State of Michigan's

Status and Strategy for New Zealand Mudsnail Management

Scope

The invasive New Zealand mudsnail (*Potamopyrgus antipodarum*) threatens Michigan's waterways. The goals of this document are to:

- Summarize current level of understanding on the biology and ecology of the New Zealand mudsnail.
- Summarize current management options for the New Zealand mudsnail in Michigan.
- Identify possible future directions of New Zealand mudsnail management in Michigan.

Biology and Ecology

I. Identification

U.S. Geological Survey

The New Zealand mudsnail is a gastropod of the genus Potamopyrgus within Hydrobiidae. This small aquatic snail is native to New Zealand and typically measures between 4-5mm in size. Its dextral, spiraling shell is helpful in identification. The gray to light or dark brown shell is cone-shaped and slender with a pointed whorl. Adults have seven to eight right-handed whorls and can measure up to 12 mm long (Richards et al. 2004). The operculum is ovate in shape, resembling an ear; this feature separates this species from other freshwater snails (Zaranko et al. 1997).

The New Zealand mudsnail shares similar shell appearances to native species including *Eremopyrgus eganensis* and *Juturnia tularosae* (Richards et al. 2004). However, the New Zealand mudsnail has a longer and narrower shell when compared to *Eremopyrgus eganensis* and *Juturnia tularosae*, which typically have five or less whorls (Zaranko et al. 1997, Richards et al. 2004).

II. Life History

The New Zealand mudsnail reproduces both sexually and asexually. Females can reproduce asexually through parthenogenesis. Populations in the United States are mainly composed of asexually reproducing females (Nielson et al. 2012), while males normally make up less than five percent of the population (Zaranko et al. 1997). New Zealand mudsnails reach sexual maturity around 6 months of age or 3mm in length, reproduction occurs during the summer and fall. (Benson et al. 2014, Cheng and LeClair 2011). A single female snail can produce up to 120 embryos and bear about 70 live, genetically identical offspring every three months (NZMS Management and Control Plan Working Group 2007, Cheng and LeClair 2011, Nielson et al. 2012). The highest numbers of offspring are produced during summer months (Zaranko et al. 1997).

III. Diet

The New Zealand mudsnail is a detritivore-herbivore. It prefers to feed on plant and animal detritus, but will also feed on green algae and diatoms if present (Zaranko et al. 1997). Their high population growth rate and an abundance of food sources make it possible for New Zealand mudsnails to dominate the primary productivity within an ecosystem (Alonso and Castro-Diez 2008).

IV. Habitat

The New Zealand mudsnail has been known to thrive in a wide range of fresh water and brackish habitats including lakes, rivers, streams, estuaries and reservoirs (Benson et al. 2014). The species can tolerate a wide range of salinities, with maximum tolerances reaching 26 percent (Zaranko et al. 1997). In North America, the New Zealand mudsnail is found in freshwater streams, creeks, lakes, and estuaries in very high densities (Alonso and Castro-Diez 2008). Within its invaded range, New Zealand mudsnails are most concentrated in disturbed systems (Alonso and Castro-Diez 2008).

V. Effects from the New Zealand Mudsnail

Because of its high reproductive capabilities, the New Zealand mudsnail can spread rapidly, consuming large amounts of primary production within an ecosystem (Alonso and Castro-Diez 2008). When at high densities, New Zealand mudsnails compete with native macroinvertebrates, like the caddisfly, for food and space. Dense populations of mudsnails could also reduce the abundance and alter the distributions of native species (Kerans et al. 2005). In a field study done by Kerans et al. (2005), the number of New Zealand mudsnails was the strongest predictor of the number of macroinvertebrates. This study suggests that the colonization of New Zealand mudsnails interferes with the ability of other native macroinvertebrates to colonize invaded systems. When at high densities, New Zeland mudsnails also dominate carbon and nitrogen fluxes within the environment while sequestering a large fraction of the available carbon needed for invertebrate production (Hall et al. 2006, Davidson et al. 2008). Krist and Charles (2012) found that New Zealand mudsnails removed as much or more periphyton than native grazers. The mudsnails also altered the diatom assemblage to a greater extent than native species (Krist and Charles 2012).

