

# Native Freshwater Mussels of Central Oregon: Life History, Distribution, and Status

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**Emilie Blevins, Xerces Society for Invertebrate Conservation**

30<sup>th</sup> Annual Fisheries Workshop

Portland General Electric & Confederated Tribes of Warm Springs

July 18, 2024

## About Us



We are an international nonprofit organization that protects the natural world through the conservation of invertebrates and their habitats.

Our mussel conservation program aims for...

*healthy, diverse, connected, and abundant freshwater mussel populations.*



XERCES  
SOCIETY

# Acknowledgements

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- Prineville District BLM and central Oregon landowners
- Kier Associates and Alaska Bio Map
- Confederated Tribes of the Umatilla Indian Reservation
- South Fork John Day Watershed Council
- Oregon Department of Fish and Wildlife
- Oregon Natural Desert Association
- Smith Rock State Park
- Environmental Science Associates
- University of Washington Olden Lab
- Doug and Anthony Gordon
- Xerces staff: Hanna Barbé, Michele Blackburn, Vince Butitta, Jack Feters, Candace Fallon, Alex Frankila, Jim Holley, Sarina Jepsen

# What is a freshwater mussel?

## Asian clam

- nonnative
- does not use a host fish
- globally widespread



Credit: Xerces Society; USFWS.



## zebra/quagga mussel

- nonnative, more widespread in eastern US river systems
- does not use a host fish
- small, use of byssus

## freshwater mussel

- uses a host fish to complete life cycle
- benthic, burrowing, and forming beds
- long-lived and high diversity in North America
- native and imperiled



