USDA Forest Service
U.S. DEPARTMENT OF AGRICULTURE

Rocky Mountain Research Station
Science You Can Use *(in 5 minutes)*
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Don't Judge a Lamprey by Its Teeth: Genetic analysis shows need to reconsider species classification, possibly influencing conservation decisions

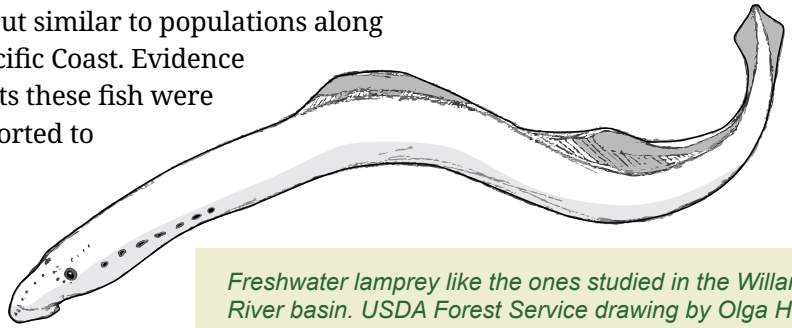
Lamprey are a lineage of boneless fish that is older than trees. Traditionally, lamprey species have been identified by morphology—that is, their visible features, such as teeth. However, this method can be unreliable because without bones, lampreys don't have many distinguishing features, and most of these don't develop until adulthood. Thus, significant conservation actions may be taken, or not taken, based on species designations that are . . . slippery.

Genetic analysis is a more reliable way to classify species. No comprehensive gene-based classification had been done to resolve the relationships of western river and brooks lampreys to one another, or to other lampreys at a global scale. To address this gap, Rocky Mountain Research Station research ecologist Kellie Carim and colleagues examined a large database of gene sequences that included lamprey from around the world plus many new sequences of fish in the Willamette River basin in Oregon. The results support several reclassifications at both the genus and species level.

Of particular interest are results for two species formally petitioned for listing under the Endangered Species Act: *Lampetra ayresii* (western river lamprey) and *Lampetra richardsoni* (western brook lamprey). "Our analysis demonstrated that these lampreys are actually one species representing two different life history forms—migratory vs. resident," Carim explains. To the eye, adults look quite different, but their DNA sequences show they are the same. "This phenomenon is well known in trout and salmon, but it had not been formally demonstrated in lampreys," Carim says.

At a local scale, the study identified more than a dozen genetically distinct populations of L. ayresii that are endemic to individual subbasins of the Willamette River—with one exception. One population was very different from all others in the study area, but similar to populations along the Pacific Coast. Evidence suggests these fish were transported to the Willamette through "headwater capture." Headwater capture occurs when mountain ranges shift, causing streams to change course and "capture" fish into a new watershed.

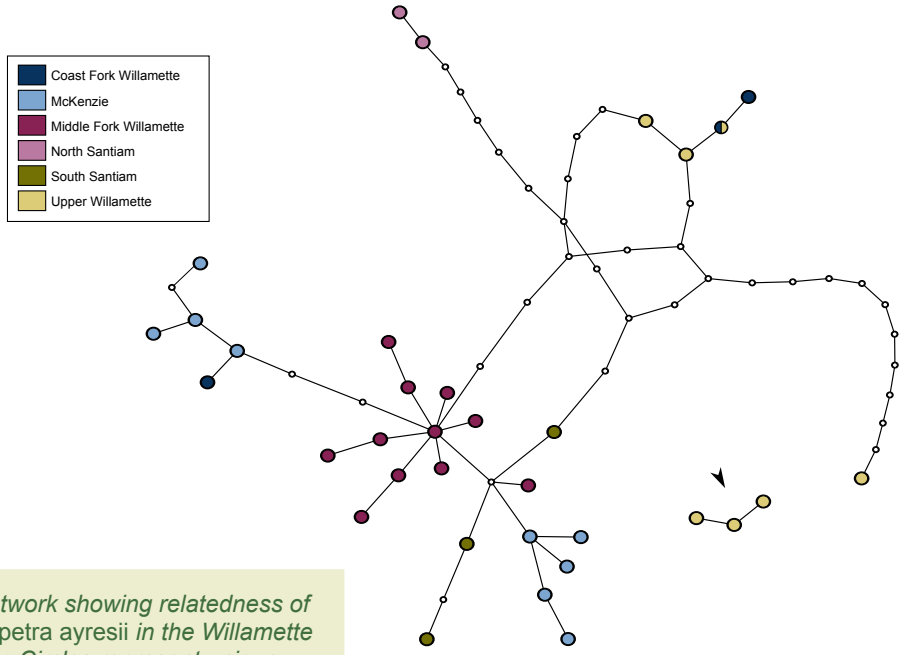
The merging of *L. ayresii* (migratory form) and *L. richardsoni* (nonmigratory form) and the strong differences among populations in Willamette River basin have meaningful management implications, according to Doug Larson, a district fish biologist based at the Middle Fork Ranger District of the USDA Forest Service and a coauthor on the study. Specifically, conservation and remediation decisions would need to consider local adaptation and interaction among populations. "With a better understanding of how all lamprey species are interconnected, land managers can better design projects to benefit all species," Larson says.



Freshwater lamprey like the ones studied in the Willamette River basin. USDA Forest Service drawing by Olga Helmy.

At a regional scale, results confirmed the existence of several undescribed species of freshwater lamprey in Oregon and California. This result, along with a few other geographic observations, suggests that there are likely even more species of freshwater lamprey living "under the radar" in Oregon and California that may not be properly protected.

This work is an important contribution to lamprey classification efforts because of its scope and rigor. Carim says: "We took a comprehensive approach starting with assessing taxonomic relationships at a global scale and progressively narrowing our analysis to understand species diversity and boundaries at a regional scale (western United States), and also population genetic structure within a species at a local scale (Willamette River basin, Oregon). As a result, we were able to confirm observations made about many different lamprey species all in one paper."



A network showing relatedness of Lampetra ayresii *in the Willamette River. Circles represent unique gene variants and are color-coded by subbasin of capture. Circles that are more closely connected are more genetically similar. The outliers (indicated with an arrow) are too different to be connected to the network, and evidence suggests these variants arrived via headwater stream capture. None of the other variants have been observed outside the Willamette River basin. Figure by Kellie Carim, USDA Forest Service.*

Management Implications

- Species delimitation analysis of lamprey indicates the need for several reclassifications at both the genus and species level.
- Two western North American lamprey species, *Lampetra ayresii* (migratory) and *Lampetra richardsoni* (nonmigratory), should be considered one species under the earlier name *Lampetra ayresii*.
- Results confirmed existence of multiple new species in Oregon and California that require formal species description.
- In the Willamette River basin, lamprey group by subbasin making this a logical unit for population level management.

Further Reading

Carim, K.J.; Larson, D.C.; Helstab, J.M.; Young, M.K.; Docker, M.F. 2023. A revised taxonomy and estimate of species diversity for western North American Lampetra. Environmental Biology of Fishes. 106: 817–836.

Boguski, D.A.; [et al.]. 2012. Genetic diversity, endemism and phylogeny of lampreys within the genus Lampetra sensu stricto (Petromyzontiformes: Petromyzontidae) in western North America. Journal of Fish Biology. 81(6): 1891–1914.

Scientists & Managers

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