A Pilot Study to Assess the Effects of Sediment Deposition on Larval and Juvenile Lampreys in Prosser, Washington (Chandler Canal)

(Cover Photo: Overview of the initial setup with the three enclosures on shallow fine sediment larval lamprey habitat on 24 November 2020)

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*This write-up was incorporated as a case study in the Lamprey Technical Work Group white paper "Monitoring and Minimizing Effects of Dredging on Lampreys" available at: https://www.fws.gov/pacificlamprey/Documents/Dredging__and_Lampreys_03.19.21.pdf

A pilot study was conducted in November 2020 in a dewatered irrigation canal along the Lower Yakima River (Chandler Canal, Prosser, WA) using 1-m^2 enclosures to assess lamprey responses to electrofishing settings related to voltage and duty cycle and to deposition of fine sediment (Figure A-7). Thirty four lampreys (small [30-60 mm] = 10, medium [60-90 mm] = 10, large [90-120 mm] = 10, juvenile Pacific Lamprey = 2, subadult Western Brook Lamprey = 2) were released into each of the three cylindrical enclosures. The two primary goals were to test the effectiveness of electrofishing settings in cold water conditions (< 10˚C) and to evaluate lamprey behavior associated with the deposition of fine sediment on top of their rearing habitat.

The conditions within the three enclosures at the start of the study were the following: water depth 6-10 cm, sediment depth 10-15 cm, water temperature 6.3-6.8˚C, and water conductivity 208-219 (see A in Figure A-8). Most of the released larval lampreys burrowed instantly after release and all burrowed within 15 min; over 80% of the transformed lampreys also burrowed in the fine sediment. The initial electrofishing test using various voltage settings (125-225 volts) was conducted 60 min after the burrowing of all larval lampreys were confirmed. The capture efficiency was the highest for 225 volts (100%) and was high for 175 volts (74%) and 125 volts (82%) as well (Figure A-8). However, these lampreys received very little acclimation time after release, so these capture efficiency rates we report here are likely inflated compared to electrofishing of lampreys under natural conditions.

Thirty min after all lampreys were again released back into each enclosure and burrowed again, 9-13 cm of fine sediment (primarily sand, secondarily silt) was deposited inside each enclosure (to 2 cm above the surrounding water depth) to test "dry shocking" method of electrofishing using three duty cycle settings (10%, 25%, and 50%) (see C in Figure A-8 and A in Figure A-11). Within 30 min after the sediment was added, at least a portion of the lampreys emerged to the top based on the appearance of 5-7 lamprey filter feeding holes in each enclosure (see B in Figure A-11) and prior to electrofishing two larvae emerged out of the sediment (see C in Figure A-11). Electrofishing was conducted 80-90 min after the last load of sediment was deposited. Based on the first pass results, the 25% duty cycle setting performed the best (18% capture efficiency; Figure A-10). However, when captures from all four passes were combined, the results were relatively similar and only 21-26% of the total number of lampreys were recaptured.

Due to the low overall recapture rates (with 74-79% still remaining in the enclosures), we systematically excavated/dredged the deposited fine sediment in each enclosure in 1.5-2.0 cm increments to assess the final depth profile of lampreys within the enclosure. Lampreys were found at various depth profile all the way down to 10-11.5 cm depth (Figure A-11). The mortality rates of the excavated lampreys were generally high in the 4-5.5 cm and deeper sediment profile (50-88%). Altogether 25% of the lampreys were unaccounted (i.e. never found at the end of the study); these lampreys may potentially have 1) burrowed into deeper sediment, 2) escaped the enclosure, or 3) been consumed overnight by avian / mammalian predators. Mortality rates were highest for the small larvae (48%), whereas no mortalities were observed for transformed lampreys, indicating they may be more resilient to sediment weight and pressure (Figure A-12). On the other hand, confirmed survival rates were similar across all size classes and species.

In summary, approximately one third of the lampreys were able to traverse ~10 cm of newly deposited sediment to the top, but many others remained in between the original depth and the sediment surface. Some caution is advised with the interpretation of these data. Because fine sediment was deposited above the water line (by 2 cm) in our study, this distinguishes this operation from a standard sediment deposition operation that occurs all under water. The canal water was 3.7 C in the morning of the second day and this very low temperature conditions may also have contributed to higher rates of immobilization and mortality within the fine sediment.

Figure A-7. Overview of the initial setup with the three enclosures on shallow fine sediment larval lamprey habitat.

