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November 5, 2019

MEMORANDUM

TO: Fish and Wildlife Committee Members

FROM: Mark Fritsch

SUBJECT: History and Significance of Freshwater Mussels

BACKGROUND:

Presenter: Gene Shippentower and Alexa Maine of the Confederated Tribes of the Umatilla Indian Reservation (CTUIR).

Summary: Gene and Alexa will provide a summary of the importance of freshwater mussels in the Columbia Basin, and provide an overview of the accomplishments by the tribe with the information gained through Project #2002-037-00, *Freshwater Mussel Research and Restoration*.

Relevance: Since its inception in 2003, the Freshwater Mussel Project has been working to understand the biology and ecology (both biotic and abiotic) of freshwater mussels. Specifically, the project has focused on nine main components:

- Objective 1. Long Term Abundance and Distribution Monitoring
- Objective 2. Genetics and Taxonomic relationships
- Objective 3. Habitat Relationships
- Objective 4. Host Fish Relationships
- Objective 5. Artificial Propagation
- Objective 6. Promote Freshwater Mussel Best Management Practices
- Objective 7. Education and Outreach
- Objective 8. Freshwater Mussel Master Supplementation Plan

In addition, the CTUIR is incorporating project findings into a freshwater mussel monitoring and recovery plan in the Umatilla River and other mid-Columbia River watersheds. Through this project, information has been gained to guide freshwater mussel restoration and monitoring efforts for the mussel populations known to be declining throughout the Columbia River Basin.

This project was recently reviewed as part of the *Mainstem and Program Support Project Review*. As part of that review the Council conditioned the project to address the ISRP qualification by January 30, 2020.

Background: Historically a lack of basic understanding of freshwater mussel distribution, genetic structuring, reproductive requirements, ecology, and even appropriate taxonomy have hindered management and restoration efforts in the western United States. The CTUIR, through Project #2002-037-00, *Freshwater Mussel Research and Restoration*, have provided basic understand of freshwater mussels and brought the attention to this important cultural and ecological.

Freshwater mussels are experiencing a global decline greater than any other species. These declines were first observed in North America in the early 1950's. Many of the early declines were documented in the eastern U. S., but more recent surveys indicated mussels are in decline nationwide. The reason(s) for the decline include, but are not limited to, habitat degradation, introduction of invasive bi-valves, decline in native fish populations, pollution, disease, and inbreeding.

Freshwater mussels are an important component of freshwater ecosystems because they provide positive feedback loops for both biotic and abiotic components. Freshwater mussels provide food for wildlife and ecosystem services including, sediment stability, enhanced nutrient cycling, water quality improvement, and support greater macroinvertebrate communities. The burrowing activity of freshwater mussels has also shown to provide increased oxygen levels which benefits larval Pacific Lamprey. Freshwater mussels remain an important cultural resource for Tribal communities.

More Info:

- [Freshwater Mussels of the Pacific Northwest](#), 2nd edition
- [Project #2002-037-00 - Freshwater Mussel Research and Restoration](#)



