CHEHALIS BASIN STRATEGY

FRESHWATER MUSSELS

Study Goals and Objectives

Since 2020 we have been conducting baseline surveys to document the occurrence and distribution of native freshwater mussel species in the Chehalis Basin. These include Western Ridged, Western Pearlshell, and Floater mussels. The Western Ridged Mussel (WRM) is an ASRP indicator species, in part, because of its symbiotic association with native fish and its ability to improve water quality. WRM is also going through a federal status review and has been declining across its range, including in the Chehalis Basin. Documented mussel bed die-offs have been recorded in the Basin and are affecting both WRM and Western Pearlshell mussels in the mainstem and lower Newaukum River.

In cooperation with Xerces Society, USFWS, and other WDFW partners, we are filling knowledge gaps about the occupancy, species health (die-off beds), and habitat requirements of these mussels. These data are crucial to future Status & Trends efforts by establishing a baseline of freshwater mussel distribution for the Basin and specifically in areas where mussels have not previously been surveyed for. Further, these efforts are essential to document the extent of mussel die offs relative to extant mussel beds (**Figure 1**). Information regarding the distribution and status of freshwater mussels, as well as threats to their persistence in the Chehalis watershed, is limited. By improving baseline knowledge of mussel distribution, status, health, and threats, this study supports future conservation efforts to restore mussel habitat and maintain healthy, abundant mussel populations over their maximum possible extent in the Chehalis Basin.

Fig 1. Western Pearlshell Mussels at a die-off bed on the Newaukum River downstream of Jackson Hwy. The first die-off bed found outside the mainstem Chehalis was discovered in Summer 2022, photo credit Hannah Burnett.

Methods / Study Design

Surveys were conducted by teams of 2-5 technicians snorkeling and wading reaches and using visual encounter surveys or hand-feel to locate mussels. During surveys air and water temperature (°C) and water clarity and visibility were recorded. When mussels were observed, a GPS point for downstream and upstream extents of mussel bed, bank side, and species ID were collected. We recorded categorical abundance counts for live, recently dead, and empty (dead) shells. In addition, for "Common" or "Abundant" beds (defined as beds of 20+ mussels), we also recorded the presence of variable age classes of mussels, macrohabitat, embeddedness in substrate, density (Clumped, Scattered, or Continuous), and photographs of observed species and habitat.

If newly documented die-off beds are located, we relay observations to our cooperative partners at the Xerces Society for further investigation. The cooperative project with Xerces Society and USFWS is investigating new die-off beds and intensively studying three previously known die-off beds and three healthy beds for mussel condition, habitat, and water quality. In 2020, mussels were analyzed for condition analysis at Abernathy Labs from multiple locations in the Basin. In addition, tissue hemolymphs from mussels within and outside the die-off areas have been sent to USFWS LaCrosse Fish Health Lab and University of Wisconsin-Madison.

Summary of Results

Census surveys from 2020-2022 have covered 200 miles of river (**Figure 2**). These surveys have vastly expanded our knowledge of the three native mussel species in the Basin. In addition to the census surveys, our crews have also surveyed all nine historic WRM sites and confirmed live WRM at only two of these sites. In both sites, mussel density was low with only 3 and 1 mussel being detected. Five sites only had mussel shells present and two sites had no evidence of WRM (alive or dead). Our crews have also surveyed several confluence junctions of major rivers with the mainstem Chehalis and have documented five additional sites with small numbers of WRM (four sites with 1 or 2 live mussels and one site with only shells detected). One of these locations is the furthest upstream observation to date at the Southfork Chehalis confluence, but only one live WRM was found. Between the historic and newly documented sites, WRM abundance are sparse and at low densities where they are still alive.

We have also worked with WDFW partner Marie Winkowski on eDNA assessment, conducting 23 ground-truth snorkel surveys at locations with positive eDNA detections. In these surveys, we have confirmed Western Pearlshell at 17 sites. The cooperative work with Xerces Society has also resulted in a central database for all known mussel observations in the Chehalis Basin. These data have been incorporated into WDFW's PHS database and have been used for the federal status review.

Interestingly Lincoln Creek and the Black River show spatial segregations of Western Pearlshell and Floater Mussels. Within Lincoln Creek, Western Pearlshell beds are largely upstream and Floaters are found downstream (**Figure 3**). The reverse pattern is seen in the Black River where Floater beds tend to be concentrated upstream and Western Pearlshell Mussel beds are largely downstream (**Figure 4**). Why these species are spatially separated is unclear. Floater Mussel natural history suggests they tend to be found in softer sediment reaches, whereas Pearlshells can embed into harder substrate without causing damage to their shells. Further analysis of macrohabitat data and site characteristics may illuminate why we observe such stark spatial segregations in mussel occupancy in these two streams.