Figure A-8. Examples of the sediment levels at various points of the study: A) the starting condition prior to any sediment addition, B) after ~10 cm of fine sediment was added, C) after the top 2 cm of fine sediment was excavated down to the surrounding water level.

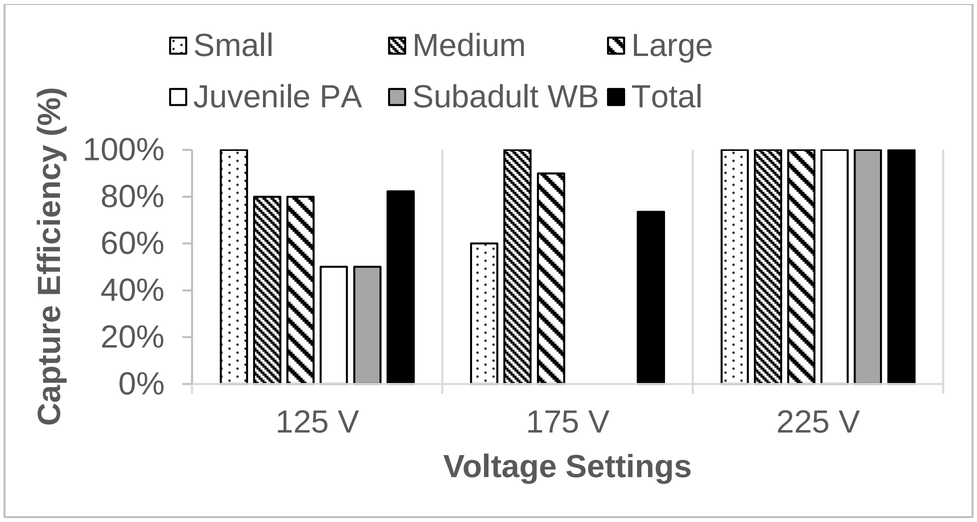

Figure A-9. Capture efficiency of lampreys with 125, 175, and 225 volt settings using ETS ABP-2 (larval lamprey) backpack electrofisher. Aside from the voltage gradient, we used the standard lamprey setting of 3 bursts/s slow pulse, 30 bursts/s fast pulse, 25% duty cycle, and 3:1 train pulse. PA stands for Pacific Lamprey and WB stands for Western Brook Lamprey in the legends.

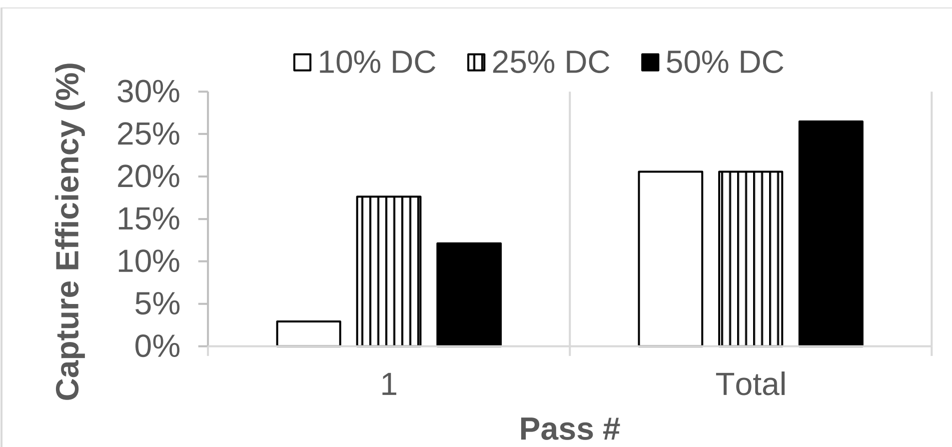

Figure A-10. Capture efficiency of “dry shocking” using three different settings of duty cycle (10, 25, 50%) after one pass and the cumulative total after four passes (“Total”). A voltage of 200 volts (instead of 125 volts) was used for all treatments due to the low water temperature conditions. Aside from the duty cycle gradient and voltage, we used the standard lamprey setting of 3 bursts/s slow pulse, 30 bursts/s fast pulse, and 3:1 train pulse.