# Oregon's Species



Western Ridged Mussel  
*Gonidea angulata*

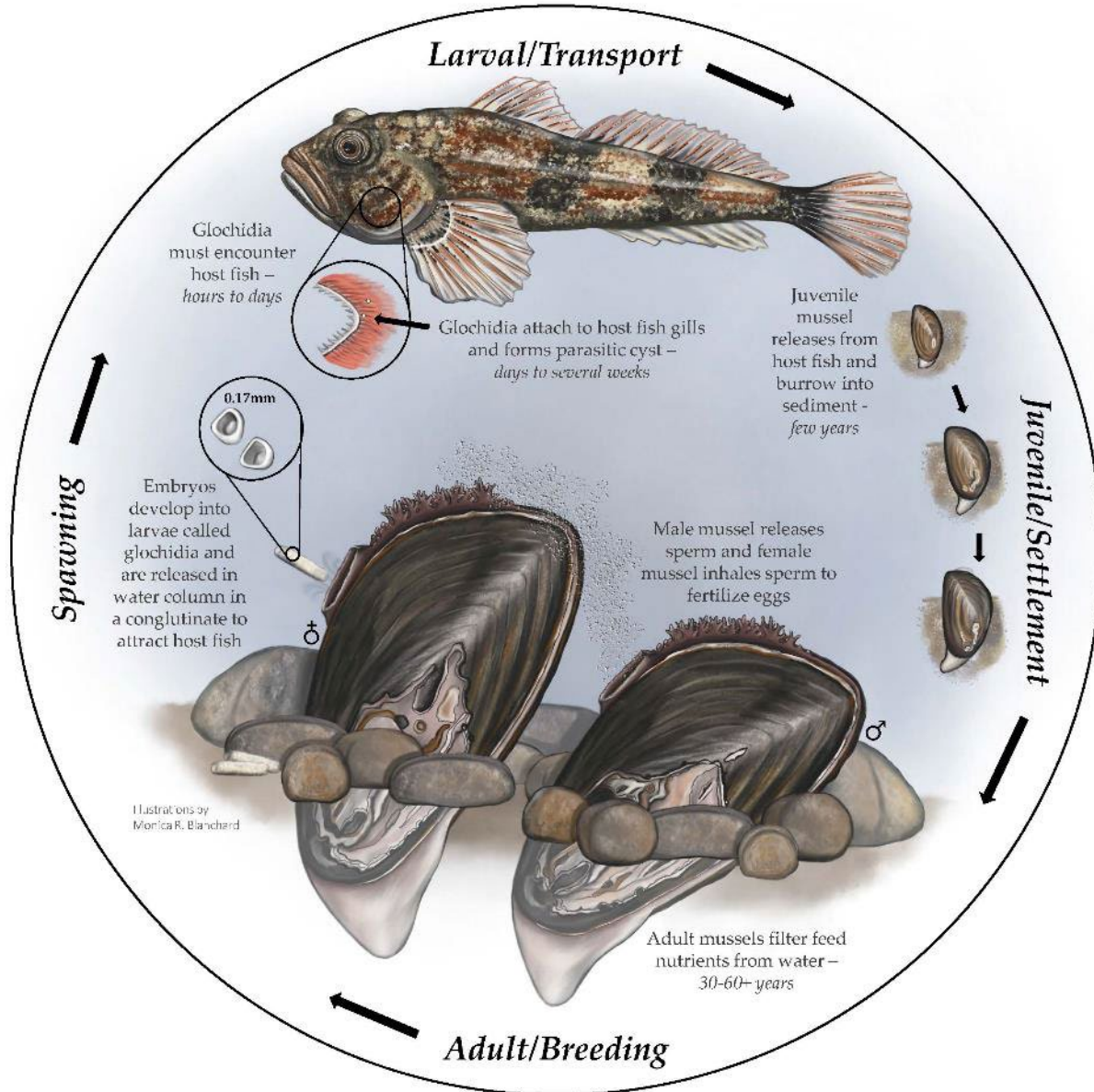


Western Pearlshell Mussel  
*Margaritifera falcata*



Floater Mussel  
*Anodonta* spp.

## Western Ridged Mussel (*Gonidea angulata*) Life Cycle



# What is a freshwater mussel?

- Long-lived, filtering, bivalve mollusk
- Relies on host fish to complete life cycle
- Can form dense beds in rivers and streams

# Mussel Needs

Perennial Flows  
and Clean Water



Stable Habitat  
Features



Burrowing  
Material



Host  
Fish



Credit: Methow Salmon Recovery Foundation/John Crandall; Xerces Society; USFWS/Roger Tabor.

# Importance of Freshwater Mussels

Filter water and capture nutrients, remove pollutants



Create habitat, increase benthic complexity



Serve as food for mammals, birds, and other species



Increase growth and production of other aquatic species



Credit: Xerces Society.



# Ecosystem Services Lost

	PRE MASS MORTALITY <sup>a,b</sup>	HOURS	DAYS	WEEKS	MONTHS	YEARS	DECADES
<b>BIOFILTRATION</b>	~5,200 L h <sup>-1</sup> m <sup>-2</sup>	Reduced	[B] Reduced biofiltration, paired with increased nutrients, lead to algal blooms <sup>a,c,d</sup>	[C] Potentially altered biofiltration capacity & timing, due to community change			
<b>NUTRIENT REGENERATION</b>	~345 μmol N m <sup>-2</sup> h <sup>-1</sup>	[A] Increased N & P in the water column <sup>e</sup> & the interstitial space <sup>f</sup>	Increased N & P in the interstitial space <sup>f</sup>		Loss of nutrient capacitance* & shift of excretion stoichiometry because of the homogenized community and reduced biomass		
	~26 μmol P m <sup>-2</sup> h <sup>-1</sup>		[D] Loss of nutrient capacitance, due to individuals lost <sup>g</sup>				
<b>NUTRIENT STORAGE</b>	~47 g N m <sup>-2</sup> ~4.8 g P m <sup>-2</sup>	Soft tissue storage reduced while shell is stable <sup>g</sup>			[E] Shells begin dissolving, slowly releasing nutrients into the water column <sup>h</sup>		Storage reduced until biomass completely rebounds
<b>HABITAT</b>	~28 ind. m <sup>-2</sup> ~5 species m <sup>-2</sup>	Increased interstitial spaces from shells without tissue			[E] Decreased habitat heterogeneity of mussels & mussel shells <sup>i</sup>		More homogenous benthos

Credit: Dubose et al. 2019.

“Our research provides an example of how the loss of an abundant, long-lived organism has cascading and long-term impacts on ecosystems. These impacts are analogous to loss of a forest in terrestrial ecosystems; habitat provision and nutrient sequestration is altered as the community shifts and takes decades to rebound (Ellison et al., 2005; Boyd et al., 2013). The loss of this long-lived organism and the subsequent release of this nutrient pulse has large impacts on stream ecosystems.”

