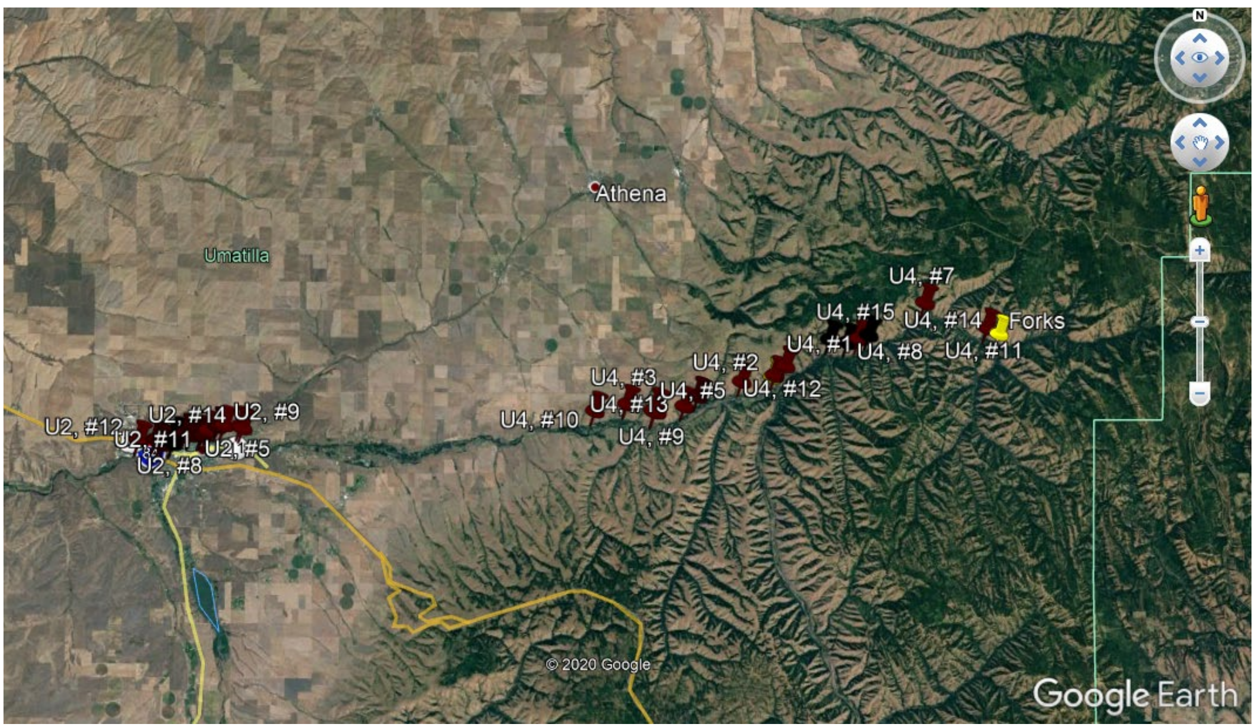
U.S. Fish and Wildlife Service

*Columbia River Fish & Wildlife Conservation Office*

# What is the upper thermal tolerance limit of larval Pacific Lamprey?

*Annual Report: 2018*





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***On the cover:***

*Generalized Random Tessellation Stratified (GRTS) sample reaches in two thermal zones of the Umatilla River (Oregon) (picture credit - Google).*

***Disclaimers:***



***The correct citation for this report is:***

Whitesel, T. A. and Sankovich, P. M. 2022. What is the upper thermal tolerance limit of larval Pacific Lamprey? Annual Report: 2018. U.S. Fish & Wildlife Service, Columbia River Fish & Wildlife Conservation Office, Vancouver, Washington (USA). 7 pp.

# What is the upper thermal tolerance limit of larval Pacific Lamprey?

## Annual Report: 2018

*Work funded by*

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March 2022

## Executive Summary:

Lampreys are obligate ectotherms and directly influenced by the ambient water temperature. In a variety of species other than Pacific Lamprey, evidence exists that lethal water temperatures for larvae occur near 27.0-31.0°C (e.g. Potter and Beamish 1975; Arakawa et al. 2020). Relatively few studies have addressed the thermal tolerance of larval Pacific Lamprey. Recently, Uh and Whitesel (unpublished data) conducted laboratory experiments in which larval Pacific Lamprey were able to survive in 27.0°C water for 30 days and suggesting the ultimate upper incipient lethal temperature (UUILT) for larval Pacific Lamprey is approximately 27.5-30.0°C. How climate change will influence the status of Pacific Lamprey is uncertain (see Wang et al. 2020). Currently, many of the locations where Pacific Lamprey rear naturally experience water temperatures near 26.0°C. With predictions that during the next 25-35 years in the Pacific Northwest air temperatures may rise 2-5°C (Wu et al. 2012), maximum water temperatures where some lamprey exist now may exceed the lethal limit for larval Pacific Lamprey. Whether the UUILT derived from larval Pacific Lamprey reared in a laboratory reflects their natural distribution (i.e. in a stream), or whether there are sublethal effects at temperatures approaching their UUILT, is unclear. We propose to evaluate i) whether larval Pacific Lamprey occupy streams where water temperatures exceed 27.5°C, ii) whether larvae occupy areas that exceed 27.5°C at a similar rate than areas where temperatures do not exceed 27.5 and ii) whether warm conditions that are not lethal influence these larvae.

