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Assessment of Larval Lamprey Use of Dredged Materials Placed in the Columbia River at Woodland Islands for Beneficial Use, Summary Report 2023

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On the cover *is an aerial oblique view of Woodland Islands looking upstream as observed after dredged material placement (picture credit – USACE).*

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Background

Across their native range, many lamprey species have declined in distribution and abundance (Close et al., 2002; Maitland et al., 2015; Clemens et al., 2017, 2021). For all lamprey species, the life cycle includes a multi-year larval stage during which they burrow into fine sediments for up to ten years (Hess et al. 2022) and feed on algae, bacteria, and organic detritus in freshwater habitats (Dawson et al. 2015; Evans et al. 2019). Native lampreys are important fishes in freshwater ecosystems. Research suggests larval lampreys alter the physical and chemical environment of the benthic community (Shirakawa et al. 2013; Boeker and Geist 2016; Nika et al. 2021), aid in filtration of harmful bacteria out of the water column (Kalan et al. 2023), and act as a vital food source for aquatic and terrestrial predators (Cochran 2009; Arakawa and Lampman 2020). The extent that outmigrating juvenile lamprey act as a predation buffer has not been assessed, but it is thought to be significant. Anadromous adult lampreys are especially important in freshwater ecosystems because they modify communities when building redds, and their carcasses supply marine-derived nutrients (Hogg et al. 2014; Weaver et al. 2016, 2018; Dunkle et al. 2021; Georgakakos 2020).

The Columbia River Estuary Study Taskforce and the U.S. Army Corps of Engineers (USACE) are collaborating to evaluate potential benefits associated with strategic placement of dredged material, also known as "beneficial use". Their goal with beneficial use is to expand and restore shallow water habitats (USACE 2020). Eighty percent of dredged material is placed back into the river and yet effects of the dredged material placement (including beneficial use) on the density, distribution, and survival of larval lampreys have not been assessed. Likewise, there are no regulatory requirements to assess entrainment of any fishes, freshwater mussels, or other aquatic organisms during dredging operations in the Columbia River. The goals of this work were to initiate monitoring of lamprey relative to dredging and placement of dredged materials and to learn about the extent of use of the Woodland Island area by larval lampreys.

In the Lower Columbia River (LCR), relatively little is known about larval lamprey use of benthic habitats. Blanchard et al. (2023) documented that larval lamprey densities varied seasonally, annually, and among river mouths, ranging from 0.04 to 9.73 larvae/m^2 in the Columbia River Basin. This study included locations straddling Woodland Island at Columbia River tributary mouths, including the Kalama, Sandy, and Washougal, and at tributaries upstream of Bonneville Dam (Blanchard et al. 2023). In the lower Willamette River, in the Portland Harbor Superfund site, Blanchard et al. (2021) are currently conducting a long-term study (>20 years) to assess larval lamprey occupancy relative to cleanup and restoration efforts; however, no quantitative results have been reported yet that could inform restoration efforts. Finally, Jolley et al. (2011) sampled using the same gear as used in this study and at sites in the Columbia River downstream between river kilometers 24 and 61. Fifteen sites were sampled and no larval lampreys were caught.

The Woodland Islands are located between river kilometers 136-139 in the lower Columbia River (Figure 1) and were originally created from dredge material placement from the 1920s through the 1970s. The island locations include upland and wetland habitats and were primarily selected to increase shallow-water habitats for juvenile salmonids. The islands are located two km downstream of the Lewis River confluence with the Columbia River. Lamprey observed in the Woodland Island area, including Pacific and *Lampetra* species are likely from the Lewis drainage or from further upstream.

Figure 1. Location of the Woodland Islands and proximity to the Lewis River.