As they rapidly invade new freshwater systems, the New Zealand mudsnail could have negative impacts on native fish species. A study done by Vinson and Baker (2008) showed that rainbow trout subsisting on New Zealand mudsnails actually lost weight, serving as evidence that the snails have little to no nutritional value compared to native species. Additionally over half of the New Zealand mudsnails passed through the digestive system of rainbow trout alive (Vinson and Baker 2008). Aside from offering little nutritional value, the New Zealand mudsnail can physically cover egg sites or masses, while attracting the predators of native fish (Zaranko et al. 1997). Given their potential to alter community food webs and dominate available space the New Zealand mudsnail could negatively impact native plant species, fishes, and macroinvertebrates (NZMS Management and Control Plan Working Group 2007).

Structurally dense populations of New Zealand mudsnails have the potential to block water pipes and meters and could prove destructive or expensive to irrigation companies (NZMS Management and Control Plan Working Group 2007).

Current status and distribution in Michigan

The New Zealand mudsnail was first documented in North America in 1987 after being found in the Snake River in Idaho. It is suspected that they were introduced via international shipping or foreign fish stocking. Today the snail has spread to tributaries of the Snake River in Idaho and has expanded its range across the North American continental divide into the Madison River in Montana and the neighboring Missouri River basin (Zaranko et al. 1997, Figure 1).

A second population of New Zealand mudsnail was discovered in Lake Ontario and the St. Lawrence River in 1991. According to the United States Geological Survey (USGS), the New Zealand mudsnail has also been found on the west and north shores of Lake Superior, the west shore of Lake Michigan near Waukegan, Illinois, and in Lake Erie (Figure 1, Figure 2). No records of New Zealand mudsnail locations can currently be found in the USGS, Biodiversity Information Serving Our Nation (BISON), and Midwest Invasive Species Information Network (MISIN) databases, but a new occurrence has been reported for Black Creek in Wisconsin (Figure 2).

Management of New Zealand Mudsnails

The New Zealand mudsnail's ability to thrive in a wide range of habitats, high reproductive capacity, and effective dispersal mechanisms make it a serious threat to Michigan waters (Zaranko et al. 1997). Live New Zealand mudsnails can be transported in the guts of fish and are estimated to be able to move upstream at a rate of 1 km/year. New Zealand mudsnail could also be moved to new areas by birds, waders worn by fly fisherman, and commercial fishery operations (Loo et al. 2007). Because the New Zealand mudsnail has been highly successful in its dispersal, a combination of management strategies including preventive measures and physical, biological, and chemical methods should be implemented to prevent further range expansions.

I. Prevention

Managing potential pathways of introduction for the New Zealand mudsnail is essential in preventing dispersal into new waterways. Pathway specific management plans include close visual inspection and the treatment of fish hatcheries and aquaculture operations. The regular inspection of equipment transported between waterways, including boats and trailers, is essential in stopping the spread of these snails. Additional regulatory inspections of the aquarium and aquatic plant trades as well as the inspection and cleaning of sand/gravel mining and dredging equipment could help minimize the spread of New Zealand mudsnails (NZMS Management and Control Plan Working Group 2007).

The use of GIS systems can also be used to map potential future habitats for New Zealand mudsnails, these models should be based on current distribution status. High-risk areas can then be selected for preventative efforts (Loo et al. 2007).

The distribution of New Zealand mudsnails is expected to widen in North America through several transport vectors. These vectors include but are not limited to: boots, waders, fishing poles, boats, anchors, trailers, and other attachable surfaces (Loo et al. 2007). Removing debris from boating and fishing equipment before leaving the launch area is important in minimizing spread (Benson et al. 2014) as well as cleaning gear with hot water or a pressure washer. Freezing for several hours after use as well as drying equipment at 30ºC for 24 hours or 40ºC for 2 hours can also treat infected equipment. Chemical applications are an option as well; equipment can be treated with copper sulfate, Formula 409 disinfectant, and benzethonium chloride compounds (Davidson et al. 2008). Virkon Aquatic, a concentrated disinfectant powder, mixes with water to form a powerful cleaning solution that can be used to disinfect boats, trailers, waders, nets, and sampling gear.