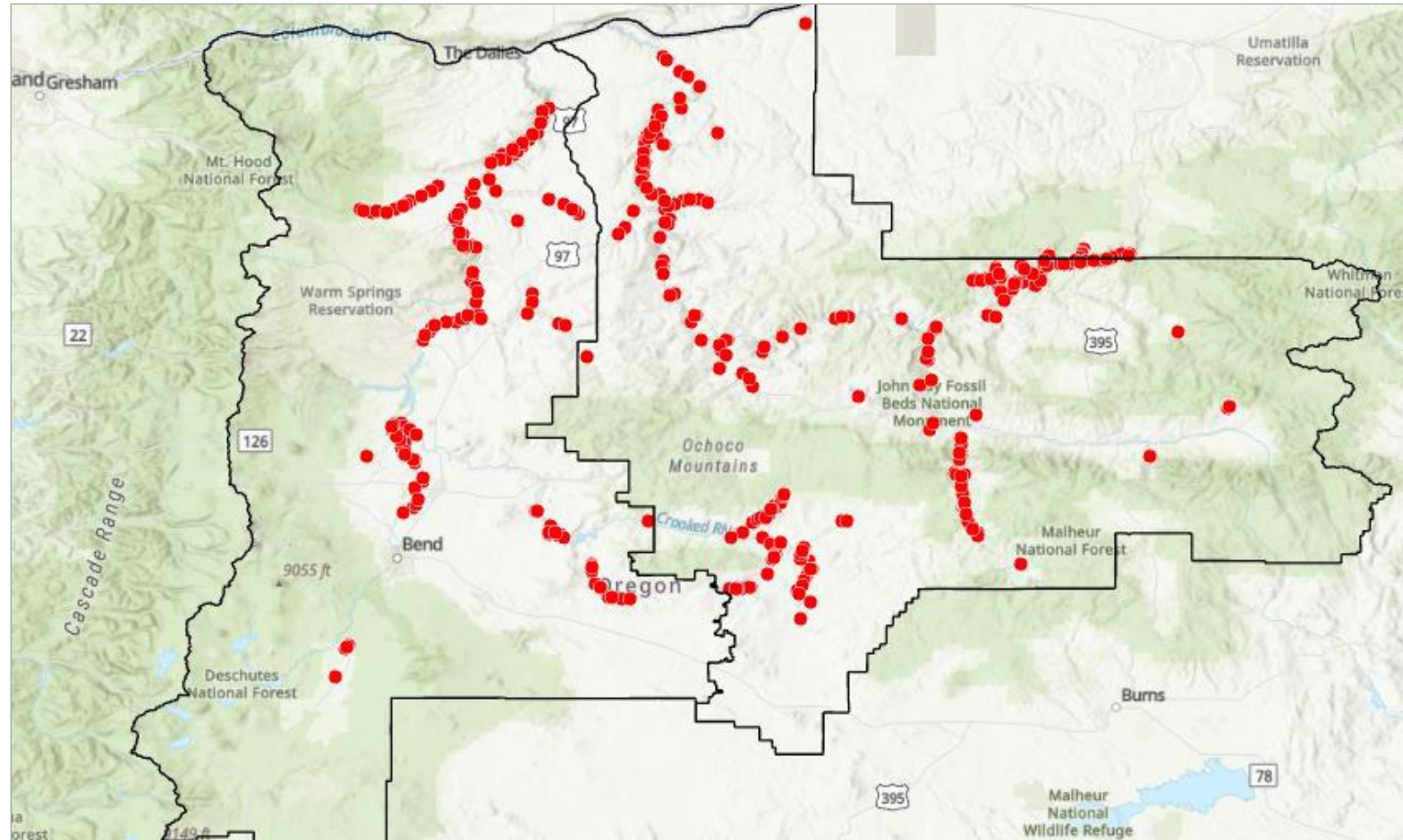
# Diversity of Freshwater Mussels in North America



Credit: USFWS/J. Butler.

- ❖ 307 species in North America. >97% of diversity occurs east of the continental divide
- ❖ More than 90 ESA listed species. ~10% now extinct
- ❖ Western ridged mussel a sensitive species for FS and BLM, state SGCN – being considered for federal ESA listing
- ❖ Absence of needed data for western species to support management

