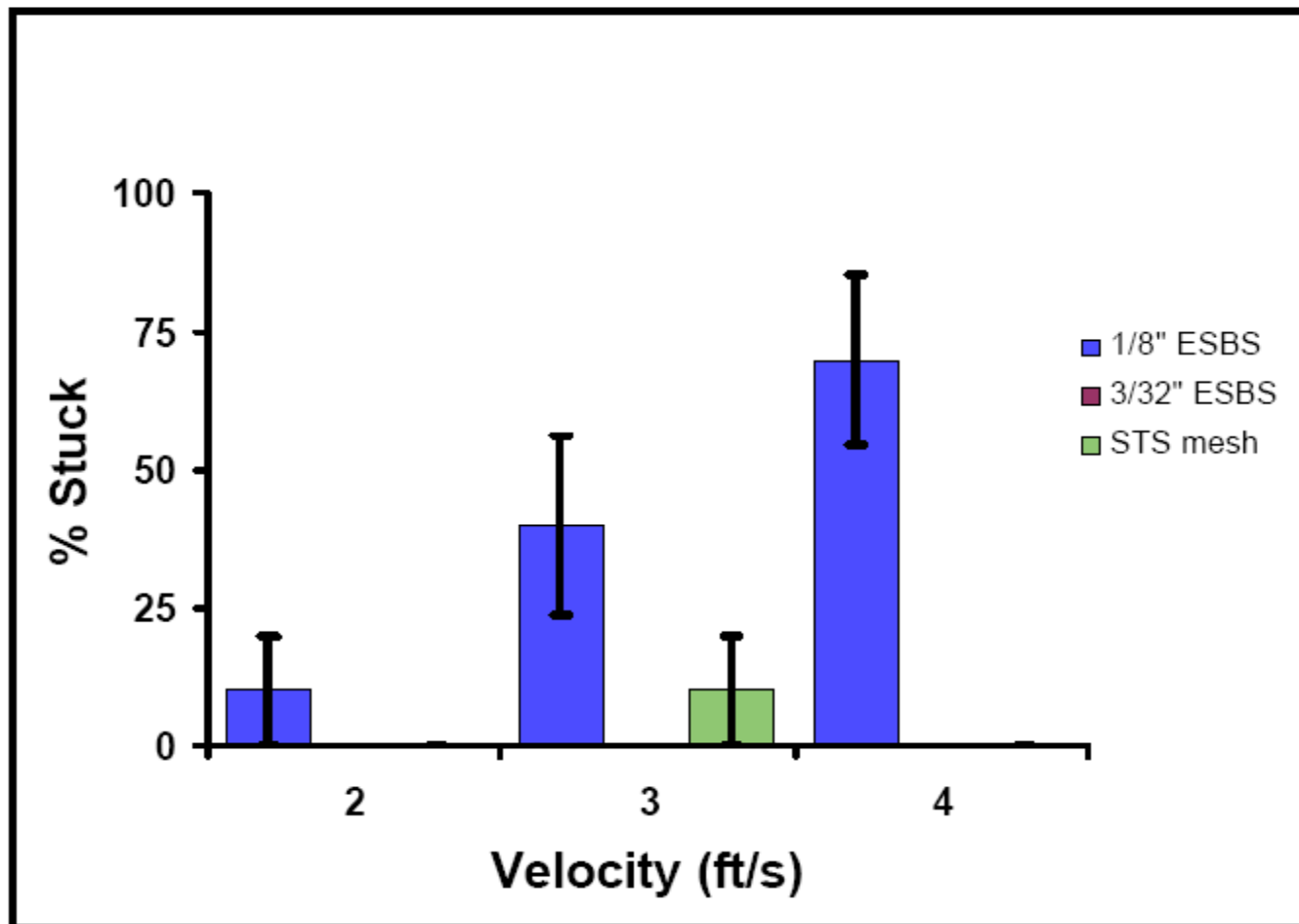
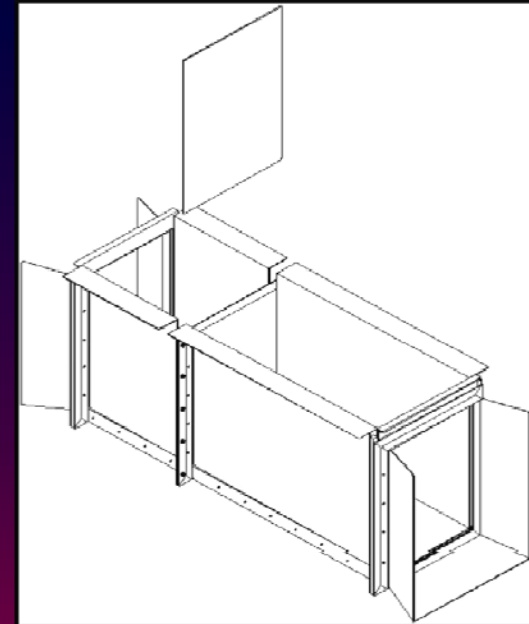