Public awareness can be utilized to keep New Zealand mudsnail populations at minimal abundance. Brochures can help the public identify these small snails and the proper ways to dispose of them. A combination of preventive measures such as postage at boat ramps, informational media distribution via brochures or website postings, and mobile washing station establishment at boat ramps could prove useful in limiting their spread (Davidson et al. 2008).

II. Management/Control

a. Physical

To limit the spread of the New Zealand mudsnail, fish stocking equipment should be maintained and cleaned between uses while hatcheries should be monitored regularly for new invasions. In addition to equipment cleanliness, holding of stocked fish for 48 hours in invasive free tanks before release is a good management practice that should be implemented at commercial fisheries (Vinson and Baker 2008).

Physical treatments include the use of temperature, low humidity, and desiccation to kill off New Zealand mudsnails (Richards et al. 2004). For example, the drainage of infested areas in the summer allows for sunlight exposure and desiccation. Drainage in the winter allows for freezing of substrate and eradication. Flamethrowers will directly kill New Zealand mudsnails attached to walls of raceways in hatcheries (NZMS Management and Control Plan Working Group 2007).

b. Biological

Biological treatments using parasites such as trematodes (*Microphallus* sp) have been shown to be effective at infecting the mudsnail genotype found in the western United States (NZMS Management and Control Plan Working Group 2007). Tests for specificity must still be conducted for *Microphallus* sp. to check for possible effects on vertebrates. The snail is the first intermediate host to several species of trematodes that cause complete sterilization of infected snails (both male and female) (Jokela et al. 2009).

c. Chemical

The use of molluscicides and algaecides could be used to eradicate existing populations of New Zealand mudsnails. Chemical means of eradication include the use of Bayer 73, copper sulfate, and 4-nitro-3-trifluoromethylphelow sodium salt (TFM). Use of Bayluscide, a molluscicide, has been 100% effective in eradicating New Zealand mudsnails when tested by Montana Fish, Wildlife, and Parks. (NZMS Management and Control Plan Working Group 2007).

Benzathonium chloride, Formula 409, and copper sulfate pentahydrate were all found to be effective in removing New Zealand mudsnails from wading gear in a reasonable amount of time. The effectiveness of these chemicals was not dependent on an open or closed opercula and they had no apparent effect on the integrity of wading gear (Hosea and Finlayson 2005).

Future Directions for Michigan and New Zealand mudsnail management

Monitoring for new occurrences of New Zealand mudsnail should be the top management priority, as there are currently no confirmed sightings in Michigan. The distribution information needs to be easily accessible and regularly updated to allow for rapid response to new outbreaks. The snails can be detected through regular physical surveillance at targeted sites by searching large woody debris, structures, vegetation, rocks, etc. (Shultz 2014). A zigzag technique can also be used to survey the presence/absence of New Zealand mudsnails. This opportunistic sampling requires few supplies and very little experience. Supplies include collection vials, ethanol, waders, and gear disinfectant. This technique has been used by the Center for Lakes and Reservoirs at Portland State University for the past five years and has proved successful in finding snails even at low densities. Visual surveys of streams and boat ramps using kick nets or grab samples are also potential methods for futures surveillance (Draheim 2014). Once the mudsnail's distribution is determined, pathways and vectors of dispersal need to be identified, evaluated, and regulated. These pathways may include ship ballast water, transportation via fishes, government agencies, private consultants, hunters, bank fishermen, tribal gillnet fishermen, boats, anchors, boots, waders, and other fishing gear (NZMS Conference 2011). Currently the primary vectors for New Zealand mudsnails are believed to be aquaculture and ballast water while secondary vectors include gear, boats, and fishing equipment (Draheim 2014).

One of the most important steps in controlling New Zealand mudsnails is to limit their range. The Washington Department of Fish and Wildlife has protocols for decontaminating field gear and equipment. The precautionary protocols include the regular inspection and cleaning of field gear before and after use and work areas devoid of plants and sediment. The protocols fall under two levels. This protocol starts out with Level 1 and includes cleaning, draining, and rinsing of all contaminated equipment with a bristle brush, boot picks, and clean water between uses. Level 1 decontamination protocols are required whenever moving from one water body to another. Level 2 is required when leaving infested waters, before entering protected/highly sensitive sites, or when moving between still water habitats. Level 2 solution treatments include the use of solutions known to be successful in decontaminating equipment, as outlined in Prevention. Cleaning stations near boat launches and the development of cleaning methods for boats, nets, and vehicles will help limit further dispersal to new bodies of water. Acquiring strict protocols for managing and disinfecting ballast water and aquaculture will also limit the spread of New Zealand mudsnails (Draheim 2014).