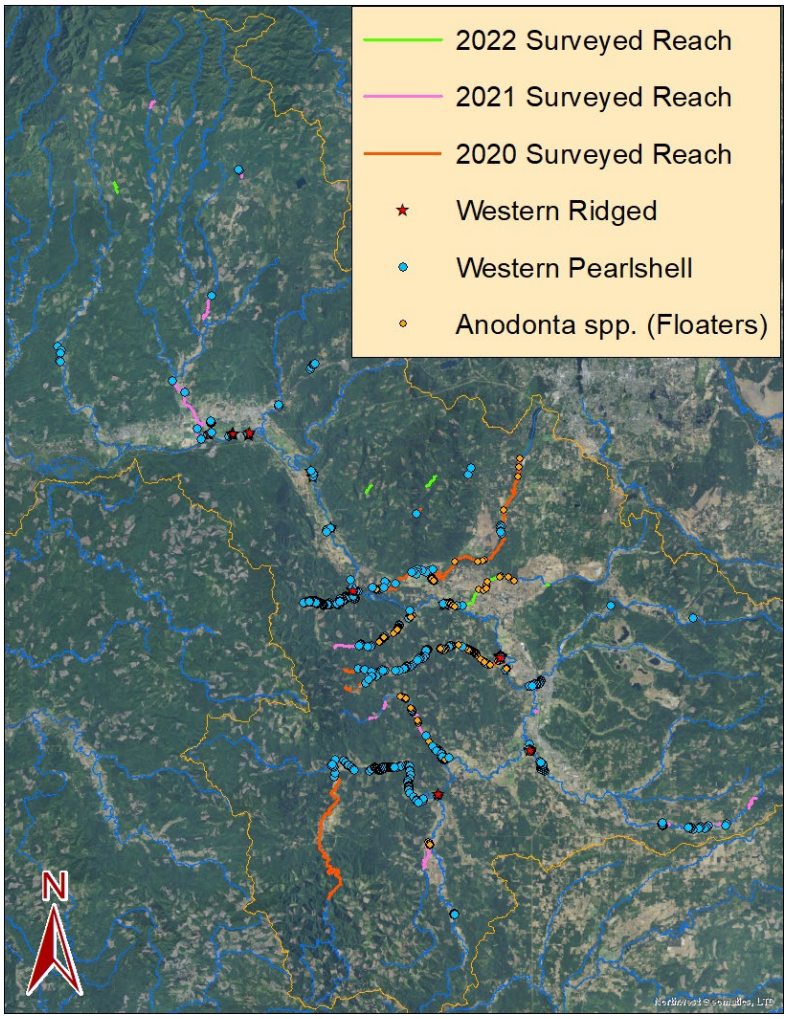

Fig 2. Mussel occurrence in the Chehalis Basin from 2020-2022 surveys.

Condition analysis results from the Abernathy Lab on the six sites sampled in 2020 show that mussels from some Chehalis sites form NMID fatty acids. Mussels form NMID fatty acids to protect their tissues from lipid peroxidation when they are exposed to contaminants or a harsh environment. These results suggest that some of our sample sites appear to have environments that caused stress for the Western Pearlshell. Evidence of similar changes in fatty acids with known causes in mussels has been found elsewhere (Abernathy 2022). However, it remains unclear what factors, including water quality, are associated with NMID fatty acid formation and whether this contributes to die-offs (Blevins pers comm.). Initial review of water quality results did not suggest a cause of this stress (Blevins pers comm.). Further intense review of water quality data and mussel tolerances for different heavy metals is pending by Xerces and will be reported on when complete. Further, an analysis of the tissue hemolymphs identified the first documented rhabdovirus jumping from finfish to mussels (Goldberg et al. 2023). Since freshwater mussel larvae attach to fish and feed on tissues and blood, researchers have hypothesized that this may explain how these rhabdoviruses originally jumped between mussels and fish. Western Pearlshell mussels where this virus was detected use salmonids as larval hosts. In finfish, rhabdoviruses can cause hemorrhagic, ulcerative, and other diseases that pose serious threats to wild fisheries. At present, we do not know whether this rhabdovirus causes disease in mussels, finfish, or other

species and a currently unreleased set of data from the same project is showing that mussels in general carry large viral loads of at least 80 different viruses (Blevins pers comm.)

