COLUMBIA BASIN
FISH AND WILDLIFE AUTHORITY

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TO: Lamprey Technical Workgroup

FROM: Ray Hartlerode, Fish Screening Oversight Committee (FSOC) Chair

SUBJECT: Questions Regarding Lamprey and Screening Facilities

The Fish Screening Oversight Committee (FSOC) is aware of the need to protect lamprey as well as salmonids at screening facilities, but realizes that expertise on lamprey passage within the FSOC is limited. The FSOC therefore requests that the Lamprey Technical Workgroup review the following initial questions and assumptions regarding lamprey, and provide the FSOC with a summary of available and related information.

1) What is known about lamprey attachment and detachment from screens? What are the impacts of different cleaning mechanisms?

   The tribal restoration plan seems to address only the macrophthalmia at screen sites and the impact that a cleaning system might have should they reside on the screen. The cleaning system in question typically applies to flat plate screens and consists of a single brush or numerous (gang) brushes. The plan suggests modifications including spray or bubble devices "that would cause lamprey to detach from the screens." At sites without power this isn't an option, especially remote sites.

   At rotary drum and traveling belt screen sites the same issue is present sans the cleaning device issue. If lamprey were to attach to the screen material and were carried vertically, would they detach as soon as they were lifted out of the water?

   Based on our lab studies with juvenile lamprey, I would say that lamprey would not become detached from a surface when they are dewatered. Especially for a short duration as they would be when carried over a drum screen. They would probably become detached on the downstream side when they encountered the rubber seal at the base of the screen.

   The brush type screen mechanism for vertical plate screens may pose a problem for lamprey which are attached to the screen. I am not aware of any studies addressing this but the brush bars on the ESBS screens at the intakes of large dams have shown to be detrimental to lamprey which have become stuck on profile bar screens.

Lamprey can become impinged with perpendicular water velocities of 45- 76 cm/s and become stuck in 1/8" bar screen when approach velocities exceed 85 cm/s (Moursund et al. 2002).

I think macrophthalmia are more likely to attach to screens by their sucker mouth and ride the screen to be crushed by the cleaner. Whether or not they attach at least partly depends on approach velocity. They are also able to detach. Back flushing, spray or bubble devises may encourage macrophthalmia to detach.

But if a macrophthalmia or ammocoete is impinged on the screen, they probably cannot detach. The impingement itself, or the cleaning device, is likely to kill them. A combination of approach velocity and size of the screen mesh needs to be used to decrease impingement.

The location of the bypass facility and the time of year that the facility is operated may determine whether macrophthalmia or ammocoetes, or both, are likely to be passing.

2) Are the current mesh size and approach velocity criteria adequate for various life stages of lamprey?

   Sweeping velocity should be high enough to discourage temporary residency and sweep lamprey directly into the bypass. Currently, the criteria stipulates, "The sweeping velocity shall equal or exceed the maximum allowable approach velocity." Does this need to be more specific to accommodate the needs of macrophthalmia? Of equal if not greater concern is the ammocoete phase. Current criteria mesh size may not be small enough to preclude entrainment of young ammocoetes.

   Based on my experience the current NMFS screening requirements would be adequate to protect ammocoetes and juvenile migrating lamprey. Water velocities would be low enough to prevent lamprey from becoming stuck in profile bar screens. Perforated plate screen may promote lamprey attachment. Wedge-wire screen would likely be less condusive for lamprey attachment. The NMFS approach criteria in canals to protect juvenile salmon fry is 0.4 ft/s (12.2 cm/s).

   In discussions with Dennis Dauble, there is an optimal velocity to avoid lamprey mortality. At too high velocities, lamprey will reverse and impinge tail-first on the screens. At too slow velocities, lamprey will adhere to the screen via their sucker mouths and be crushed by the cleaning device (especially a problem with macrophthalmia). Optimal velocities may vary depending on the configuration so some project-specific testing may be needed.

Lampreys should be expected to be able enter any gap in the mechanisms that is their diameter or bigger. They can impinge on any gap that is the diameter of their tail-end.

3) Is information available regarding swimming strengths (including burst speed as well as sustained speed) of the various life stages of lamprey?