Physical and chemical eradication methods could possibly eradicate some existing snail populations. The drainage of smaller water bodies, allowing for desiccation, could prove successful. Lowering the water level during freezing temperatures would eventually lead to a drop in productivity (Cheng and LeClair 2011). Populations were reduced in Olympia Washington's Capitol Lake when subjected to freezing temperatures.

Raising awareness about New Zealand mudsnails to the public and fishing community through outreach, presentations, annual conferences, internet media, brochures, and identification guides is a good preventative measure. The public needs to be informed of the New Zealand mudsnail's potential harm to native aquatic species and that humans are the most common vector for their transportation (NZMS Conference 2011).

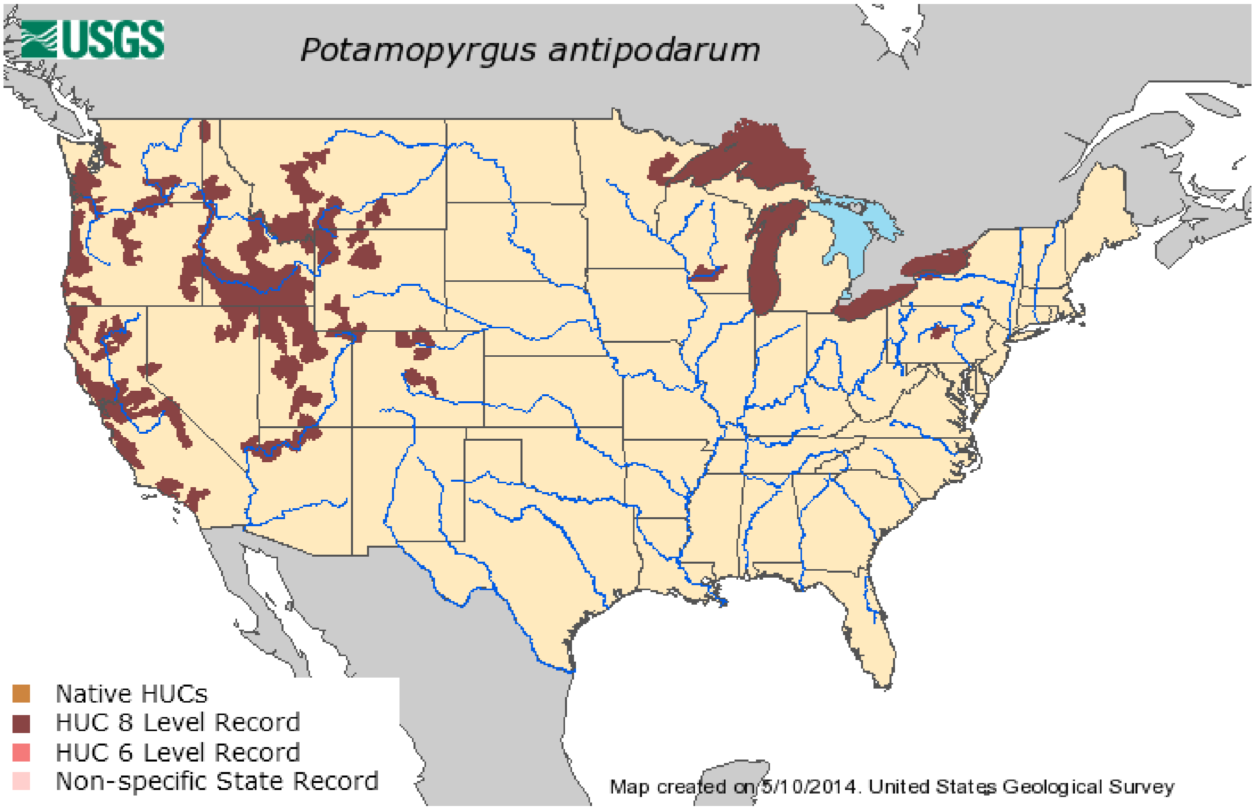

Figure 1. Distribution of New Zealand mudsnail in the United States (Benson et al. 2014). Accessed May 23, 2014.