Methods

For deep water habitats, each sampling event consisted of a single drop with deepwater electrofishing equipment (Figure 2) at each of the 50 sites selected using a generalized random tessellation stratified (GRTS) approach (Bergstedt and Genovese 1994; Stevens and Olsen 2004; Jolley et al. 2012). Quadrats were accessed and sampled by boat using quadrat center points in Universal Transverse Mercator (UTM) coordinates for navigation. Including the boat and gear, the system can generally sample at depths from 0.3-21.3 m, and excessive aquatic vegetation can prelude sampling. The deepwater electrofisher comprised a modified AbP-2 electrofisher (ETS Engineering, Madison, WI), which delivered electrical stimulus to river bottom substrates at electrodes mounted to a fiberglass bell (or hood; 0.61 m^2 in area). The electrofisher delivered three pulses D.C. per second at 10% duty cycle, with a 2:2 pulse train (i.e., two pulses on, two pulses off). Output voltage was adjusted at each quadrat to maintain a peak voltage gradient between 0.6 and 0.8 V/cm across the electrodes. A 76 mm vinyl suction hose coupled the electrofisher bell to a gasoline-fueled hydraulic pump. The hydraulic pump was started approximately 5 seconds prior to shocking to purge air from the suction hose. Suction was produced by directing flow from the pump through a hydraulic eductor, which allows larvae to be collected in a mesh basket (27 x 62 x 25 cm; 2 mm wire mesh) while preventing them from passing through the pump. A 60-second pulse delivery was followed by an additional 60 seconds of pumping to allow further displaced larvae to cycle through the hose and into the collection basket. The sampling techniques are described in detail by Bergstedt and Genovese (1994) and were similar to those used in the Great Lakes region (Fodale et al. 2003) and the Willamette River (Jolley et al. 2012). Surveys were conducted before dredged material placement on July 5, 2019, and then after dredged material placement on September 29, 2022.