The burst swimming rate for lamprey (120-170 mm in length) ranges from 60 to 100 cm/s (mean 76 cm/s) which equates to a average speed of ~ 5.6 body length (BL)/s (Mueller et al. 2006) The sustained swim speed for lamprey with lengths of 128 to 170 mm varies from 23 to 37 cm/s (see Dauble et al. 2006, Mueller et al. 2006).

4) Can any stage in lamprey life history burrow below a screen structure?

A concern is the potential for ammocoetes to burrow into the canal sediment in front of the screen. When lamprey are observed on the downstream side of a screen it is assumed that the screen did not work, the screen material was large or there was a gap allowing them to get through. Is it possible that the screen worked as designed but the lamprey took a path through substrate?

If substrates are available lampreys should be expected to try to burrow through them.

5) What is the de-watering rate necessary to protect ammocoetes?

At fall shut-down canals are typically dewatered, unless stock water is provided throughout the winter. Any lamprey in the canal could then be stranded and lost. Ammocoetes are susceptible to pressure changes and should emerge during a ramped down dewatering.

An exact rate is not known. However lampreys have been observed to be stranded during draw-downs so a much slower rate is necessary than would be implemented for typical project operations. The draw-down rate may vary by time of day (daylight vs darkness).

6) Is the strength of common electrofishers used for juvenile salmonids (e.g. Smith-Root model-12) detrimental to ammocoetes?

If water remains in the canal for some reason, electrofishing typically occurs to salvage any remaining juvenile salmonids. Ammocoetes are also susceptible to electrofishing and will emerge. There appears to be one specific model that is used nationally for ammocoete research; model AbP-2™ backpack electrofisher (Engineering Technical Services, University of Wisconsin).

Another concern is the periodic dredging of the canal by the irrigator to reduce sediment load in front of the screen. If the dewatering isn't ramped down and/or the canal electrofished prior to dredging activities, ammocoetes will be lost.

It is not known whether salmonid targeted electrofishing is detrimental to ammocoetes. It is thought, however, that the stronger settings may potentially induce a narcosis in ammocoetes causing them to be immobilized in the sediment instead of irritated out of the sediment. The University of Wisconsin AbP-2 shocker is definitely the model that is used most often for ammocoete targeted sampling. Smith Root does have a new model, the LR-24, which can be used with the lower power lamprey settings. In a comparison study the AbP-2 and LR-24 (using lamprey settings**) showed similar results in detecting lamprey and capture efficiency (Luzier et al. unpublished data).**

Dredging will certainly be harmful to ammocoetes left in the canal sediment. Care should be taken to remove ammocoetes by slow watering down and electrofishing with lamprey specific shocker settings. Additionally, enough electrofishing passes must be made to increase probability that ammocoetes are being removed. Capture efficiency is not constant between electrofishing passes as with salmonids (Luzier et al. 2006, Luzier et al. unpublished data).

7) Is information available to indicate operation procedures to minimize effects of screening facilities on all life stages of lamprey?

   This may be related to migration timing and biology.

   I suspect a general answer for all configurations of facilities is "No". A testing and monitoring program should be part of new installations to optimize lamprey passage, including consideration of approach velocities, screen cleaning, screen mesh, time and locations, and draw-downs. Careful collection of data during these tests may eventually lead to some generalizations that could be applied to similar configurations.

8) To what extent are diversion structures barriers to adult lamprey?

   We know that some of the diversion structures are currently barriers to salmonids during certain times of the year. During the design of fishways in the future, lamprey passage should be a consideration.

   I think the task force could provide some information about what causes problems for adult lamprey, and therefore should be avoided, such as:

   - **High water velocities;**
   - **Openings that are big enough for lamprey to crawl into;**

- **Any feature that would require jumping in order to pass, such as:**
  - **Steps;**
  - **Hanging openings;**
  - **Flash boards;**
- **Smooth surfaces;**
- **No resting areas;**
- **Gratings;**
- **Lights;**

A nice pile of rocks with a gentle but steady flow over it is a great adult lamprey passage design.

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****Additionally, please see Mary Moser's work and Dennis Dauble's observations and information based on some work he did at irrigation facilities in the Yakima.**