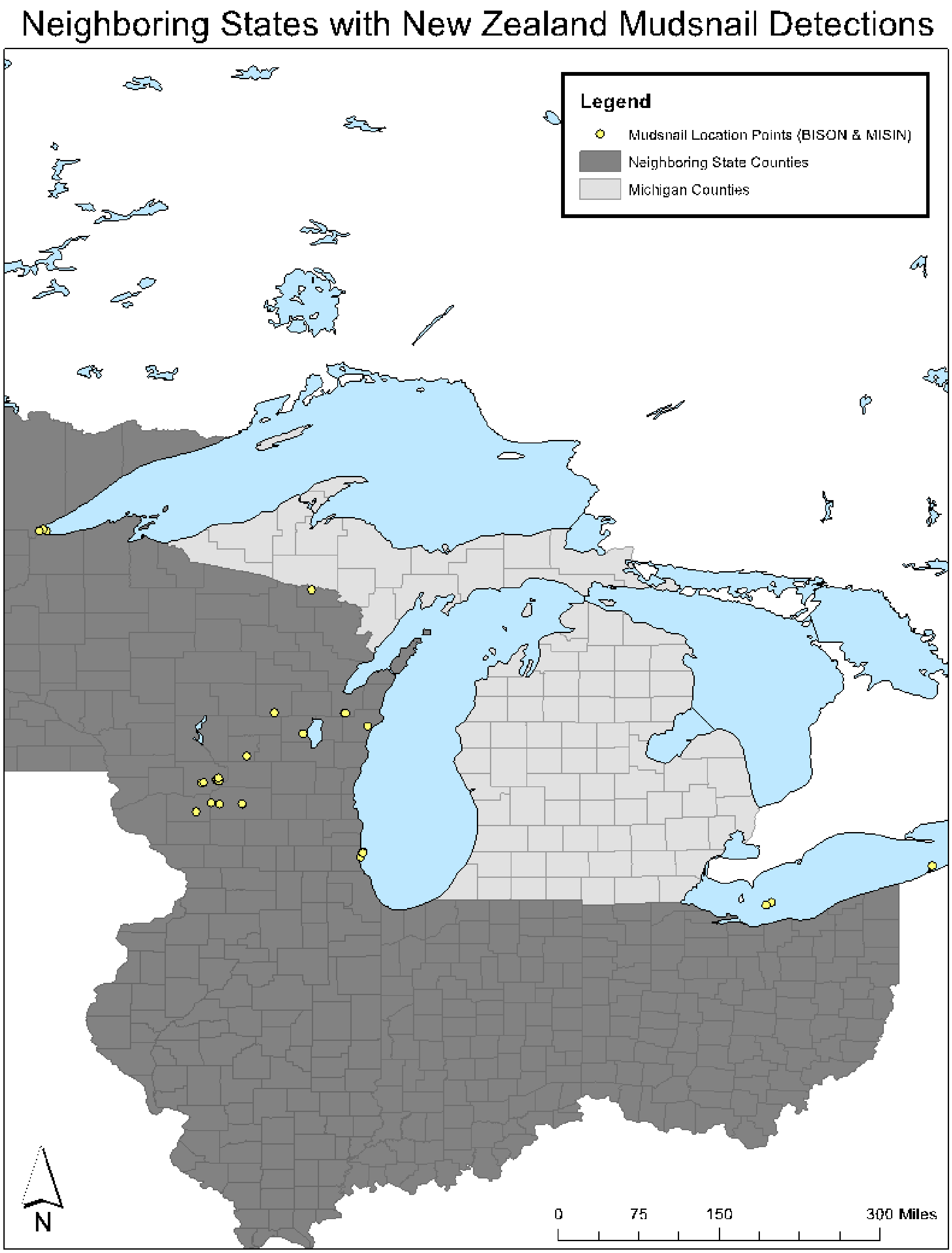

Figure 2. Unique coordinate location points which New Zealand mudsnails were detected in states surrounding Michigan. This data is according to the Biodiversity Information Serving Our Nation (BISON) and Midwest Invasive Species Information Network (MISIN) databases.

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