

Modelling the Effects of Streamflow and Habitat Loss Changes for Juvenile Pacific Lamprey Conservation in the Columbia River Estuary

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Client: Columbia River Inter-Tribal Fish Commission (CRITFC), comprising the Yakama Nation, the Nez Perce Tribe, the Confederated Tribes of the Umatilla Indian Reservation, and the Confederated Tribes and the Bands of the Warm Springs Reservation of Oregon.

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Objectives:

This project aims to identify areas of overlap between juvenile Pacific Lamprey and salmon use of the Columbia River estuary and analyze future climate change and other anthropogenic impacts on the ecosystem. We will use current research, traditional ecological knowledge, geospatial modeling, and existing Columbia River estuary data to make policy and management recommendations to aid the Columbia River Inter-Tribal Fisheries Commission (CRITFC) Tribal Pacific Lamprey Restoration Plan.

Significance:

Native American tribes of the Columbia River Basin have relied on the ecological and cultural importance of the Pacific Lamprey (*Entosphenus tridentatus*) for many generations. Culturally, the Pacific Lamprey embodies a spiritual, ceremonial, medicinal, and subsistence value for indigenous communities (CRITFC 2011). Additionally, lamprey support a variety of ecosystem dynamics. They are known to transport marine nutrients to inherently nutrient-poor watersheds and act as a predator buffer for other ecologically important fishes—including salmon (Weitkamp et al. 2015). Larval, or

ammocoete, lamprey filter feed, removing organic matter from the river. As a native species, Pacific Lamprey bring important value to Native American tribes of the Columbia River Basin as well as fulfill a critical role in the ecosystem.

For many years, the Columbia River Basin has faced many challenges from climate change impacts and direct anthropogenic disturbances. As a result, the native Pacific Lamprey population has declined dramatically since the mid-1990s (Weitkamp et al. 2015). Native American tribes of the Columbia River Basin have brought awareness to this issue and driven restoration efforts. Not only does a declining lamprey population threaten ecological function, it also affects cultural connections. Consequently, the loss of Pacific Lamprey has altered the “tribal way of life”: removing a sacred element from cultural practices; depriving young tribal members of their heritage by limiting opportunities to develop harvesting techniques; and displacing traditional fishing areas, forcing members to travel longer distances (Close et al. 2002).

Background:

Current research has provided a wealth of knowledge for understanding Pacific Lamprey and the necessary conservation efforts in riverine habitats in the Columbia River Basin. However, the complex life cycle of the Pacific Lamprey makes them a challenging species to monitor and protect. Pacific Lamprey, like salmon, are an anadromous fish species: they spend their larval and adult spawning phases in freshwater environments and live their juvenile, parasitic phase in the ocean. Similarly to salmon, migration to and from the ocean suggests that marine, estuary, and freshwater habitats play a vital role in the lamprey life cycle. While conservation efforts have largely focused on upstream freshwater habitats, the Columbia River estuary has been mostly neglected. Besides a study by Weitkamp et al. (2015) investigating the seasonal abundance, size and host selection of Pacific Lamprey, many conservation efforts have failed to address the importance of the Columbia River estuary in their restoration and conservation actions.

Life cycle analyses suggest that before juvenile lamprey migrate from freshwater to the ocean, they spend three to eight years in tributaries as blind, filter feeding larvae, or ammocoetes, burrowed in soft sediments (Clemens et al. 2020). Lamprey undergo transformation from the larval to juvenile, or microphthalmia, phase, where they develop eyes, a sucking disk mouth with teeth in preparation for the parasitic, ocean phase environment (Clemens 2019). As juvenile Pacific Lamprey migrate to the ocean, changes in hydrologic stream flow regimes (Elsner et al. 2010) and habitat loss (Rostaminia 2017) due to anthropogenic disturbances may present unforeseen challenges. Therefore, it is important to understand how changes in habitat conditions, both physically and quantitatively, affect lamprey survival. Quantifying habitat variability can provide a baseline for addressing the range of potential changes in estuarine habitats in future scenarios (Rostaminia 2017). Filling in this knowledge gap would provide critical information for implementing management actions that could benefit the Pacific Lamprey in the Columbia River Basin and beyond.

The similarities between juvenile Pacific Lamprey and salmon smolt migration patterns and habitat use present an opportunity to address any overlapping needs for both lamprey and salmon. Fortunately, there is a plethora of research regarding salmon use and function of estuaries. The Columbia River

estuary provides nursery habitats and food resources, and acts as a transition zone for different life stages for salmon (Rostaminia 2017). Understanding how future changes in the estuary may impact salmon during critical life stages can potentially provide information relevant to Pacific Lamprey populations and aid restoration efforts that will benefit both species.

Equity:

CRITFC was formed by four Columbia River Basin tribes - the Yakama Nation, the Nez Perce Tribe, the Confederated Tribes of the Umatilla Indian Reservation, and the Confederated Tribes and the Bands of the Warm Springs Reservation of Oregon - to provide coordination, management, and technical assistance to ensure the protection of fishing rights through the continuation and restoration of tribal fisheries into perpetuity. This project would provide CRITFC with critical knowledge about Pacific Lamprey habitat use in the Columbia River estuary that can be used to inform future management decisions that protect the Pacific Lamprey population for future generations of CRITFC member tribes.