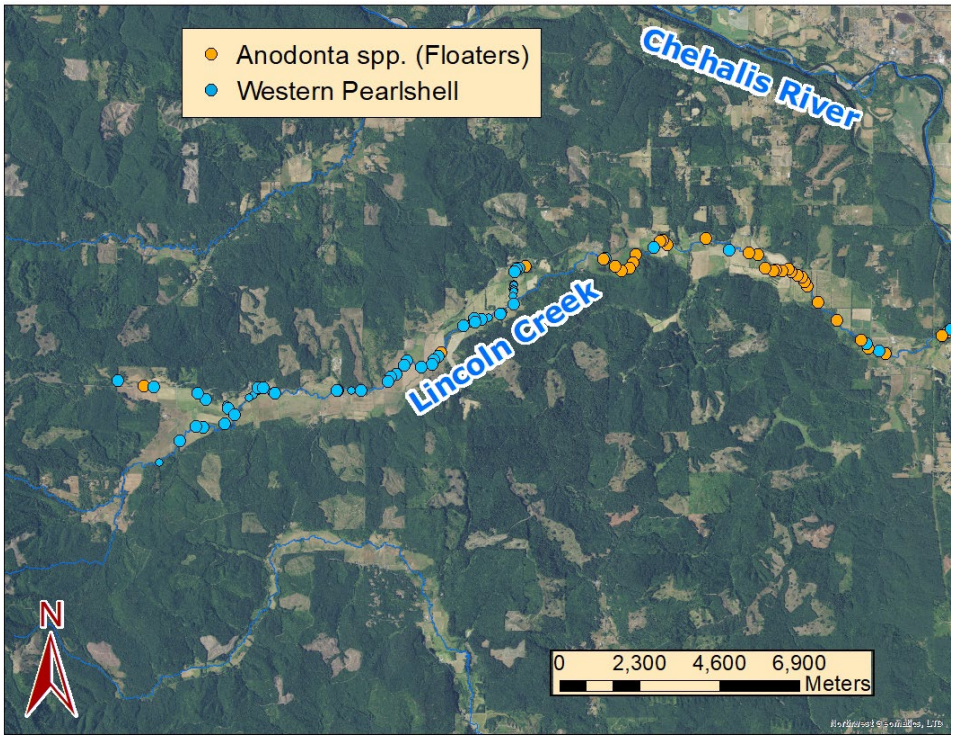

Fig 3. Lincoln Creek Mussel Beds

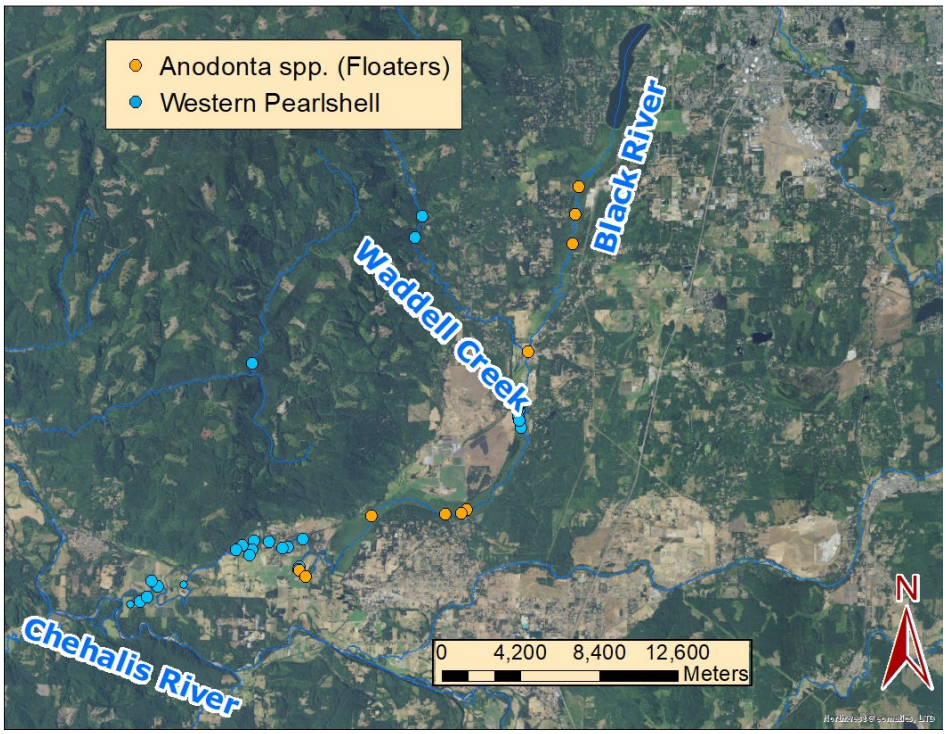

Fig 4. Black River Mussel Beds

Discussion

Our efforts have significantly expanded our knowledge of mussel beds in the basin and the extent of die-offs. This work is also providing preliminary evidence for habitat segregation between species. This information and the cooperative partnership with Xerces Society and USFWS is establishing a powerful baseline for current and future Status & Trends monitoring. Our work may be useful in guiding future interventions to bolster and restore mussels in the Chehalis. Unfortunately, the causes of mussels die-offs observed across the Chehalis and the nation more broadly are still unclear. Ongoing conversations among project partners are exploring potential alternative interventions to recover and protect the unique genetic populations of WRM in the Chehalis Basin, potentially including future propagation and reintroductions.

Adaptive Management

This work has potential to inform Steering Committee decisions around habitat project development. Currently there are no known interventions for mussel restoration. Future ASRP funding could be used to develop restoration projects for this species if successful interventions emerge. The data from this work would be useful in prioritizing where to place those interventions. Relatedly, should mussels be a priority for the Steering Committee, the data here can inform additional studies to test innovative restoration initiatives for mussels. Specifically, these data underscore a need to test approaches for mussel restoration given the scale of mussel die-offs in the Chehalis Basin. Our observations of mussel beds provide a foundation for where to target future experimental restoration efforts.