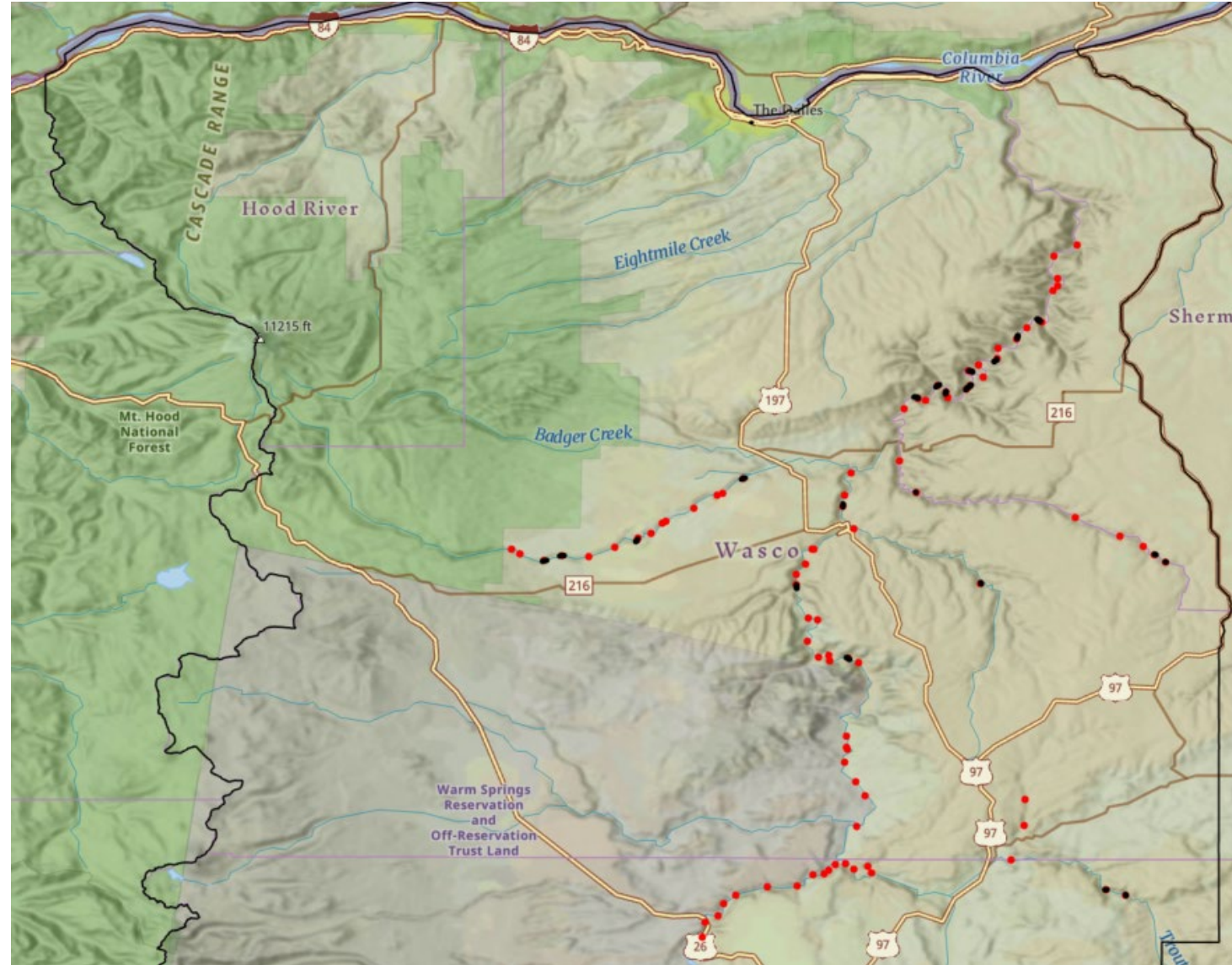
# Recent Central Oregon Surveys: BLM Prineville District



- Multi-year effort: 2020-2025
- GRTS design on BLM lands
- Perennial, stream order of 5<sup>th</sup> or greater (bankfull width 7m+), fish-bearing
- Limited to 475km of stream
- Weighted toward upper basin sites
- 125 sites sampled for presence/absence
- Further estimates of density at select sites
- Trend analysis at 22 sites (so far), random and purposive

