Pretty Dam Different: Using 3D Geometric Morphometrics to Assess Shape Differences in the Klamath Smallscale Sucker (*Catostomus rimiculus*) Above and Below the Klamath Dam Complex

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Master's of Science in Biological Sciences

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Expected Graduation Date: Spring 2026

Project Background and Justification:

For more than a hundred years, dams along the Klamath River cut off fish from their natural migration routes, dividing populations and changing the river's ecosystems. But in 2024, the landscape shifted with the removal of dams along the Klamath Dam Complex. As the river starts to flow freely again, native fish are getting the chance to reconnect with parts of their habitat they haven't seen in generations, presenting an unprecedented opportunity to study the ecological and evolutionary consequences of long-term isolation and sudden reconnection.

The Klamath River is home to four native sucker species, one of which is the Klamath Smallscale Sucker (*Catostomus rimiculus*). The Klamath Smallscale Sucker is the only species with a range that spans both upstream and downstream of the former dam sites. This distribution makes it uniquely valuable for investigating how dams have

influenced fish morphology and how populations may respond to restored connectivity.

The research focuses on sucker fish specimens collected from the Klamath River Basin, including the main Klamath River and its tributaries, the Trinity, Shasta, Scott, and Salmon River, with a study area that includes a section within Humboldt County. Understanding how sucker populations have diverged in morphology due to isolation will offer insights into post-dam recovery and species management.

Project Objectives:

1. Quantify skull shape differences in *C. rimiculus* populations isolated above vs. below the former Klamath Dam Complex.
2. Establish a baseline for monitoring future morphological shifts as populations reconnect.
3. Contribute publicly accessible 3D anatomical datasets to support education and conservation.
4. Inform local agencies and conservation groups managing native fish in Humboldt County and the broader Klamath Basin.

Research Methods and Work Procedures:

I am using 3D Geometric Morphometrics (GM) to analyze skull shape variation in historical museum specimens of *C. rimiculus* collected from locations upstream

and downstream of the Klamath River. Specimens are sourced through loans from multiple institutions, including the University of Michigan Museum of Zoology (UMMZ), Oregon State University (OSU), and Cal Poly Humboldt (CPH), among others.

Computed Tomography (CT) scanning has been conducted at CPH for nearly all fish needed for the project, where high-resolution imaging can capture fine anatomical detail. A final batch of scanning will be conducted at UMMZ, to include a large subset of fish previously collected from the lower Klamath. Reconstructed 3D models of skulls are segmented using **3D Slicer** and the extension **SlicerMorph** is used to place anatomical landmarks and semilandmarks to capture skull geometry. Shape variation will be quantified using Generalized Procrustes Analysis (GPA) and Principal Components Analysis (PCA). A t-test will assess whether shape differences between upstream and downstream populations are statistically significant.

All scan data and models will be uploaded to **MorphoSource**, a free online repository that supports transparency, reuse, and education.

Work Schedule:

- **Fall 2025** – Complete UMMZ CT scanning
- **Winter 2025** – Generate and process 3D models; conduct statistical analyses
- **Spring 2026** – Prepare report for Humboldt County Fish & Game Commission and upload scans to MorphoSource, defend thesis, submit paper to peer-reviewed journal
- **Summer 2026** – Present results at Joint Meeting of Ichthyologists &

Herpetologists

Proposer's Qualifications:

I am a graduate student in the M.S. Biological Sciences program at Cal Poly Humboldt, with specialized training in CT scanning, fish biology, anatomy, and morphometric analysis. Before grad school, I worked at the UC Davis Aquatic Health Program on research projects in the Sacramento-San Joaquin Delta focused on the endangered Delta Smelt (*Hypomesus transpacificus*). I contributed to the Delta Regional Monitoring Program, tracking long-term toxicity in the Delta, and the Enhanced Delta Smelt Monitoring Program, where I developed lab techniques to dissect tiny smelt larvae for histological analysis. A publication from this work is currently under review.

I also worked on the Surface Water Ambient Monitoring Program in collaboration with the State Water Resources Control Board, with the goal of augmenting the USEPA 303(d) List of Impaired Water Bodies. These experiences taught me how to manage focused research on a single species and location, skills I now apply to my current project.

My current project is conducted under the supervision of Dr. Allison W. Bronson, a vertebrate biologist with expertise in 3D imaging and comparative anatomy. My graduate committee includes researchers from OSU and the National Marine Fisheries Service with extensive experience in GM.

Budget Request and Justification:

I am requesting **$1,880.34** to support the cost of **CT scanning** at UMMZ. This scanning

is essential for creating the remaining 3D models required for morphometric analysis of the lower Klamath.

Budget Breakdown:

- **Scanning of 42 fish specimens**
  - Rate: $89.54/hour
  - Estimated scanning time: 21 hours (2 specimens/hour)
  - **Total: $1,880.34**

No salaries, materials, travel, or other expenses are requested.

Funding and Matching Contributions:

Additional funding was provided by the Cal Poly Humboldt Master's Student Grant, which covered previous travel expenses to OSU for specimen collection and data storage equipment (hard drives).

Anticipated Benefits:

This project contributes directly to the **conservation, preservation, and education** goals of the Humboldt County Fish & Game Advisory Commission, as the results can help scientists and resource managers better understand how historic fragmentation influenced fish morphology. These data can then serve as a baseline to assess how native populations may respond as habitats reconnect.