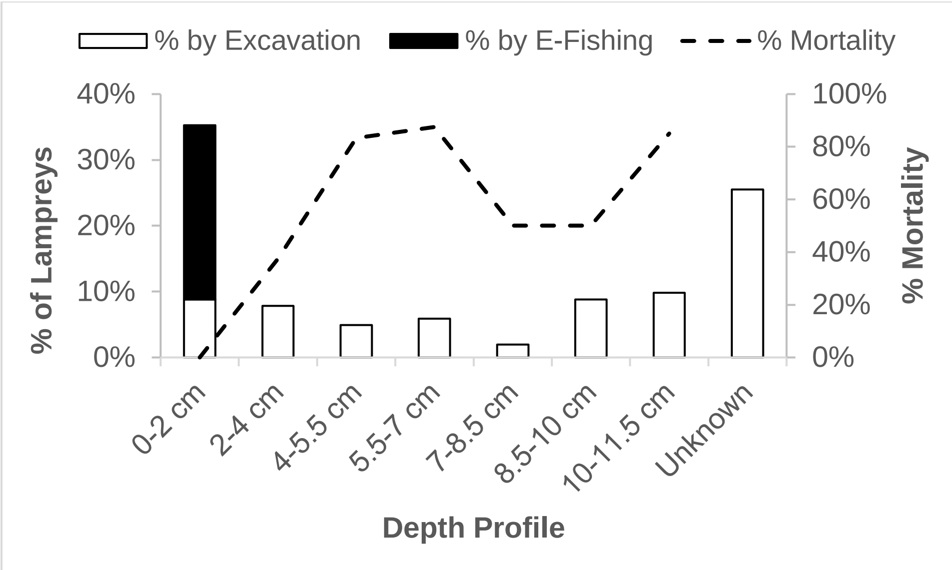

Figure A-11. Percent of lampreys captured by depth profile during sediment dredging and the associated mortality rates of the lampreys. “Unknown” denotes the unaccounted lampreys that were never found. The 0-2 cm excavation took place on the first day while the rest of the dredging took place the following morning.

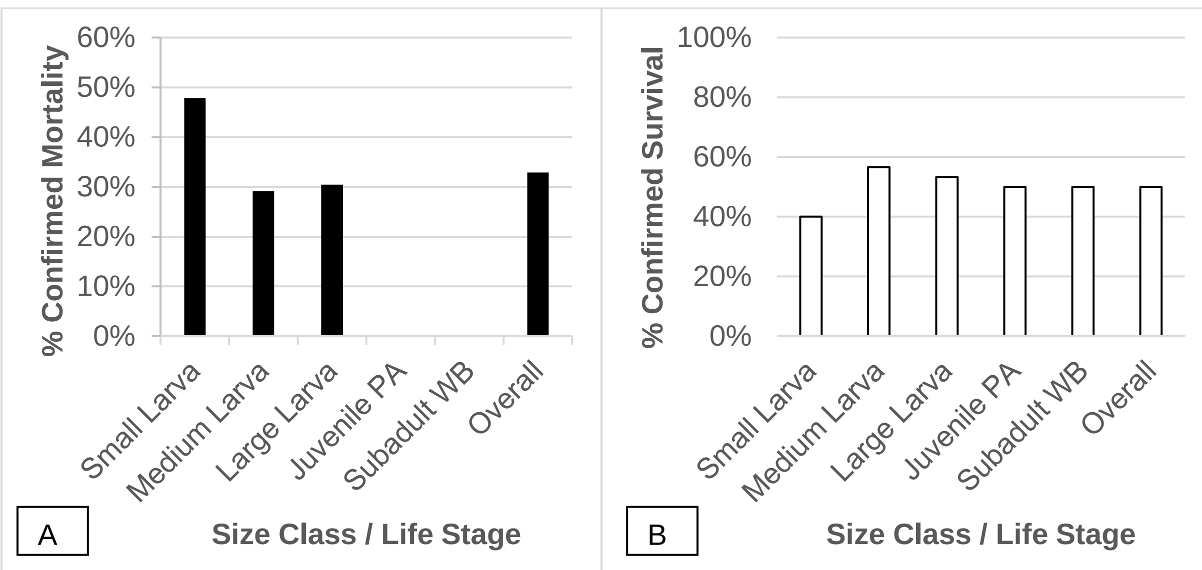

Figure A12. A) Percent confirmed mortality and B) percent confirmed survival by size class and life stages. PA stands for Pacific Lamprey and WB stands for Western Brook Lamprey in the legends.

Figure A-13. A) Dry shocking in one of the enclosures. B) Examples of larval lamprey holes that emerged on the dry surface soon after fine sediment was deposited. C) Larval lamprey tracks left on the fine sediment surface after lamprey emergence. D) Fresh mortalities of curled larval lamprey found in deep profile fine sediment.

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