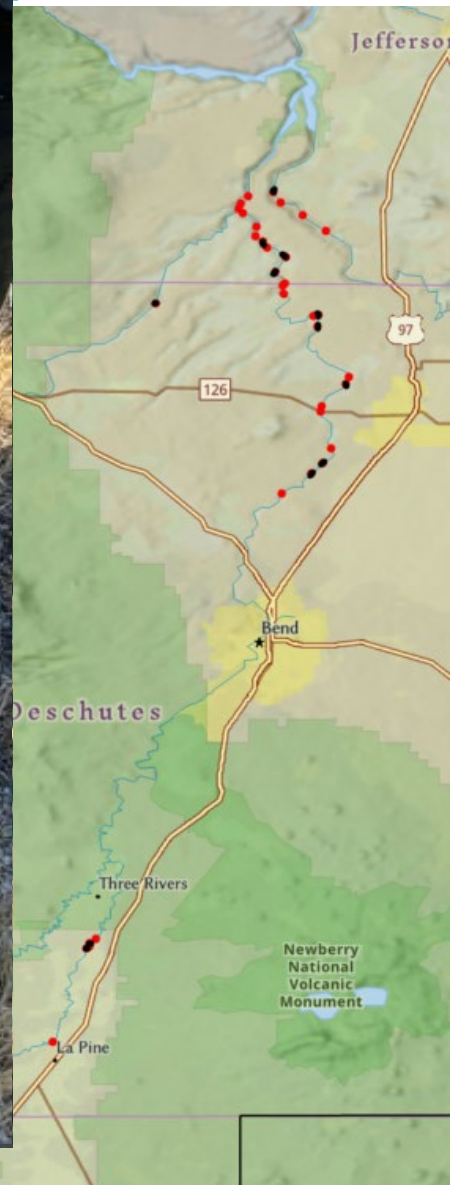
# Lower Deschutes River Focal Area

- Surveys at 22 sites, total of 7.6km
  - Deschutes River (12 sites)
  - White River (4 sites)
  - Buck Hollow Creek (3 sites)
  - Deep Creek (1 site)
  - Trout Creek (2 sites)
- Mussels present at 10 sites (all Deschutes River)
  - Floaters (6 sites, 100 mussels)
  - Western pearlshell (6 sites, 8 mussels)
- Unable to survey the middle, mussels in soft substrate close to shore
- Others have confirmed western pearlshell and floater in Trout Creek



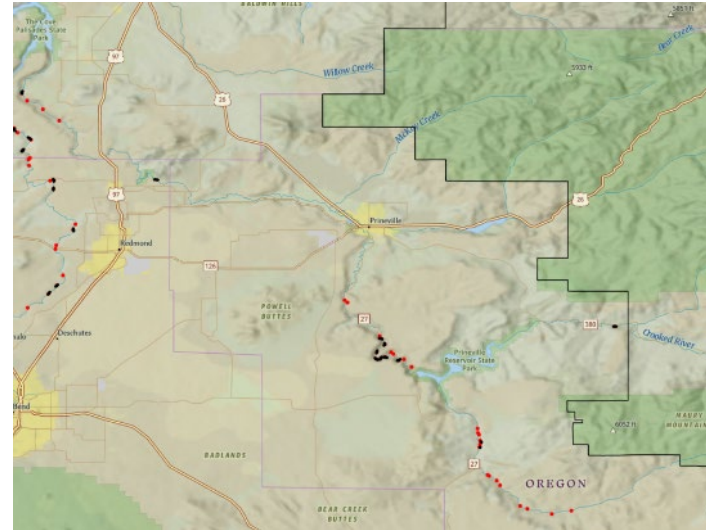


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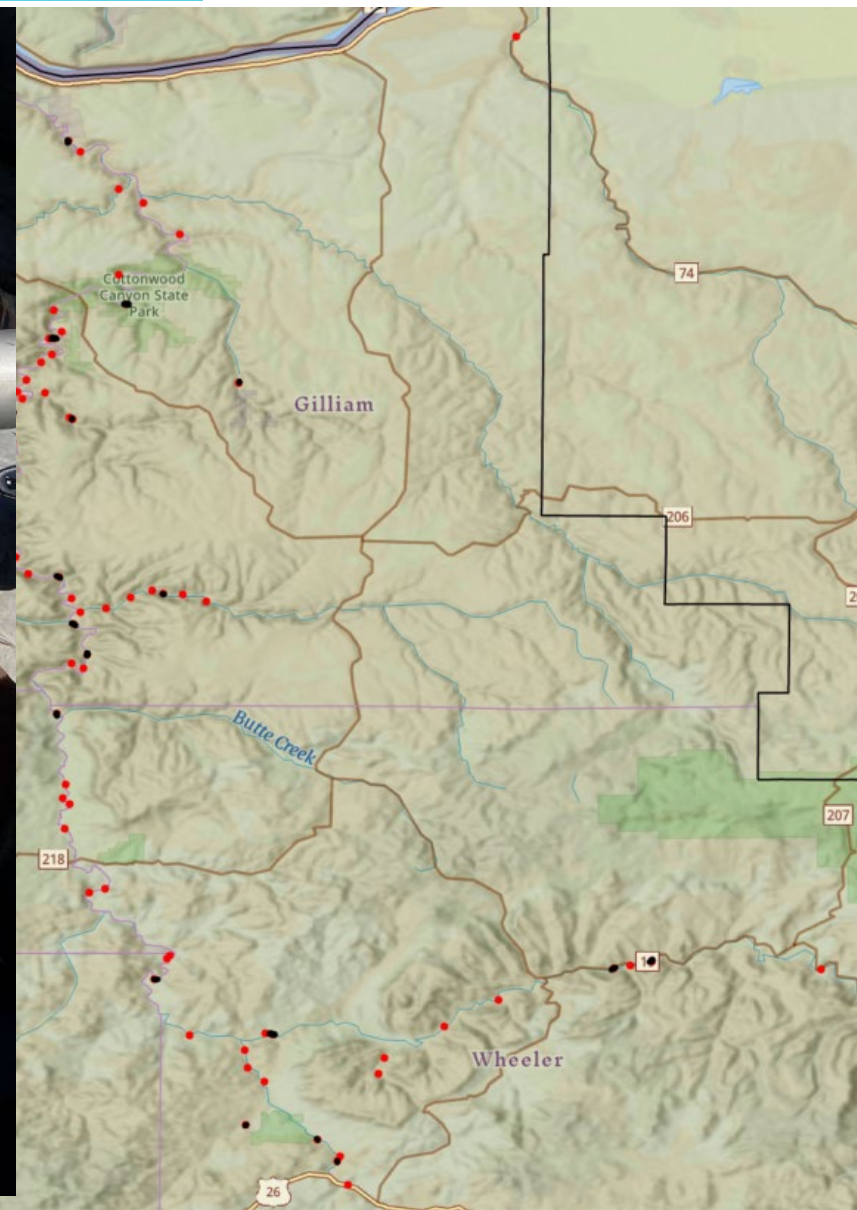


