## Pacific Lamprey Conservation Initiative

**PROJECT TITLE:** Lethal Air Temperatures for Dewatered Lamprey: Research to Improve Best Management Guidance

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| ***Project Applicant/Organization:*** US Geological Survey***Project Lead:*** Theresa “Marty” Liedtke***Email:*** tliedtke@usgs.gov***Phone:*** 509-538-2963***Project Applicant/Organization:*** US Fish and Wildlife Service***Contact Person:*** Joe Skalicky and Julie Harris***Email:*** joe.skalicky@fws.gov; julianne\_harris@fws.gov***Phone:*** 360-604-2544; 360-604-2500***Short Project Summary***Dewatering events occur routinely throughout the range of Pacific Lamprey and each event may kill many thousands of larvae (Harris et al. 2020)(Figure 1). Such events can have devasting impacts to populations because larvae can be densely concentrated, with multiple species and age classes in the same area. The Best Management Guidelines (BMGs; LTW 2020) for lampreys during in-water work recommends actions to limit negative impacts to lamprey. The goal of this project is to relate air temperature and mortality of dewatered larval lamprey to improve the guidance in the BMGs, specifically, adding guidance on the maximum recommended air temperature under which dewatering can safely be conducted. Solar radiation (UV) deserves consideration along with air temperature as both likely contribute to larval mortality due to desiccation. The project will test full exposure to sunlight (unshaded) and diffuse (shaded) exposure at each test air temperature to understand the role of UV exposure and provide BMG guidance that can be tailored to a range of real-world dewatering locations. In the future, dewatering events will continue because in-water work is an ongoing need and climate change my increase lethal effects. The best approach to protect lamprey is scientifically defensible information to guide dewatering procedures that can be applied throughout the species’ range. ***Detailed Project Description***We will complete 6 experiments to relate larval lamprey survival to air temperature and UV exposure during dewatering. Tests will be conducted outdoors and include a constant water temperature, 3 air temperature bands (low, medium, and high) and 2 UV conditions (shaded and unshaded). The shading material will allow partial UV penetration, depicting realistic field conditions. A weather station will measure environmental conditions throughout each experiment, including air temperature, relative humidity, and UV radiation. *Objective 1: Summarize water and air temperatures from RMUs*We will summarize summer-fall water and air temperature data from several RMUs to determine test temperatures. One water temperature will be selected and used in all experiments. Air temperatures cannot be tightly controlled because experiments will be conducted outside. We will select 3 air temperature bands: *low* (representing fall dewatering events), *medium* (typical summer conditions) and *high* (elevated summer temperatures). Summarizing temperatures from real-world conditions will increase the applicability of the experiments and the updated BMGs.*Objective 2: Conduct experiments*Experiments will be conducted in pairs, with an unshaded and a shaded experiment conducted together, for the same air temperature band (Table 1). Lamprey (in a range of sizes) will be dewatered for 3, 6, or 9 hours and control groups will undergo the same exposure and handling but will not be dewatered. Each experiment will include 8 containers (8 lamprey/container). At each sample point (3, 6 or 9 h), 2 containers will be sampled. Treatment containers will be randomly positioned within a tank (dewatered) and controls (two containers, 8 lamprey/container) will be in an adjacent, watered tank (Figure 2). Control containers will be sampled with the 9 h treatment group. As temperatures and UV exposure change over the course of a day, we will randomly assign the 3 h and 6 h treatment groups to start/end within the 9 h exposure period. That is, the 3 h treatment may begin after 2 h of exposure and be sampled after 5 h of exposure. Lamprey in the treatment groups will not be provided sediment for burrowing. The experiments will therefore represent larvae that emerge from the sediment during dewatering and are exposed on the surface. Previous research demonstrated that lamprey that remain burrowed are more likely to survive (Liedtke et al. 2015) so our tests will reflect worst-case scenario for dewatered lamprey. The containers used to hold lamprey will be neutral colored, simulating a sandy substrate, to avoid excessive heat absorption. Control groups will have light-colored shallow sediment for burrowing. At each sample period we will evaluate survival and condition as determined by the time required to complete burrowing. Larval length and weight will be recorded before and after the experiment to evaluate changes due to desiccation. Larvae will be held for 24 h following the test to evaluate delayed mortality. *Objective 3: Summarize findings and update BMGs*A logistic regression will be used to explore the influence of duration of exposure, air temperature, UV exposure, and lamprey size and make predictions about the risk of mortality. The goal is to make recommendations for the maximum air temperature under which dewatering can be accomplished with limited mortality and incorporate it into an updated BMG document (see Harris et al. 2020). **Table 1.** – Six paired experiments to test lamprey response to air temperature and UV exposure during dewatering. There will be three treatment sample times (3, 6, and 9 h of exposure), and each sample time will include 16 lamprey. Controls will not be dewatered, will be sampled with the 9 h treatment group and will include 16 lamprey.

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| Air Temperature Band | UV Exposure | # lamprey Treatment | # lamprey Controls |
|  Low | Unshaded | 48 | 16 |
|  Low | Shaded  | 48 | 16 |
| Medium | Unshaded | 48 | 16 |
| Medium | Shaded | 48 | 16 |
|  High | Unshaded | 48 | 16 |
|  High | Shaded | 48 | 16 |

**Figure 2.** – Schematic showing paired unshaded and shaded experimentsto assess lamprey survival over time at one air temperature band. Treatment groups(left boxes) will be dewatered and sampled after 3 h, 6 h, and 9 h of expsoure andControld groups (right boxes) will not be dewatered and will be sampled with the 9 h expsoure groups. Each circle represents a light-colored plastic container that will hold 8 lamprey. ***References:***Lamprey Technical Workgroup. 2020. Best management guidelines for native lampreys during in-water work. Original Version 1.0, May 4, 2020. 26 pp. + Appendices. Available: <https://www.fws.gov/pacificlamprey/LTWGMainpage.cfm> Harris, J. E., J. J. Skalicky, T. L. Liedtke, L. K. Weiland, B. J. Clemens, and A. E. Gray. 2020. Effects of dewatering on behavior, distribution, and abundance of larval lampreys. River Research and Applications 36(10):2001–2012.Liedtke, T. L., L. K. Weiland, and M. G. Mesa. 2015. Vulnerability of Larval Lamprey to Columbia River Hydropower System Operations—Effects of Dewatering on Larval Lamprey Movements and Survival. USGS Open File Report 2015–117:28 p.**Notes on Study Execution:**Objective 1 activities defined the target air and water temperatures for each of the described temperature bands: |
|   |   | Air Temperature Target | Water Temperature Target |
| Low Temperature | to simulate fall dewatering events | 12 to 14 C | 11 C |
|   |  |  |  |
| Medium Temperature | to simulate spring-early summer dewatering events | 16 to 18 C | 14 C |
|   |  |  |  |
| High Temperature | to simulate summer max temperature dewatering events | 21 to 24 C | 18 C |
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We conducted an experiment for each temperature band, for a total of 3 experiments. Data summaries are organized by experiment and named for the target temperature band: low, medium, or high.