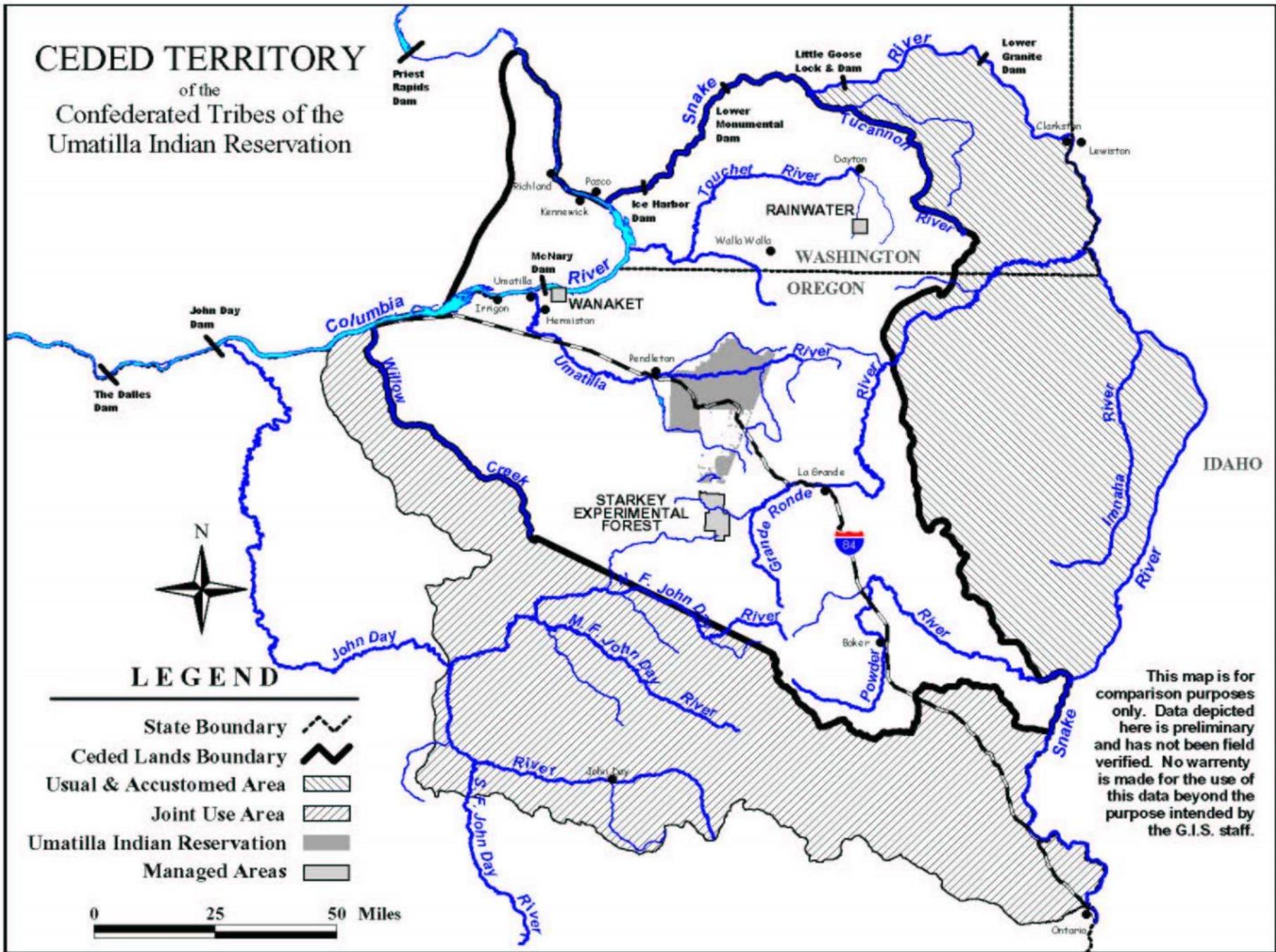
CTUIR Freshwater Mussel Project

Alexa Maine, Donna Nez, TeLa Branstetter
Christine O'Brien

Started in 2002, first field season in 2003

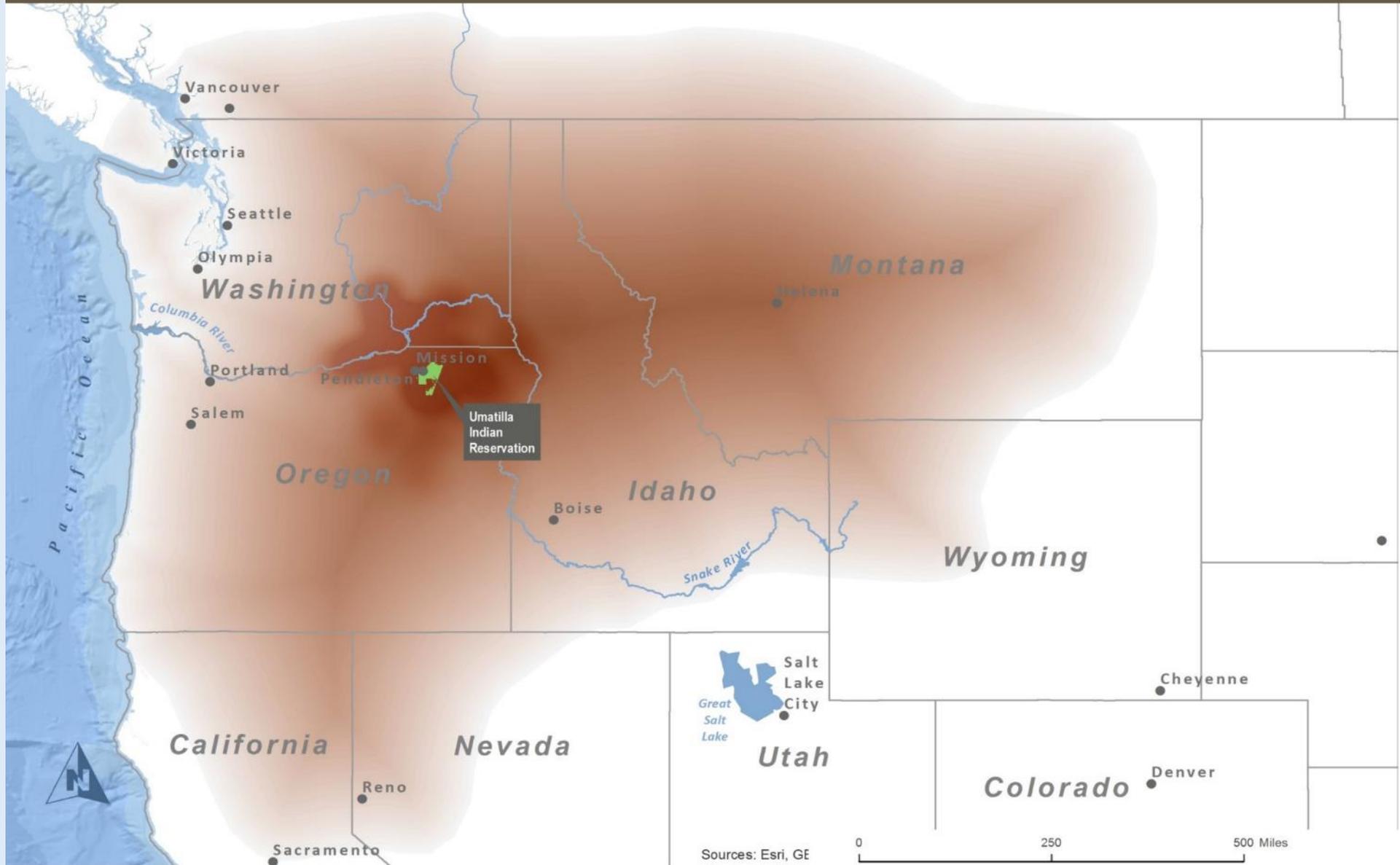


CEDED TERRITORY of the Confederated Tribes of the Umatilla Indian Reservation



This map is for comparison purposes only. Data depicted here is preliminary and has not been field verified. No warranty is made for the use of this data beyond the purpose intended by the G.I.S. staff.

Traditional Use by the Cayuse, Umatilla, Walla Walla Tribes



This map reflects traditional and customary areas used by the Cayuse, Umatilla and Walla Walla people over different seasons at or before treaty negotiations. Areas of heavier use are identified with darker color saturation. Data and information used to create this map includes the 1855 Treaty negotiation minutes, adjudicated use areas, oral histories information and documentation from literature. This map reflects non-exclusive traditional uses beyond current reservation boundaries, aboriginal lands and ceded lands defined by the Indian claims Commission findings – all of which are judicially established as inadequate to reflect the total extent of CTUIR uses, interests and rights under the Treaty. In many instances, the CTUIR Member used those areas in common with other tribes.

Freshwater Mussels: Background Information

- Bivalve mollusks
 - Kingdom: Animalia
 - Phylum: Mollusca
 - Class: Bivalvia
 - Order: Unionoida
 - Family: Unionidae
- Complex life cycles
- Highly endangered
- Cultural and traditional resource
- Lack of knowledge
- Environmental indicators