# Crooked River Focal Area

- Surveys at 29 GRTS sites (+1 adjacent to Smith Rock SP), total of 6.4km
  - Crooked River
  - North Fork Crooked River
  - Bear Creek
  - Camp Creek
  - South Fork
  - Twelvemile Creek
- Mussels present at only 3 sites outside of SF
  - 122 total mussels, all three genera
- Crooked below Bowman had no mussels (8 sites, 2.8km)
- Additional surveys at 42 continuous river sites within the ACEC, total of 11.5km
  - 9,611 live mussels: 1 western pearlshell, 99 western ridged, the rest floaters
  - Abnormal abundance of shells: >50% of total counts in 81% of sites – Result of river dewatering event in 2013? Other causes?



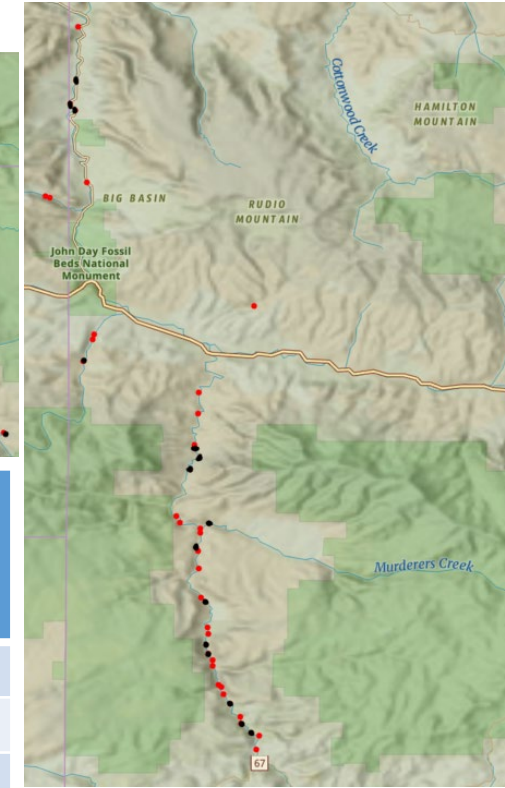
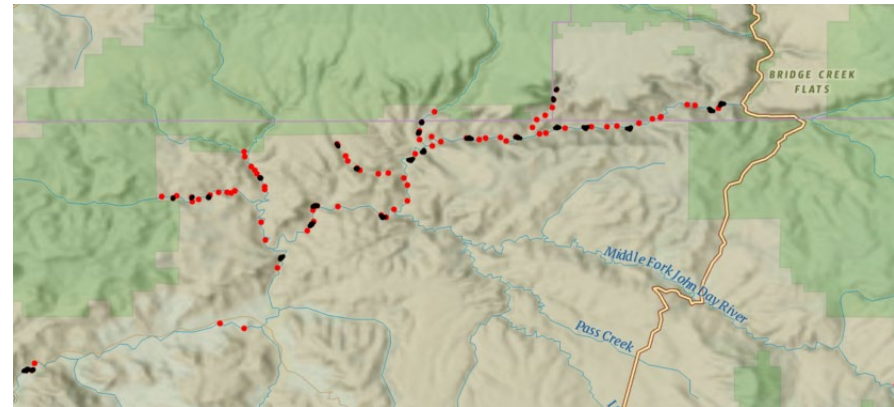
# Lower John Day River Focal Area