The study area for this project was the Umatilla River, Oregon (henceforth, river). Based on historical temperature data, we partitioned the river into four thermal zones. Thermal Zone 2 (TZ2) ranged from the confluence with McKay Creek (UTM: Zone 11, Easting 356587, Northing 5058853), upstream approximately 8.5 km (to the boundary of the Umatilla Indian Reservation; UTM: Zone 11, Easting 364055, Northing 5059189), and was characterized by summer maximum temperatures that were expected to approach 31.0°C and be relatively constant throughout the zone. Thermal Zone 4 (TZ4) ranged from a point roughly 20 km upstream of the confluence with Wildhorse Creek (UTM: Zone 11, Easting 382548, Northing 5060104), upstream approximately 30.2 km (to the confluence of the North Fork Umatilla River and South Fork Umatilla River), and was characterized by summer maximum temperatures that were expected to range from < 27.5°C at the downstream end to 19.9°C at the upstream end. We considered TZ4 as a control area (little to no thermal stress) and TZ2 as a treatment area (reaching or exceeding the UUILT for larval Pacific Lamprey). Both TZ2 and TZ4 were partitioned into a continuous layer of 50 m long reaches. We identified random and spatially-balanced sample reaches by using a generalized random-tessellation stratified (GRTS) approach (Stevens and Olsen 2004). Based on the GRTS approach, we selected the 10 highest priority reaches for occupancy surveys. Each sampling event consisted of electrofishing a 50 m reach to determine if larval lamprey were present (Silver et al. 2010). Each reach was electrofished using an AbP-2 backpack electrofisher. We spent relatively more time (approximately 30 seconds/$m^2$) within each reach electrofishing Type I habitat (Slade et al. 2003) and relatively less time (approximately 5 seconds/$m^2$) electrofishing Type II and type III habitats. The sample design was a modification of the

traditional before-after-control-impact (BACI) approach (see Smith 2014), Our sample events occurred before, during and after maximum water temperatures in both control and treatment (or impact) TZs, or as a before-during-after-control-impact (BDACI) sample design. If a larval Pacific Lamprey was captured, the reach and TZ were determined to be occupied and sampling in that reach was terminated. Otherwise, the entire reach was sampled. If larval Pacific Lamprey were detected in at least five reaches of both TZs, sampling for that event was terminated. If Larval Pacific Lamprey were not detected in five reaches of both TZs during a given sample event, all 10 reaches were sampled within each TZ. During each sampling event we compared i) the occupancy of each TZ, ii) the proportion of reaches in which lamprey were detected in each TZ, and iii) whether occupancy or the proportion within a TZ varied among sampling events.

In 2018, maximum water temperature occurred on 29 July (U.S. Bureau of Reclamation monitoring station, Pendleton, Oregon). In TZ2, the water temperature reached values > 27.5°C between 12 July and 9 August. Sample events occurred on 18-19 June (B), 26 July (D) and 27 August (A). During the B, D and A sample events; five, six and five reaches were sampled, respectively, in TZ2 while six, five and five reaches were sampled, respectively, in TZ4. In addition, on 27 July (D) and 28 August (A), one reach (Zone 11N, Easting 327679, Northing 5069544) was sampled opportunistically (not based on a GRTS selection) in Thermal Zone 1 (TZ1). During the B, D and A sample events; larval Pacific Lamprey were detected in five, five and five reaches, respectively, in TZ2 as well as in six, five and five reaches, respectively, in TZ4. During both the D and A sample events, larval Pacific Lamprey were also detected in TZ1.

Larval Pacific Lamprey occupied an area in the Umatilla River (TZ2) where the water temperature exceeded 27.5°C. Larval Pacific Lamprey occupied TZ2 before, during and after the period of maximum summer temperatures. Larvae did not appear to vacate TZ2 during or after the period of maximum temperatures. The proportion of reaches in which larval Pacific Lamprey were detected was generally high (0.83-1.00) and did not differ between either thermal zone or any sampling events. Whether occupancy in areas exceeding 27.5°C is common, the precise temperatures in sample reaches and the substrate, as well as if and how individual larvae moved into or out of thermals zones, are unclear.

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**March 2022**