Margaritifera falcata bed

**LIFE-CYCLE
FRESHWATER MUSSEL:
*Anodonta oregonensis***

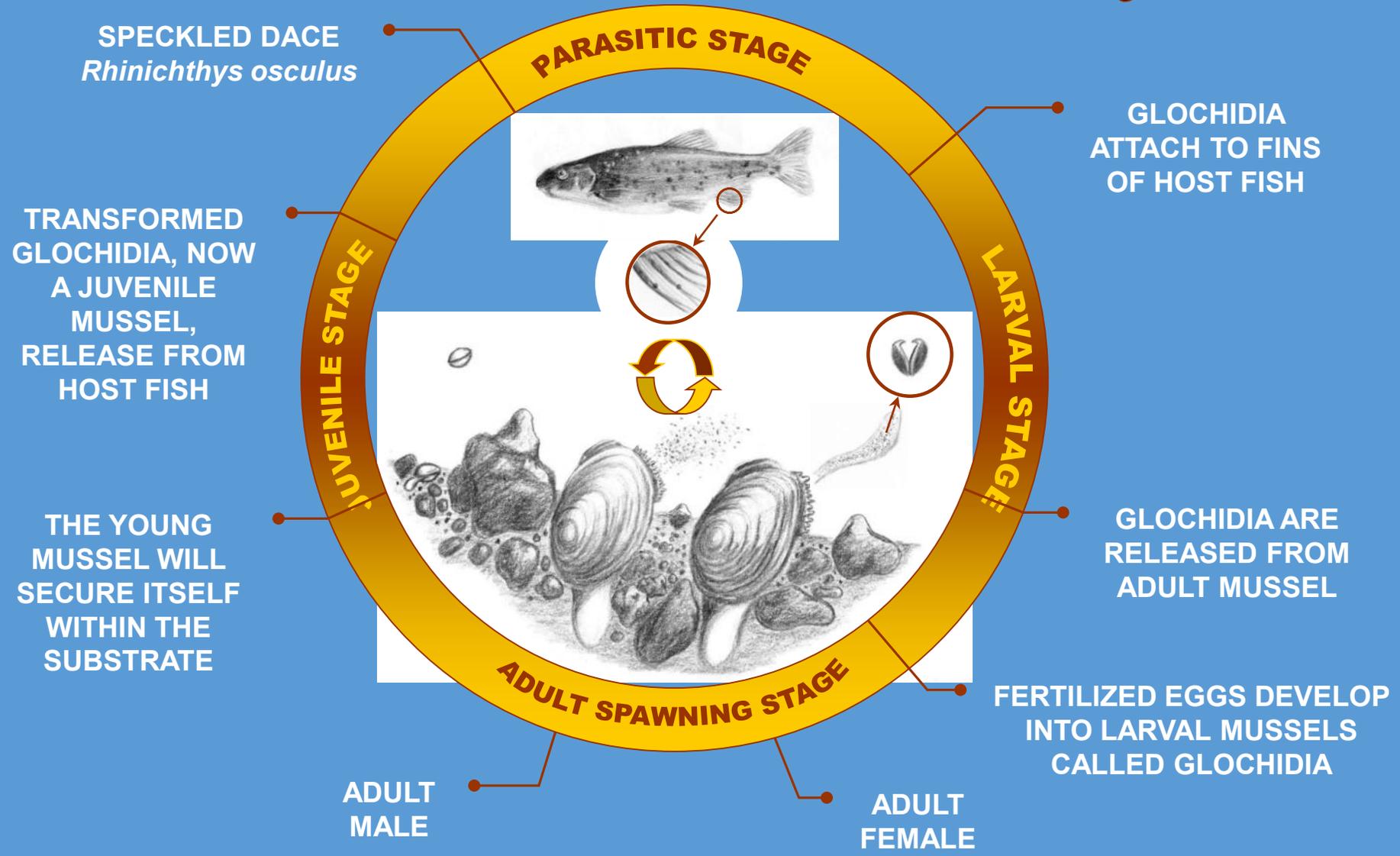
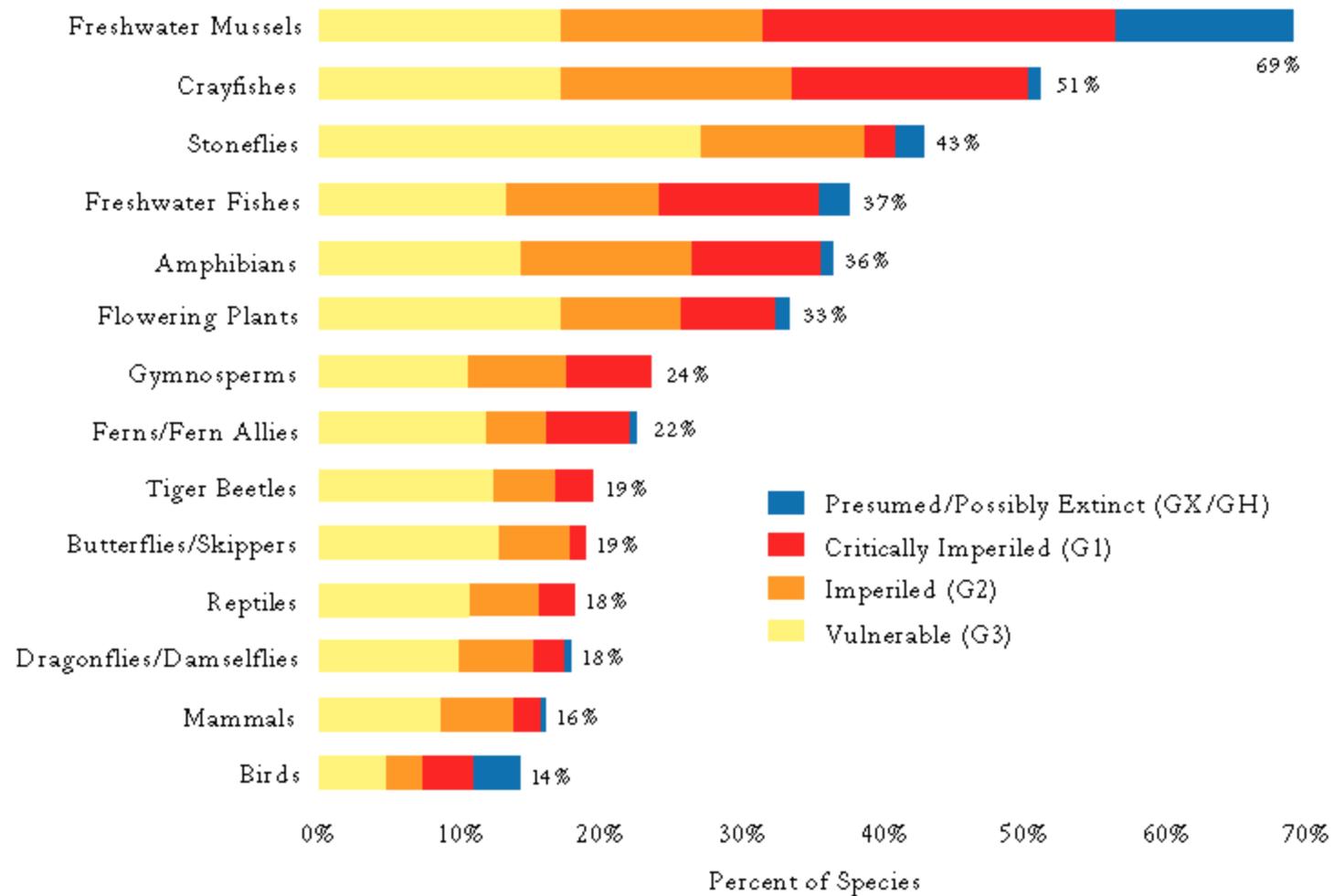