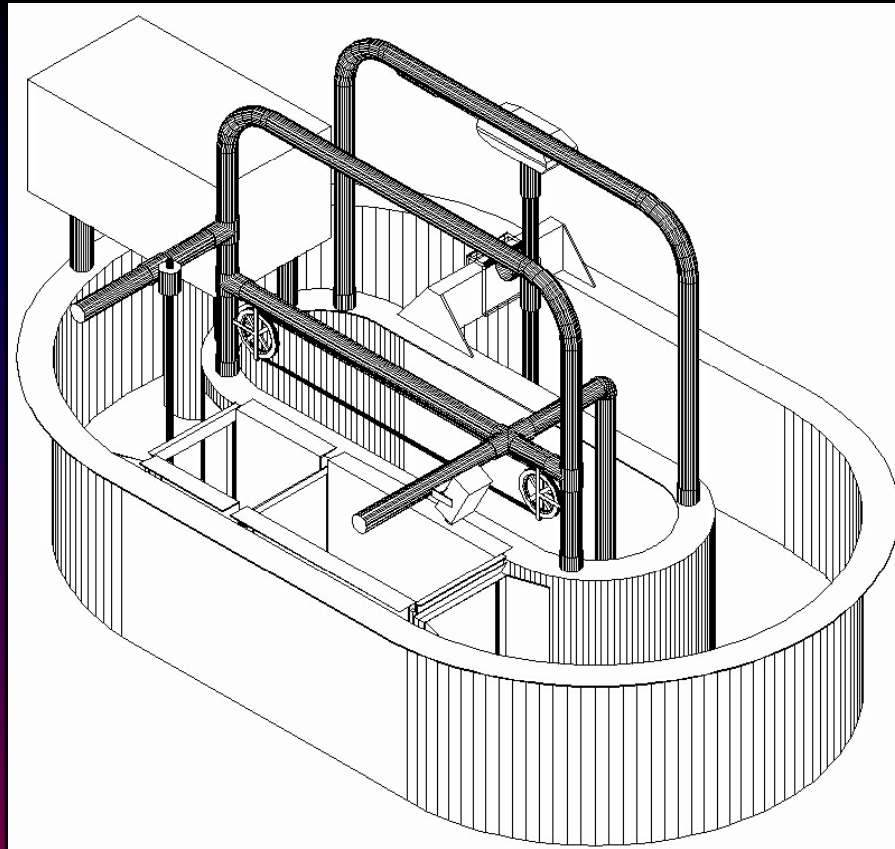