Available Data:

The main source of data used for this project will be the Coastal Margin Observation and Prediction (CMOP) model. Acquired from the Oregon Health Science University, the CMOP resource is a 20+ year database (1999-present) of numerical simulations of the estuary and coastal ocean. CMOP measures salinity, temperature, velocity, and water depth through a network of integrated sensors and platforms, models, and information flows in the Columbia River estuary, and can be used to generate salmon metrics. Additionally, unpublished simulations within the CMOP dataset can be used to represent sea level rise scenarios. Other useful resources include:

- CMOP Observation Datasets - [SATURN Observation Network: Endurance Stations | Center for Coastal Margin Observation & Prediction \(stccmop.org\)](#)
- Estuary Lamprey Observation Data (NOAA Fisheries) - Weitkamp et al. 2015
- Columbia River Estuary Tidal Habitats Dataset - [Public Project Details \(noaa.gov\)](#)
- Various NOAA Fisheries Datasets - [Public Data Sets \(noaa.gov\)](#)

Possible Approaches:

This project will use a combination of literature review, geospatial analysis, and the CMOP modeling program to determine how changes in streamflow and habitat loss in the Columbia River estuary will impact Pacific Lamprey survival and migration. Results will be formulated into recommendations for policy and management actions pursuant to CRITFC's ongoing 2011 Tribal Pacific Lamprey Restoration Plan.

- A literature review of past research for juvenile and adult salmon metrics will compare potential overlap with Pacific Lamprey life stages to determine similarities between migration patterns and habitat use.
- Using Geographic Information Systems (GIS), the group will perform spatial analysis to map the areas of overlap between salmon and Pacific Lamprey.
- Areas of interest within the Columbia River estuary will be used to model altered streamflow and habitat loss scenarios based on future implications, such as dam removals, sea level rise, etc.

- Finally, the results will be coordinated with CRITFC and used to provide policy recommendations and outreach for the restoration and management of Pacific Lamprey habitat.

Deliverables:

- A spatial analysis map of the areas of interest within the Columbia River estuary that are ecologically important to the survival of both salmon and Pacific Lamprey.
- Model results from the scenarios including changes in streamflow and habitat loss for each area of interest.
- Policy recommendations for increasing Pacific Lamprey conservation efforts.
- Information on juvenile Pacific Lamprey use of the Columbia River estuary for CRITFC to apply to the larger restoration goals of the Tribal Pacific Lamprey Restoration Plan.

Internships:

At the time of the proposal submission deadline, CRITFC will provide an unpaid summer opportunity for one student in 2021. There is potential for a funded opportunity to arise by the summer, however, students will rely on the Summer Internship Funding (SIF) in the meantime to support the student opportunity.

References:

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Budget and Justification:

The financial obligations of this project are not expected to require additional funding beyond the \$1,300 contributed by the Bren School of Environmental Science & Management.



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January 22, 2021

Attn: Group Project Coordinator
Bren School of Environmental Science & Management
2400 Bren Hall
UC Santa Barbara, CA 93106-5131

Dear Group Project Coordinator:

The Columbia River Inter-Tribal Fish Commission (CRITFC) supports the group project: **Modelling the Effects of Streamflow and Habitat Loss Changes for Juvenile Pacific Lamprey Conservation in the Columbia River Estuary.**

In 1977, the Yakama Nation, the Nez Perce Tribe, the Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes and the Bands of the Warm Springs Reservation of Oregon formed CRITFC to provide coordination, management, and technical assistance to ensure that their treaty-reserved fishing rights are protected through the continuation and restoration of tribal fisheries into perpetuity. The four tribes wholly, indivisibly, and equally own and govern the affairs of CRITFC. The usual and accustomed fishing areas of these four sovereign treaty tribes encompasses the majority of the Columbia Basin waterways still accessible to anadromous fish in Oregon, Washington, and Idaho.

Pacific lamprey is a culturally important species to the CRITFC member tribes. In addition to being a valuable food source, Pacific lamprey are also valued for their traditional medicinal properties. Pacific lamprey has not received as much scientific research interest as salmon because Pacific lamprey is not a commercially harvested species.

The proposed group project would add knowledge about Pacific lamprey usage of habitat in the Columbia River estuary and provide insight on potential estuarine management actions that would increase the survival of Pacific lamprey as they migrate through the estuary. CRITFC recently acquired the CMOP (Coastal Margin Observation and Prediction) program from Oregon Health Sciences University. The CMOP program has been collecting data in the Columbia River estuary for several decades and is part of a larger Pacific Coast data network. CRITFC also has two biologists dedicated to lamprey restoration. The students working on the group project will work with the CMOP staff and the lamprey project staff to obtain the data necessary for the project. The data for lamprey will be compared with data for salmon usage of the estuary habitat and the comparison will be used to generate policy recommendations for estuary management that will benefit both species.

At this time, CRITFC can commit to providing unpaid internships to one or more of the students working on the group project. CRITFC staff will work closely with the students and serve as mentors for the students. CRITFC is examining potential ways to provide additional funding to support the proposed project, but CRITFC cannot commit to financial support at this time.

CRITFC looks forward to working with the students on the proposed project. The project addresses an area of research that CRITFC is interested in but does not have the staff resources to complete. The project also provides an opportunity to integrate the physical data collected by CMOP with biological data. The project will advance the biological knowledge on the role of the Columbia River estuary in lamprey restoration.

Sincerely,

A handwritten signature in blue ink, appearing to read "Jaime A. Pinkham". The signature is fluid and cursive, with a long horizontal stroke extending to the right.

Jaime A. Pinkham
Executive Director