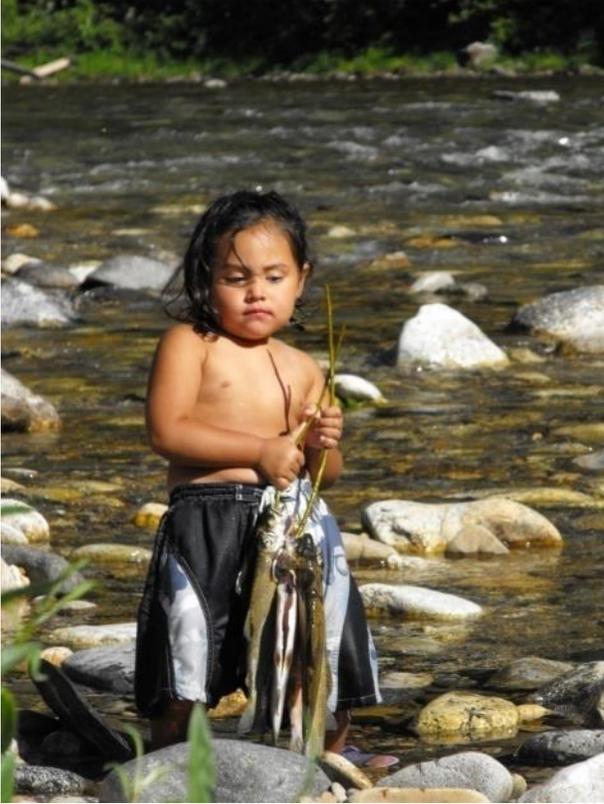
Illustration by Jeremy Wolf, CTUIR

Proportion of species at risk by plant and animal group in North America



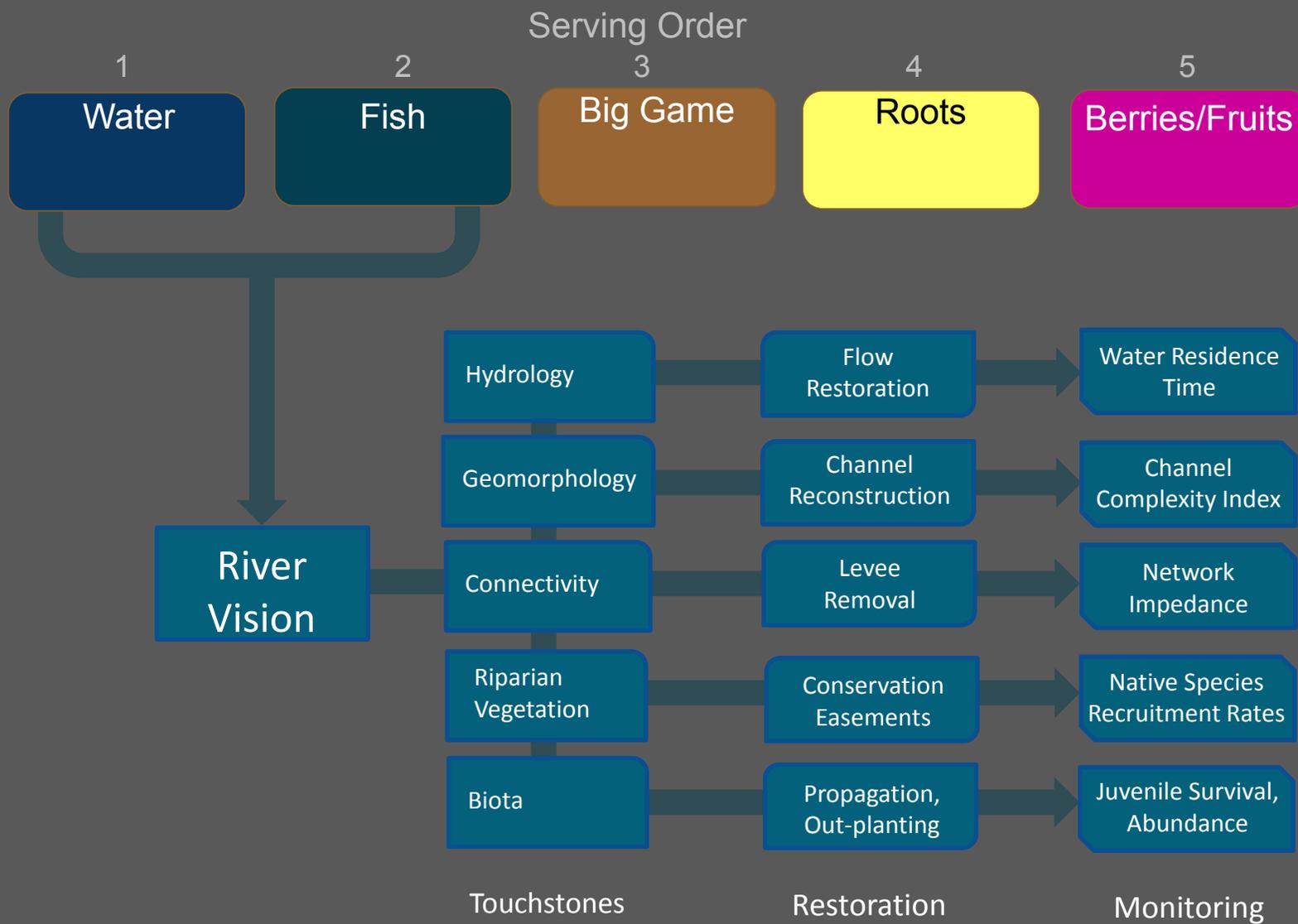
Freshwater mussels are highly endangered!!

River Vision



“ The Umatilla basin includes a healthy river capable of providing First Foods that sustain the continuity of the Tribe’s culture. This vision requires a river that is dynamic, and shaped not only by physical and biological processes, but the interactions and interconnections between those processes.”