Figure 11. Lamprey Response to Three Types of Screens Material. Tests were conducted with screens perpendicular to the flow for 10-min durations (n=20 for each 1/8-in. ESBS and n=10 for 3/32-in. ESBS and STS tests). Note that no lamprey became permanently stuck on the 3/32-in. bar screen (bars = \pm SE).



- 1) 2.4 mm perforated plate
- 2) 1.75 mm profile bar with vertical orientation
- 3) 1.75 mm profile bar with horizontal orientation
- 4) 2.4 mm woven wire, 14 gauge
- 5) Average velocity across screen face 0.4 ft/s

Findings

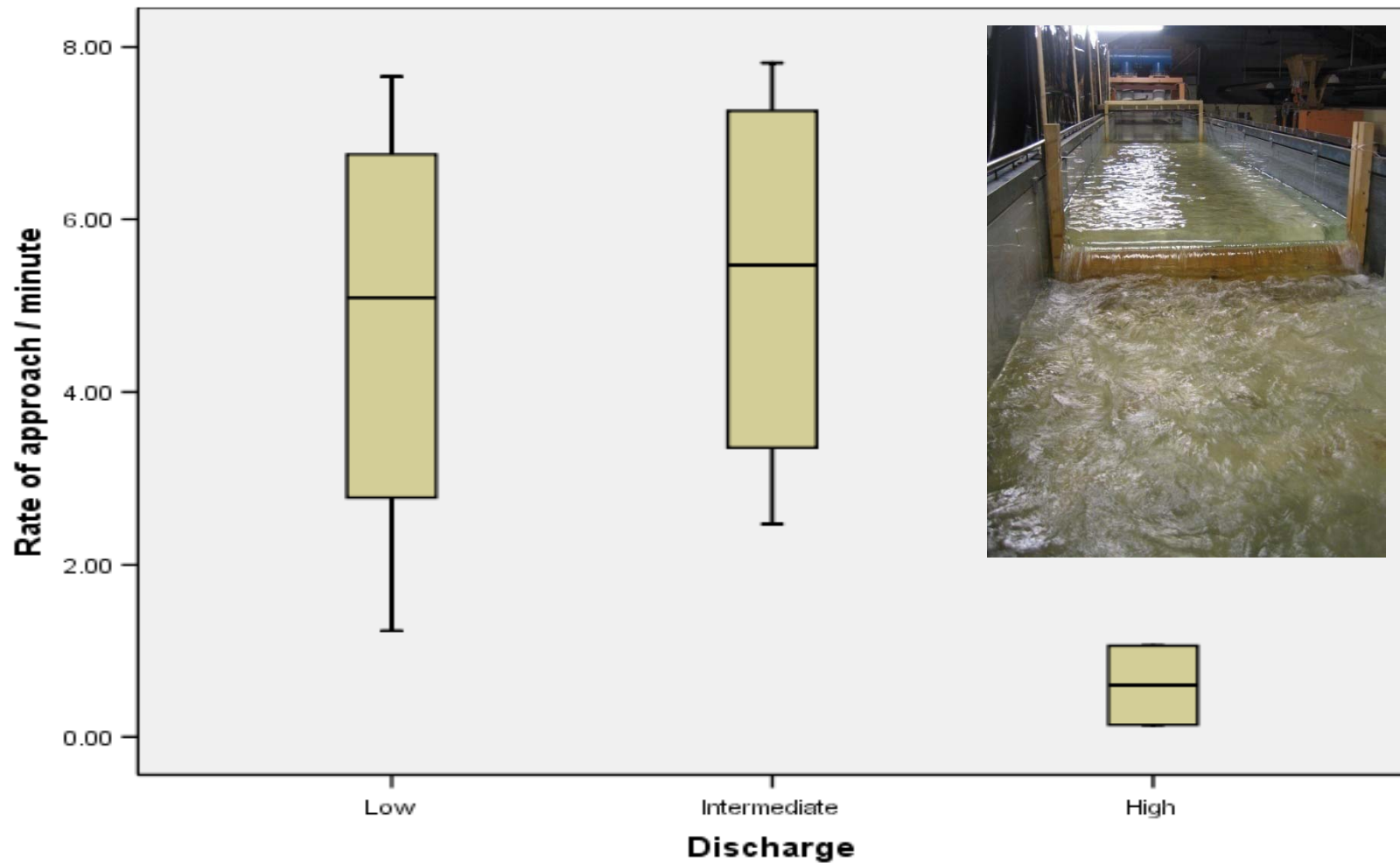
- **Frequent screen contact but impingement not common**
- **Macrothalmia spent the majority of time motionless attaching themselves with their oral disk to the screen or to the surfaces of the test chamber.**
- **Spent the majority time associated with the edges of the test chamber**
- **No initial or delayed mortality of lamprey regardless of screen type.**
- **Long resident times of macrothalmia in contact with all screen types suggest that designs should facilitate quick passage into bypass**