# Upper John Day Focal Area

Coordination with CTUIR Mussel Project in the NF and MF

- Surveys at 25 sites in the NF and MF watersheds, total of 8km
  - All three genera present, 3 total western ridged mussels counted
- Surveys at
  - John Day River
  - Cottonwood Creek
  - Murderers Creek
  - South Fork John Day River
- Repeat (monitoring) surveys at 9 sites in the SF
  - Drying events in 2021 and 2022: 36% decline in mussel counts



Site Code	Species Documented	% Abundance Change: 2020 to 2023
UJD-1036	WP, FL	173%
UJD-1100	WP, FL	-15%
UJD-1020	WP, FL	-36%
UJD-1048	WP, FL	-48%
UJD-1032	WP	-100%
UJD-1096	WP	-99%
UJD-1004	WP	-99%
UJD-1112	WP	-17%
UJD-1068	WP	-14%





# Multi-State SGCN Freshwater Mussel Project

ODFW, WDFW, and Xerces

- Improve distribution information (eDNA and visual surveys)
- Establish locations for long-term monitoring (using new protocol)
- Develop standardized viability categories and criteria for multiple species in OR and WA
- Improve data sharing and collaboration (WFMDB 2.0)
- Sites in the upper Deschutes, Crooked, and upper John Day



Credit: Xerces Society.

# Mass Mortality Events and Disease Studies



Credit: USFWS/Teal Waterstrat; Anna Smith.

- Collaborative effort with USFWS, ODFW, WDFW, Chehalis Tribe, UW-Madison
- Sampling in Crooked River at Smith Rock State Park and John Day River
  - Goldberg, T. L., Blevins, E., Leis, E. M., Standish, I. F., Richard, J. C., Lueder, M. R., Cer, R. Z., & Bishop-Lilly, K. A. (2023). Plasticity, Paralogy, and Pseudogenization: Rhabdoviruses of Freshwater Mussels Elucidate Mechanisms of Viral Genome Diversification and the Evolution of the Finfish-Infesting Rhabdoviral Genera. *Journal of Virology*.
  - Richard, J. C., Blevins, E., Dunn, C. D., Leis, E. M., & Goldberg, T. L. (2023). Viruses of Freshwater Mussels during Mass Mortality Events in Oregon and Washington, USA. *Viruses*, 15.



# Threats to Mussels



- Habitat loss and destruction
- Poor water quality
- Drought and water management
- Climate change

- Invasive species
- Fire and debris flows
- Impacts to host fish
- Instream work
- Disease?



Credit: flickr/protflux; NRCS; Karuk Tribe DNR; USFWS; USFS/Erin Miller.

# State of Knowledge, Conclusions, and Next Steps for Surveys in Central Oregon

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- We've learned a lot more about freshwater mussel distribution in central Oregon in recent years!
- Western ridged mussel is scarce and rapidly declining/disappearing from rivers in central Oregon
- Western pearlshell and floaters persist with declining populations in some areas and dense beds in others
- Surveys continue in 2024 and 2025, including repeat visits and new sites
- Trend analysis and population estimates forthcoming
- CTUIR's freshwater mussel program conducts long-term monitoring in the NF and MF John Day

# Resources

Peer-Reviewed Biology and Conservation 2014-16, 2017  
© Xerces Society Conservation Society 2017

**REGULAR ARTICLE**

**EXTINCTION RISK OF WESTERN NORTH AMERICAN FRESHWATER MUSSELS: *ANODONTA NUTTALLIANA*, THE *ANODONTA OREGONENSIS/KENNERLYI* CLADE, *GONIDEA ANGULATA*, AND *MARGARITIFERA FALCATA***

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<sup>2</sup> Confederated Tribes of the Umatilla Indian Reservation, Department of Natural Resources, Fisheries Program, Freshwater Mussel Project, 40411 Timine Way, Pendleton, OR 97601 USA  
<sup>3</sup> The Nature Conservancy, 201 Mission Street, 4th Floor, San Francisco, CA 94105 USA  
<sup>4</sup> Brown River Consultants, LLC, 130 Seaside Street, Waynesville, NC 28785 USA