First Foods Management with River Vision Implementation



FWM Project Objectives

Research

- Understand FWM biology and ecology
 - Factors affecting distribution
 - Reproductive biology
 - Habitat requirements & selection



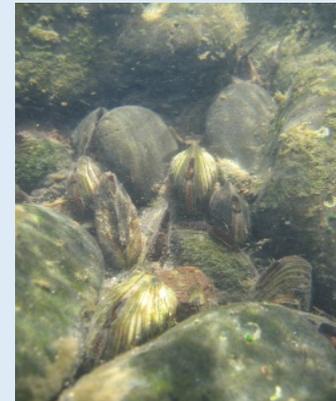
Restoration

- Restore self-sustaining FWM populations to Umatilla and other ceded basins
 - Restoration of aquatic ecosystem (water filtration, nutrient cycling, substrate stability)
 - Cultural significance (harvest for shell material) services



Restoration

- Restoring healthy mussel populations to rivers is a top priority
 - Ecosystem services that mussels provide are beneficial to aquatic organisms, especially the macroinvertebrate insect community
 - Mussels are a cultural and traditional resource to tribes like CTUIR
 - Harvesting mussels remains a treaty right for CTUIR members
- Mussels as tools for restoration
 - Filter feeding improves water quality
 - Dense mussel beds provide substrate stabilization
 - Healthy mussel populations indicate areas of high quality habitat/river conditions



Areas of Research

- Distribution
- Population Status
- Reproductive Biology
- Genetics/Taxonomy
- Artificial Propagation
- Population Restoration



Presence/Absence Surveys
Historical Sites
Shell Middens/Museum Records
Declines/Die Offs
Recruitment
Gender/Age Structure
Fecundity
Timing and Triggers of Gravidity
Host Fish Associations
Correct Taxonomic Placement
Morphology (among and between populations)
Host Fish Associations
Population Genetics
Growth/Survival in Lab/Wild
Juvenile Habitat and Food Requirements
Trial/Caged Outplanting
Host Fish Restoration
Habitat Restoration

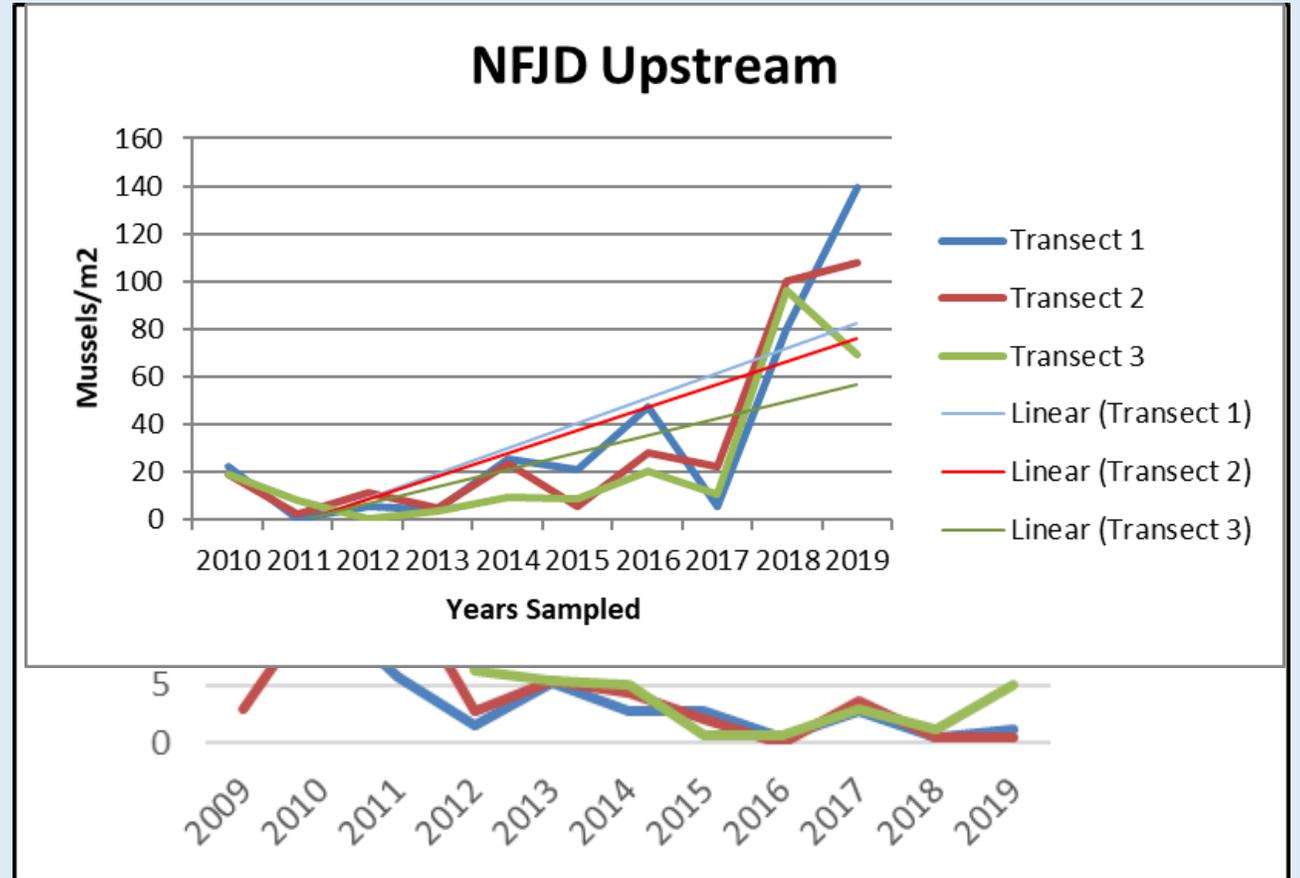
Historic FWM Distribution

- Midden/Historical Use Site Analyses
 - *M. falcata* most dominant species in Umatilla Basin
 - Now extirpated
- Brim Box et al. 2006



