



Aquatic Invasive Species (AIS) Control Plan: New Zealand Mudsail

This control plan is a living document and will be updated, as needed, to reflect the status of the species within Pennsylvania.

Natural History

Description: New Zealand Mudsails (*Potamopyrgus antipodarum*) are diminutive freshwater gastropods, typically attaining adult sizes of only several millimeters (about 1/4th of an inch) in length.

Taxonomy

Common name: **New Zealand Mudsail**
Family: **Tateidae**
Species: *Potamopyrgus antipodarum*
Integrated Taxonomic Information System (ITIS) Serial Number **205006**

Morphology: New Zealand Mudsails (hereafter in this document abbreviated to “NZM”) are small freshwater snails which typically attain maximum lengths of only 4-6 mm within invaded portions of North America (Figure 1) but can attain larger sizes in their native range (Levri et al. 2007). NZM contain a “corkscrew” shaped spiraled shell that coils to the right and typically contains 5-8 whorls (Benson et al. 2023). NZM contain a hard operculum which can close to cover the opening in the shell. Shells are typically various shades of grey or brown. Populations within the Great Lakes contain different shell morphologies, such as a keel in the middle of each whorl, which is not typical of populations elsewhere (Levri

et al. 2007). Some populations also have small spines on the shell for defense from predators (Benson et al. 2023). NZM can be easily confused with other snail species and so experts are typically required to confirm identification.



Figure 1. Top: Magnified image of New Zealand Mudsail. Source: USGS. Bottom: New Zealand Mudsail shells with penny for scale. Source: Tim Throne, Trout Unlimited.

Origin: NZM are native to freshwater environments in New Zealand and several surrounding islands. NZM have spread to numerous localities in Australia, Europe, and North America. In the United States, NZM were first reported from near the Snake River, Idaho, in 1987 (Benson et al. 2023).



Food Preferences: NZM feed primarily on detritus, periphyton, and organic particles within sediment (Bilka and Levri 2013; Benson et al. 2023).

Reproduction: In their native range, NZM females primarily reproduce asexually via parthenogenesis, although sexual reproduction is known to occur. Invasive populations of NZM within the United States are thought to be exclusively clonal colonies of asexual females (Benson et al. 2023).

Notable Characteristics: NZM can achieve high densities within invaded waters (Figure 2); with some extreme estimates suggesting densities of over 299,000 snails per m² (Kerans et al. 2005).



Figure 2. Rock infested with New Zealand Mudsnaill from Codorus Creek, Pennsylvania. Credit: Tom Feneniz, Trout Unlimited.

Historic Vectors: NZM are thought to have spread from New Zealand to other parts of the world inadvertently through the global shipping trade. It is speculated that NZM were introduced to the Great Lakes on ships from Europe, and in water with game fish shipped from infested waters and stocked in western North America (Benson et al. 2023).

Current Pathways/Vectors: On smaller geographic scales (i.e., transport between watersheds), NZM are typically unintentionally introduced as “hitchhikers” on fishing, boating, and other aquatic recreational gear (Benson et al. 2023). NZM can close their operculum and can resist desiccation for up to several days outside of water (Richards et al. 2004). In Pennsylvania, many NZM infestations are located in popular wild trout fishing streams, suggesting waders/fishing gear as a major vector of transport (Hartzell and Macelko 2022). NZM may also be transported inadvertently via fish stocking and may even survive passage through the digestive system of some fish such as trout (Vinson and Baker 2008). NZM may also disperse on aquatic plants that are transported by humans or on aquatic vegetation moved during high water events (Benson et al. 2023).

Preferred Habitat: NZM are tolerant of a broad range of freshwater habitat characteristics and can even occur in brackish waters (Benson et al. 2023). They may be collected in deeper waters of lakes (Levri et al. 2007). In general, they prefer lentic or slow flowing waters with high nutrient levels, but are tolerant of fast flows, sedimentation, and pollution (Benson et al. 2023). In Pennsylvania, they appear to prefer waters with high conductivity (> 200 µS/cm²) and basic (>7) pH levels, likely due to a greater availability of calcium ions required for shell growth at these conditions (Levri et al. 2020). A robust statewide analysis by Hartzell and Shank (2025) found significant associations among NZM and water chemistry parameters such as alkalinity, hardness, calcium, nutrients, specific conductance, bromide, osmotic pressure, strontium, and



sulfate. These are typically associated with waters influenced by karst bedrock and/or agriculture and urbanization. Parts of southwest, southeast, and central Pennsylvania appear to be of greatest risk for NZM colonization, while NZM are less likely to colonize the northern parts of the Commonwealth based on associated water chemistry (Hartzell and Shank 2025).

Distribution and Status

Distribution: NZM have been reported in at least 21 US States, with populations primarily concentrated in the western US and in the vicinity of the Great Lakes (Benson et al. 2023; Figure 3).

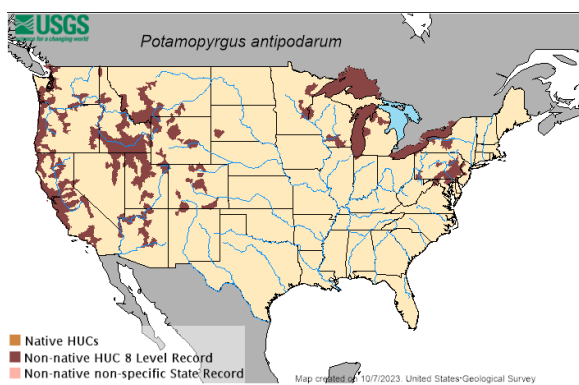


Figure 3. Distribution of New Zealand Mudsails within the continental United States. Source: USGS.