Adult Passage

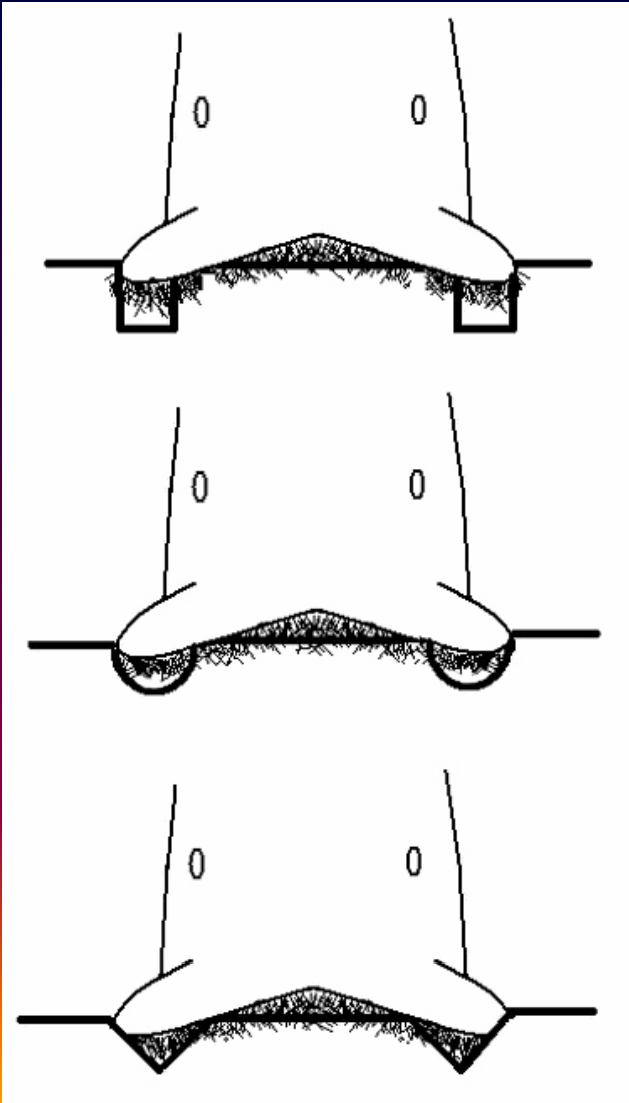


Velocity

5-6 ft/sec have been found problematic for adult Pacific lamprey and European river lamprey (Mesa et al 2003, Kemp 2008)



Corners and Attachment Surfaces



Richards 2007



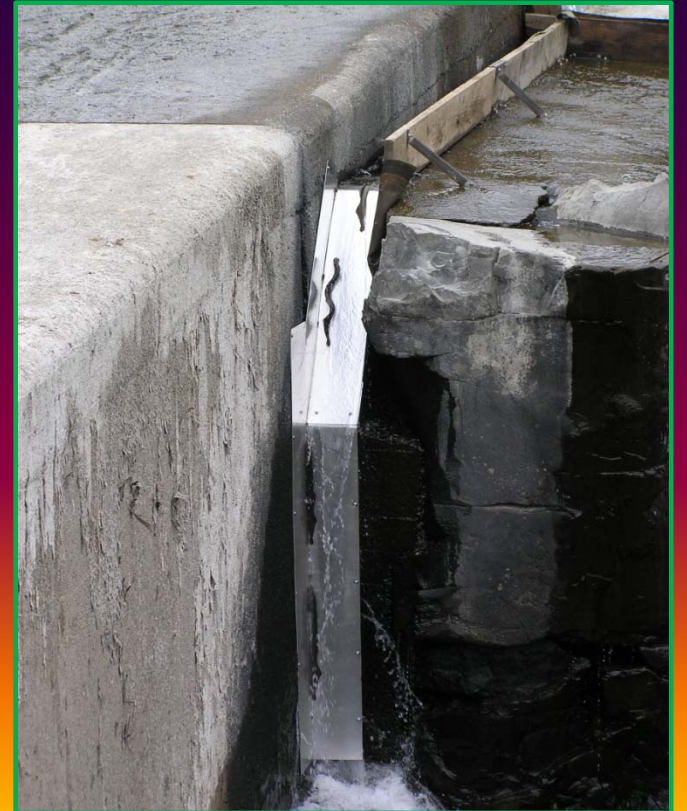
Adams 2006



Moser et al 2004

Lamprey Passage Structure (LPS)





Construction and Maintenance Considerations



Construction, channel dewatering and maintenance dredging can:

- **Strand or remove ammocoetes and macrothalmia**
- **Result in a loss of several age classes and generations**
- **Dessicate redds**
- **Disrupt Migration**

Specific considerations to reduce affects to ammocoetes during construction

- Avoid dewatering. If dewatering is necessary:
 - Dewater slowly over several days or at a minimum overnight.
 - Identify areas adjacent to ammocoete habitat outside of the disturbance area but within the channel and dig holes where ammocoetes may take refuge. Anecdotal information suggests that ammocoetes will move into areas that retain water. Cover these “refuge holes” to protect them from predators.
 - A technique yet untried is to place straw bales in or near ammocoete habitat as dewatering occurs and overnight. Based on methods used by Fraser River anglers to catch ammocoetes for bait, the lampreys purportedly will move into the straw.
- Identify and protect areas that may function as ammocoete habitat
- Protect natural surface and subsurface flows.
- Salvage lampreys using electro-shocking or seining

Needs and Challenges

- **Move beyond salmonid-centric mindset and consider multiple species solutions to screening and passage problems**
- **Are current criteria for sweeping velocities and screen material adequate for lamprey?**
- **Step up replacement of fish screens in lamprey streams with those that will prevent entrainment of lamprey**
- **Provide passage over irrigation diversions that currently block upstream migration of lamprey**
- **Negotiate water savings and ditch consolidation where possible to provide more instream flow**
- **Ramp down flows at end of season to allow ammocoetes to escape in front of ditch screens**