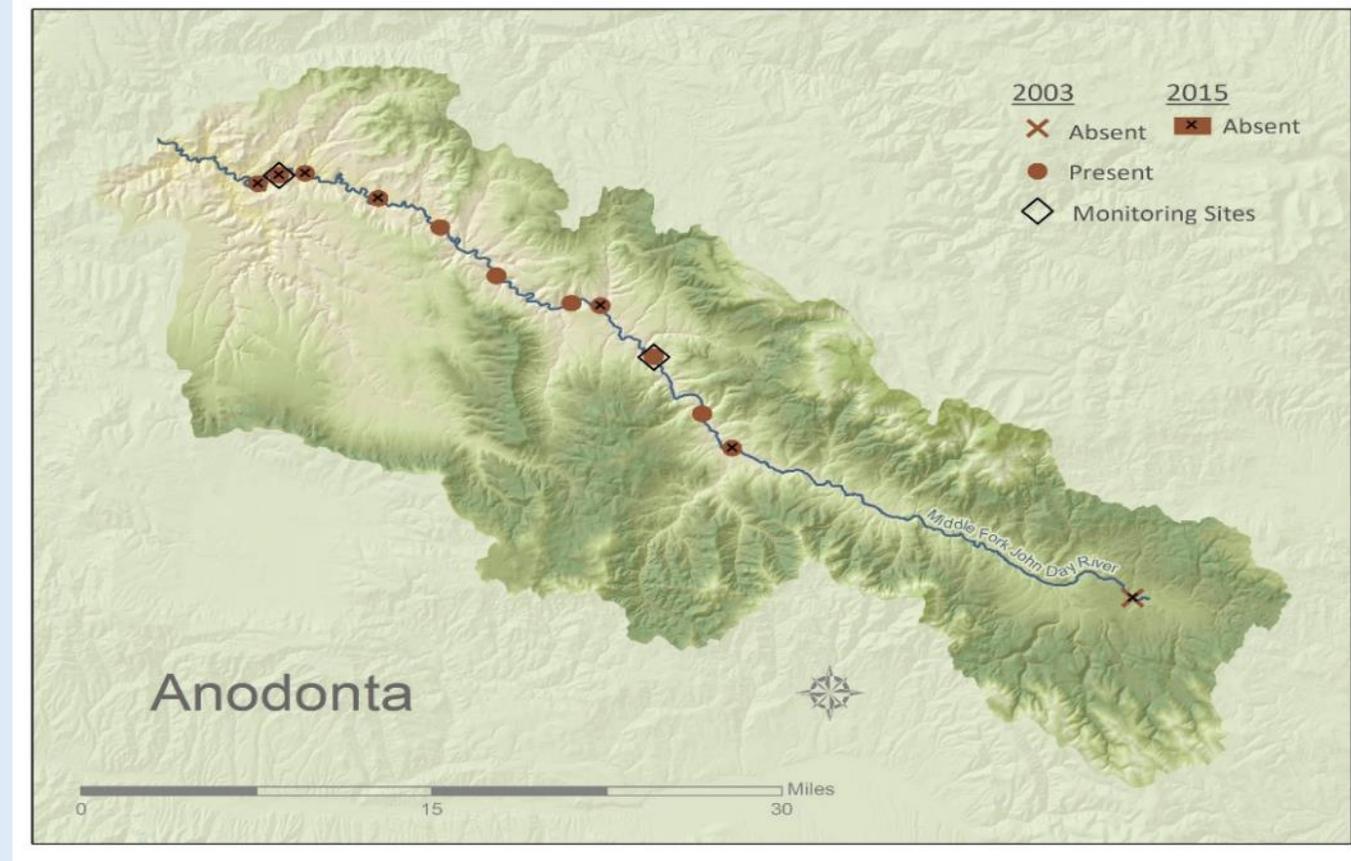
Long Term Monitoring

- Long term monitoring sites
 - Population fluctuations
- Limitations of mussel monitoring
 - Juvenile detection
 - Factors affecting decline



Population Status/Trends

- Resurvey Field Sites
 - 2003 survey sites resurveyed in MFJD 2015 (n=15)
 - *Anodonta* declined in 30% of sites
 - *Gonidea* declined in 13%
 - *Margaritifera* declined in 15%
- Annual survey work
 - Many areas unsurveyed still
 - eDNA
- Blevins et al. 2018
 - Extinction risk



Translocations and Monitoring

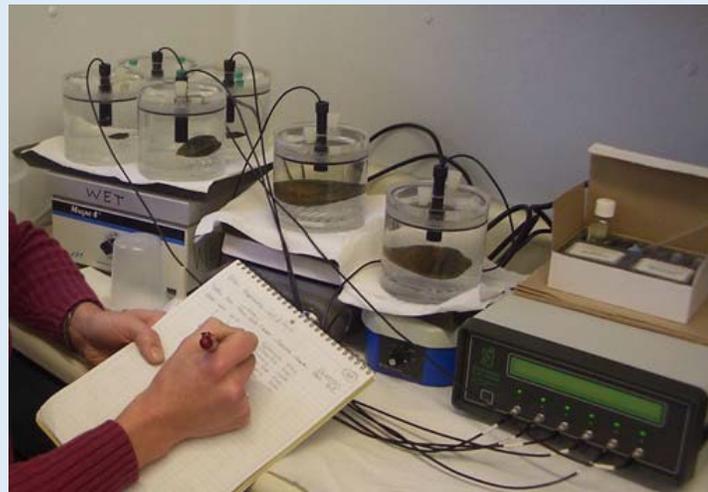
- 2004: 200 *M. falcata* relocated to Umatilla Gauging & Mission.
 - Majority were found 1 yr. later at Gauging
- 2008: 144 *M. falcata* Translocation observation
- 2012: 121 *M. falcata* & 89 *Gonidea* Gauging and 83 *M. falcata* Minthorn

Outcome: A total of 11 subadult mussels were located during 2014-2019 follow up surveys.



Ecosystem Services

- Filtration rates similar between genera
 - Seston values were similar for each species; 1-5mg/L
 - A bed of 1,000 mussels can remove up to 2kg/yr.
 - Higher filtration rates were detected in spring and summer months



Broad-Scale Habitat Associations

- There were no specific habitat associations for any of the genera
- FWM were negatively associated with riffles and cascades
- FWM were positively associated with pools and runs
- Upper gradient threshold ~3%
- *M. falcata* found <3% gradient
- *Anodonta* & *Gonidea* more common in river section <1% gradient
- All genera more common in quadrats lacking high amounts of fine sediment



Fine-Scale Habitat Associations

Background:

- 144 MF were relocated to the Upper Umatilla River
- Three sites were chosen based on upwelling/downwelling
- 8 quadrates were placed at each of three sites
- FWM movement was documented

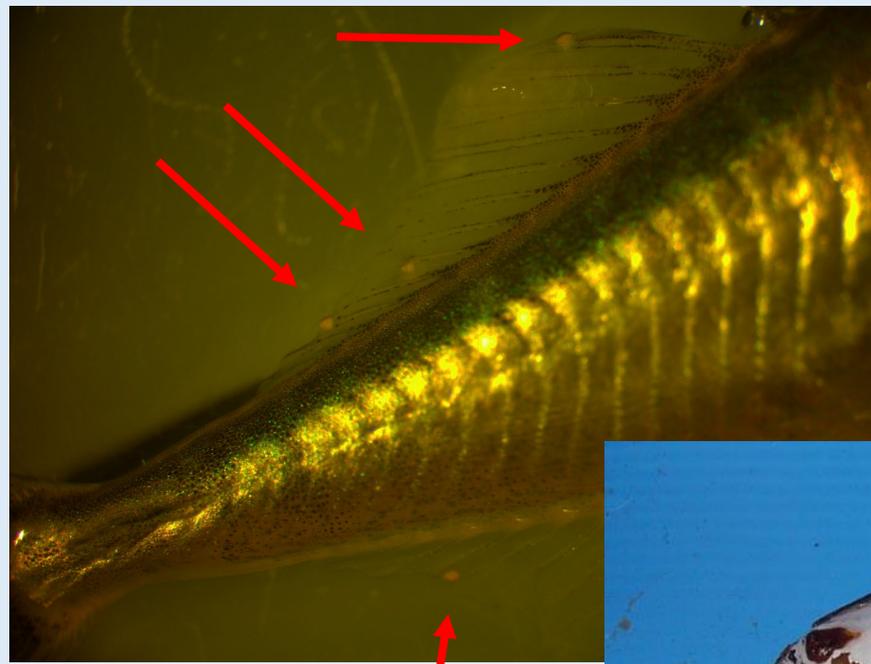
Conclusions:

- 3.7% of FWM remained in the quadrats at the downwelling site;
- 29% of FWM remained in quadrats at the slightly downwelling site;
- 42% of FWM remained in quadrats at the upwelling site.