In Pennsylvania, NZM have been reported from at least 18 counties (Figure 4). NZM were first documented within Pennsylvania in 2005 from Lake Erie in the vicinity of Presque Isle State Park (Levri et al. 2007). In 2010, NZM were discovered in Spring Creek, Centre County (Hartzell and Shank 2025). Since 2018, NZM have been documented in numerous streams and several rivers, many of which are popular trout waters within the Lake Erie, Susquehanna, Delaware, Allegheny/Ohio,

and Potomac River basins in Pennsylvania (Levri et al. 2020; Hartzell and Macelko 2022; Hartzell and Frederick 2023; Hartzell and Shank 2025). Complete information on the distribution of NZM in Pennsylvania, including specific waters, can be found at the USGS nonindigenous aquatic species webpage:

<https://nas.er.usgs.gov/queries/factsheet.aspx?SpeciesID=1008>

Pennsylvania Legal Status: As of January 2025, NZM are not legally prohibited in Pennsylvania.

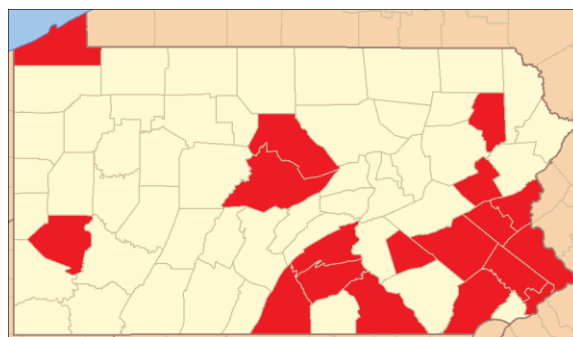


Figure 4. County-level distribution of New Zealand Mudsails in Pennsylvania (January 2025).

Threats

Ecological: Due to their potential to attain high densities within invaded waters, NZM are competitors with native gastropods and other periphyton-grazing macroinvertebrates such as caddisfly larvae and mayfly nymphs (Karens et al. 2010; Krist and Charles 2012; Larson and Black 2016) and NZM infestations may ultimately result in reductions of macroinvertebrate abundance and biodiversity (Karens et al. 2005; 2010), however, in some areas this impact may be minor (Cada 2004; Karens et al. 2005). Preston et al. (2024) found that NZM may negatively impact Amphipods and Ephemeropterans (Mayflies). Few studies



appear to have been done evaluating the potential impacts of NZM on higher trophic levels (i.e., fish). However, trout will consume NZM in both laboratory and natural settings and will lose weight due to the poor nutritional content of NZM as compared to native macroinvertebrates (Vinson and Baker 2008). NZM have also been suggested to impair wild Rainbow Trout by dietary disruption (Myers et al. 2024).

Economic: The economic costs of NZM infestations are primarily speculative and have received little quantitative investigation. Due to their high densities, NZM may cause some degree of economic damage via biofouling structures such as water intake pipes; however, this has not commonly been reported and is likely minor in comparison to other invasive freshwater mollusks such as Zebra Mussels (Proctor et al. 2007).

Likely, the most significant economic cost of NZM invasions is related to fisheries because NZM are known to reduce the weight and quality of game fish species by food web disruption (Poirier 2015) and are of particular concern to trout fisheries (Vincent and Bakker 2008). NZM infestations can also impair fish hatchery function and increase operation costs (Oliver et al. 2021).

Management

Management Goals: NZM presently have an expanding distribution in Pennsylvania. Therefore, the primary management goal must be to contain infestations.

Containment and Prevention Actions:

- Continue to coordinate with partners to conduct monitoring within invaded watersheds to determine the extent of NZM infestations and continue periodic surveys of waters at-risk of infestation.
- Continue public education efforts to acquaint anglers with the threat of, and measures to prevent, the spread of NZM.
- Routinely monitor fish hatcheries at-risk of NZM contamination due to the presence of this species in nearby waters. Continue following established Pennsylvania Fish and Boat Commission (PFBC) biosecurity protocols and response plans for fish rearing and stocking and incident response plans as needed.
- Support or initiate research in Pennsylvania further evaluating the impacts of NZM on native species and coldwater fisheries.
- Continue installing NZM-specific signage developed by the PFBC and Pennsylvania Sea Grant at locations infested by NZM and consider the installation of wader cleaning stations at infested sites. Established gear disinfection protocols include the following: freezing gear for a minimum of six hours, soaking gear in hot (>120°F) for at least five minutes, or completely drying gear for at least five days.
- Encourage the incident reporting of aquatic invasive/nuisance species such as NZM within Pennsylvania. Online reporting can now be conducted at the following PFBC web site:



<https://www.fishandboat.com/Conservation/AIS/Pages/default.aspx> as well as PA iMapInvasives at: <https://www.paimapinvasives.org/> and at the national level, USGS Nonindigenous Aquatic Species website: <https://nas.er.usgs.gov/SightingReport.aspx>

- Keep informed with research concerning the use of biological/chemical controls (see Rapid Response Options below).

Rapid Response Options:

- Several physical or chemical treatment options have been evaluated for killing or preventing the dispersal of NZM within fish hatcheries; however, these are largely ineffective for broader NZM control due to the ability of this species to seal its shell during adverse chemical conditions (Oplinger et al. 2009). Copper sulfate-based treatments were recently demonstrated to be effective at eradicating NZM but required long-term (weeks) of treatment to be effective within hatchery raceways (Oliver et al. 2021). No robust methods of control appear to have been demonstrated for streams, rivers, large ponds, or lakes.

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