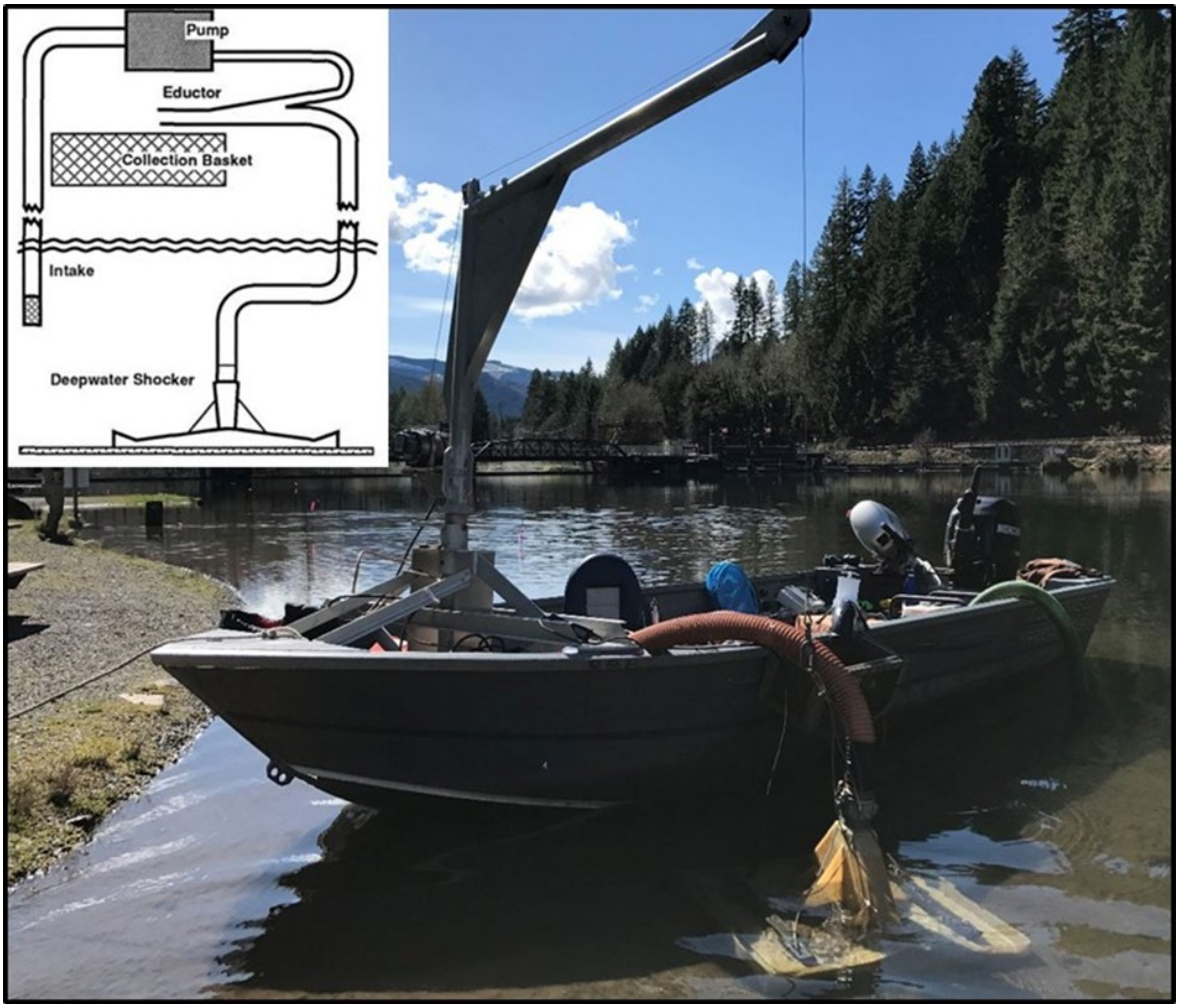

Figure 2. The deepwater electrofisher was used in this study to collect burrowed larval lamprey both before and after dredge material placement. The inset illustrates the functional components of the deepwater electrofisher. The inset is Figure 1b. *IN* Bergstedt, R. A., and J. H. Genovese. 1994. A new technique for sampling sea lamprey larvae in deepwater habitats. North American Journal of Fisheries Management 14(2):449-452.

Results

In 2019, all 50 quadrats could be sampled, with one lamprey occupying a single quadrat (Figure 3). In 2022, 27 of 50 quadrats were sampled, with a total of two lamprey occupying two separate quadrats (Figure 3). The 23 quadrats that could not be sampled in 2022 were either too shallow, contained too much aquatic vegetation to access, or were on land due to the dredge material placement. In 2022, when all sites could be sampled, depths at quadrats ranged from 0.3 to 3.5 m. Water temperatures and conductivities were 18.8 °C /133.6 μS/cm in 2019 and 19.3 °C / 136.2 μS/cm in 2022.

Figure 3. Aerial photograph of Woodland Island post placement of beneficial materials. The 50 sample GRTS points are depicted in white. The black triangle depicts the single location where a lamprey was caught in 2019, pre-placement, and the 2 black circles in 2022, post-placement. In 2020, the locations that could not be sampled (shallow water or heavy veg) are cross hatched.

Discussion

This was the first attempt to assess larval lamprey use of dredge material placement to enhance habitats in the lower Columbia River. Due to the low number of lampreys observed, we cannot assess the effects of the restoration relative to larval use or estimate the total number of larvae that may be using the site. Doing so would entail a robust assessment over many years, both before and after placement, and including reference sites (Before-After-Control-Impact). No assessments of larvae use or impacts were made at the dredging locations (source material). Larvae using the Woodland Island location likely originate from the Lewis River Basin or further upstream. Considering the proximity to the Lewis River, we expected to observe more larvae. However, the lower 11 km of the Lewis River is backwatered by the Columbia River and likely is suitable rearing habitat, potentially reducing the impetus to disperse further downstream. Future assessments should include sampling multiple years prior to and after dredging at the dredging location, the placement site, and appropriate reference locations. Larval lamprey presence can vary seasonally, annually, and among locations and tends to be highest in the spring

(Blanchard et al. 2023). Due to constraints of this study (e.g., small sample size, lack of seasonal sampling, etc.), we do not believe results of this effort adequately represent lamprey densities in the lower Columbia River.

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