**ABSTRACT**

The recent declines in western North American species of freshwater mussels have been well documented, but the status of western species has been comparatively understudied. However, various local and regional studies and anecdotal observations indicate that western mussels are also declining, suggesting the need for range-wide assessments of extinction risk and changes in freshwater mussel distributions. Using historic (pre-1970) and recent (1990-2010) occurrence data from across western states and incorporating observations of recent population dynamics, we assessed the extinction risk of western freshwater mussels according to the categories and criteria of the International Union for Conservation of Nature (IUCN) Red List. Percent change in occupied watersheds (the area between historic and recent time periods) was evaluated against IUCN classification thresholds. Additionally, we standardized relative likelihood of declines was also supported by reported observations of changes in abundance or occurrence in shallow water bodies, waterbodies, or regions. We also assessed the proportion of watersheds that have retained species richness as compared with historic levels. We evaluated four western freshwater mussel taxonomic entities: three currently recognized species and one clade consisting of two currently recognized species. Of the four entities assessed, two are Vulnerable (*Anodonta nuttalliana* and *Gonidea angulata*), one is Near Threatened (*Margaritifera falcata*), and one is Least Concern (*Anodonta oregonensis/kennerlyi* clade). Freshwater mussel richness declined 39% across western watersheds by area, and among the most biologically diverse watersheds, nearly half now support fewer specialists. Future research and conservation efforts should prioritize identifying the proximate causes for these declines and preserving existing habitat and populations.

**KEY WORDS:** extinction risk, freshwater mussel, IUCN Red List, *Anodonta*, *Gonidea angulata*, *Margaritifera falcata*

**INTRODUCTION**

Freshwater mussels (Bivalvia: Unionida) are a diverse, important component of freshwater ecosystems in North America and globally, and only recently has their ecological importance been well documented (Vogling and Hakkenberg 2008; Howard and Galley 2006; Vogling et al. 2008; Bost 2012; Lopez-Lemus et al. 2014; Vogling 2017). Their cultural importance in North America dates back more than 10,000 yr

**Conserving the Gems of Our Waters**

Best Management Practices for Protecting Native Western Freshwater Mussels During Aquatic and Riparian Restoration, Construction, and Land Management Projects and Activities

Emilie Blevins, Laura McMullen, Saffra Jessen, Michele Backburn, Almée Cook, and Scott Hoffman Black




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**Mussel-Friendly Restoration**

A Guide to the Essential Steps for Protecting Freshwater Mussels in Aquatic and Riparian Restoration, Construction, and Land Management Projects and Activities


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**VISUAL SURVEY PROTOCOL FRAMEWORK FOR WESTERN NORTH AMERICAN FRESHWATER MUSSELS**

Version 1, JUNE 2024



Credit: USFWS/Reggie/2020



**SITE MANAGEMENT PLAN FOR FRESHWATER MUSSELS IN THE SOUTH FORK CROOKED RIVER, PRINEVILLE BLM DISTRICT LANDS, OREGON**



Credit: Xerces Society

EMILIE BLEVINS AND JACK FETTERS  
THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION  
FEBRUARY 2024

PREPARED FOR THE U.S. BUREAU OF LAND MANAGEMENT PRINEVILLE DISTRICT OFFICE

Select Records


Watershed (ALSCS FWC ID): No category selected

Species: No category selected

Waterbody: No category selected

Common Name: No category selected

Status: No category selected



**Watersheds**  
457

**Species**  
26

**Waterbodies**  
1.5k

Watershed	Species Name	Common Name	Waterbody	Waterbody	Waterbody	Waterbody	Waterbody
North Fork	<i>Anodonta ligata</i>	Fishes	Shoshone	1822	1822	1822	1822
North Fork	<i>Anodonta ligata</i>	Fishes	Shoshone	2036	2036	2036	2036
North Fork	<i>Anodonta ligata</i>	Fishes	Shoshone	1810	1810	1810	1810
North Fork	<i>Anodonta ligata</i>	Fishes	Shoshone	1930	1930	1930	1930
North Fork	<i>Anodonta ligata</i>	Fishes	Shoshone	1530	1530	1530	1530
North Fork	<i>Anodonta ligata</i>	Fishes	Shoshone	2019	2019	2019	2019
North Fork	<i>Anodonta ligata</i>	Fishes	Shoshone	2019	2019	2019	2019
North Fork	<i>Anodonta ligata</i>	Fishes	Shoshone	2019	2019	2019	2019
North Fork	<i>Anodonta ligata</i>	Fishes	Shoshone	1880	1880	1880	1880

Click for: Download data (table below is open search)



# Freshwater Mussels and Management

“Efforts to manage mussels are commonly considered secondary to other economically and culturally valuable species groups or resources (e.g. fisheries, drinking water resources...).

However, given the integrative role of mussels in food webs and ecosystem structure, the restoration of mussels has a greater potential to generate ecosystem-scale benefits through providing beneficial interactions and enhancing ecosystem functioning”

-Eveleens and Febria 2021

Credit: USFWS/Roger Tabor.