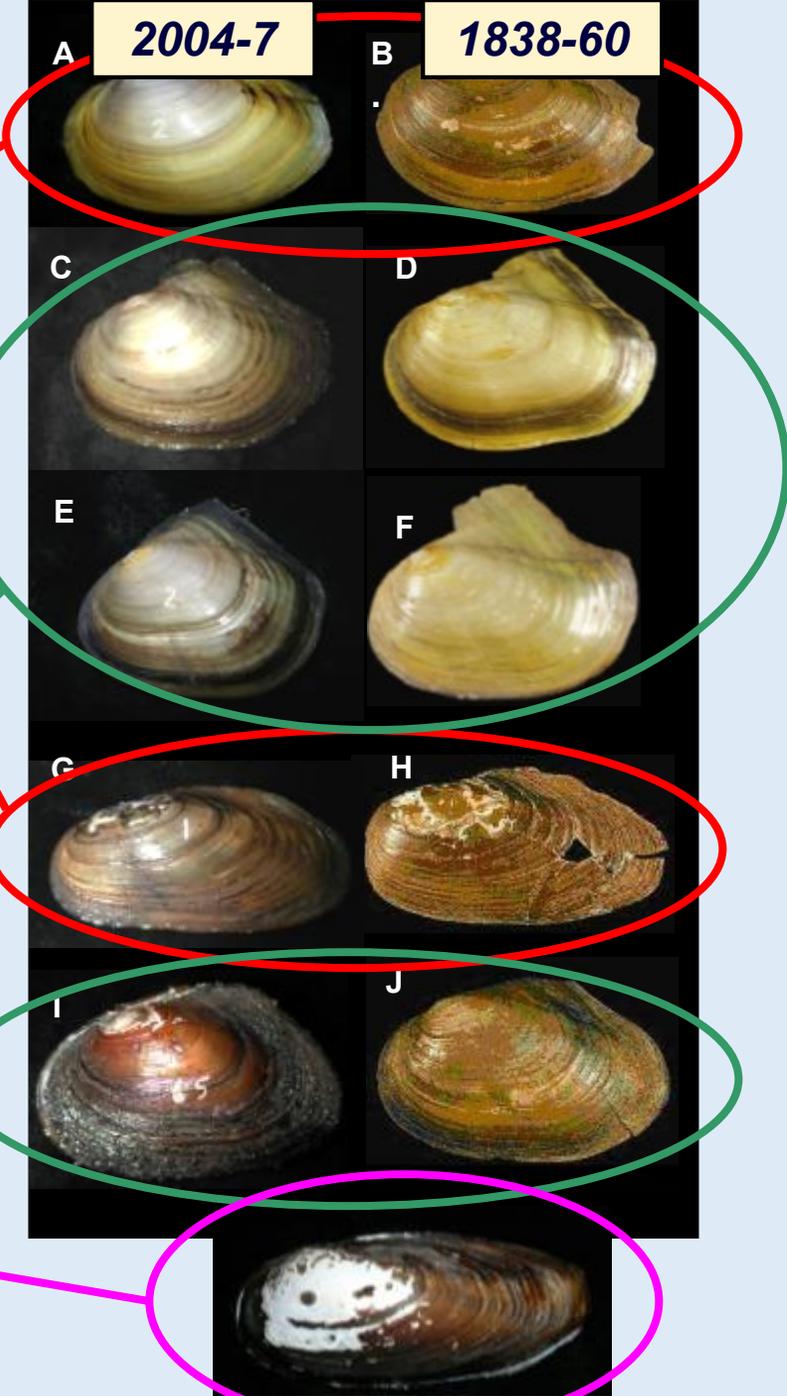
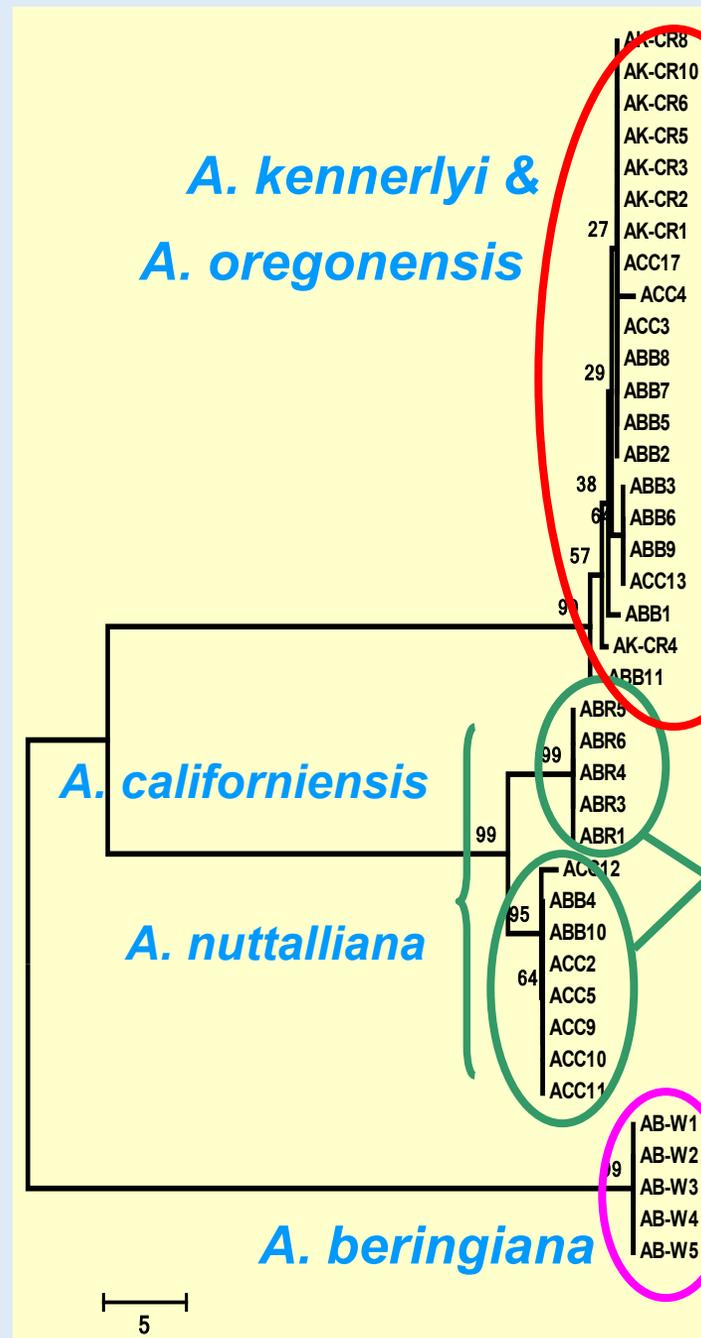
Reproductive Biology

- Host Fish Associations
 - *Anodonta* (Generalist)
 - Sculpin, dace, shiners, stickleback, chub, salmonids, crappie*, mosquitofish*, bluegill*
 - *Margaritifera* (Specialist)
 - Salmonids
 - *Gonidea* (Specialist)
 - Sculpin
- O'Brien et al. 2013



Genetics/ Taxonomy

- Chong et al. 2008
 - Three lineages of western *Anodonta*
- Mock et al. 2010
 - *Anodonta* genetic structuring specific to major watersheds
- Mock et al. 2013
 - Population genetics and contrasting life histories of *Anodonta* and *Margaritifera*
- O'Brien et al. 2019
 - Morphological variations in larvae of 4 species of *Anodonta*



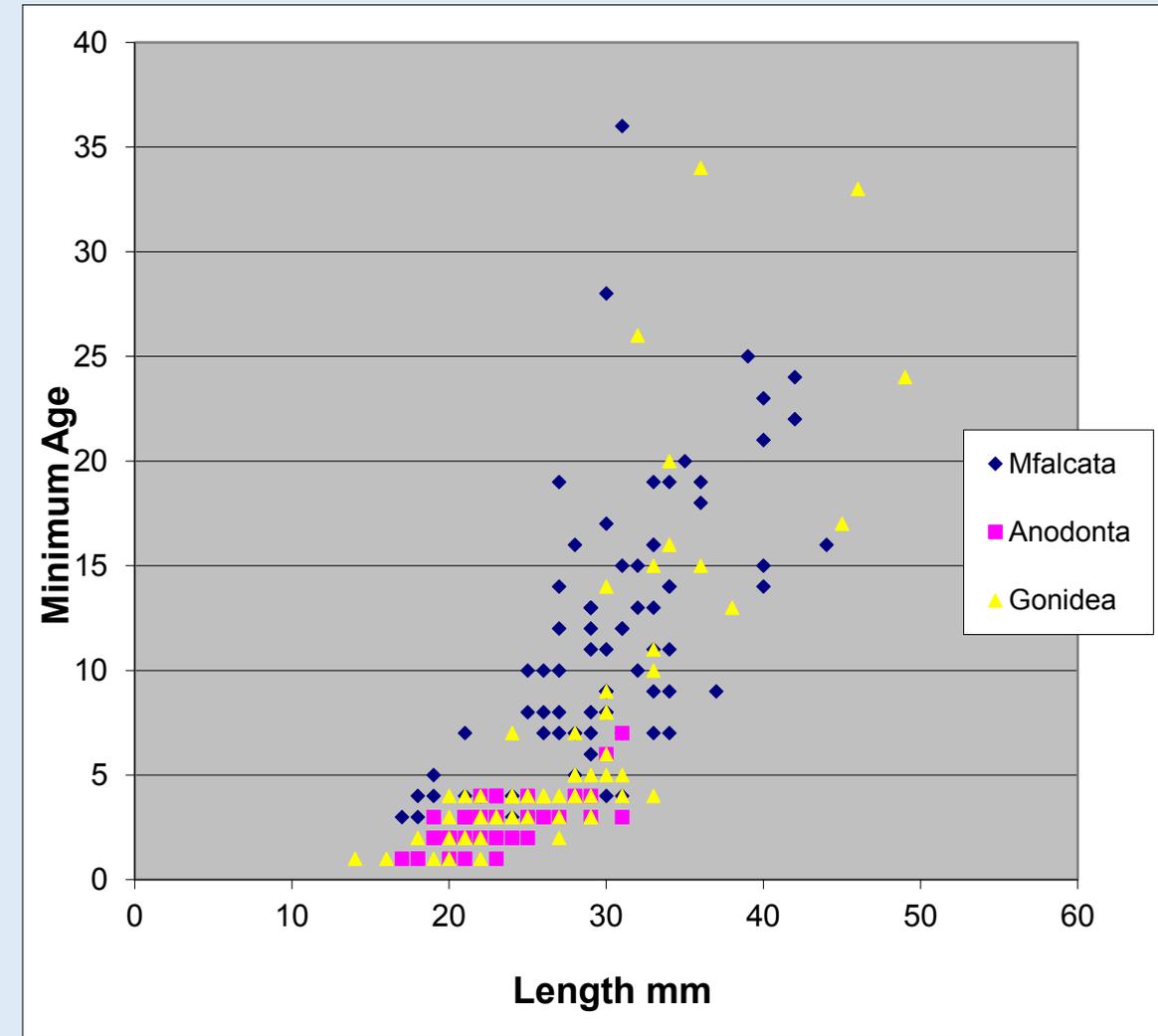
Shell aging results

Shell growth associated with environmental conditions

- Black et al. 2014. – high river discharges resulted in slowed *Gonidea* growth
- Positive growth was associated with warmer water temperatures
- Age data showed steady recruitment from 1950 to 2010

Aging mussel shell

- Preliminary results indicate *Anodonta* is shorter lived
- Length may not be a good tool for aging a mussel



Artificial Propagation



Population Restoration



- Outplanting
 - Relocations
 - Population supplementation
- Habitat
 - Continued collaboration with Fisheries habitat, biomonitoring, hyporheic exchange projects



Next Steps

- Population Restoration
 - Producing numbers needed for outplanting trials and juvenile ecology studies
 - Collaborating with habitat projects to ensure mussels are not harmed by restoration actions
- Outreach and Education
 - Reprinting mussel book: River Mussels Through Time
 - Participation in regional (2020) and national (2021) mussel meetings
 - Youth mussel curriculum/activity booklets
- Investigate mussel declines
 - Develop methods to analyze sediment, water, shell, and tissue



Freshwater Mussel Master Supplementation Plan

- Phase 1: Laboratory Phase (2020-2025) Research Basic Artificial Propagation Techniques and Equipment (produce products for outplanting)
- Phase 2: Field Phase (2022-2031): Supplementation and Biological Research
- Phase 3: Synthesis Phase (2027-2069+): Evaluation and Planning Next Steps Toward Recovery
- Phase 4: Implement Restoration and Supplement Actions (2028-2069+)

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14-49	50
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033-2068	2069
Phase I	Active														
Phase II		Active													
Phase III								Active							
Phase IV									Active						

Questions?



Thank you!