



Recommendations for Reducing Aquatic Invasive Species Contamination in Minnesota Trout Streams

As required by Minnesota Session Law 2023, Chapter 60, Article 4, Sec. 110

January 15, 2024

Report to the Minnesota Legislature

Minnesota Department of Natural Resources
500 Lafayette Road
Saint Paul, Minnesota 55155-4037
651-259-5042
bob.meier@state.mn.us
mndnr.gov

Pursuant to Minnesota Statutes, Section 3.197, the estimated cost to produce this report is approximately \$8,800. This includes staff time for drafting and reviewing the report.

Upon request, this material will be made available in an alternative format such as large print, Braille or audio recording.

The statutory requirements for this report, as mandated in Minnesota Laws, HF. No. 2310, sec. 110, are:

By January 15, 2024, the commissioner of natural resources, in consultation with Minnesota Trout Unlimited and other trout stream angling organizations, must submit to the chairs and ranking minority members of the house of representatives and senate committees and divisions with jurisdiction over the environment and natural resources policy recommendations for statutory and program changes to reduce the risk of aquatic invasive species contamination in Minnesota trout streams.

Recommendations

To develop the following recommendations, MN DNR scientists conducted an extensive literature review on the current and most probable future aquatic invasive species (AIS) to impact Minnesota trout streams and developed a series of initial recommendations. These recommendations were discussed with MN Trout Unlimited (TU) and other trout organizations through a series of emails, phone discussions, written comments, and a virtual meeting to develop this final list of recommendations.

- Implement a public education campaign highlighting the potential for fishing gear to spread aquatic invasive species and measures all wading anglers can take to reduce the risk, including methods to clean wading gear when moving between different waterways or waterbodies. There was strong interest from Minnesota Trout Unlimited and other trout stream angling organizations to partner and collaborate with MN DNR, local governments, and non-governmental units on these efforts.
- Increase directed investments in early detection and research to reduce the threat of AIS introduction and expansion in trout streams.
- Continue to further develop a response plan for AIS in trout streams. If monitoring indicates an increase in AIS, revisit other potential recommendations and react accordingly to the threat.
- While extensive research shows felt-soled waders are high probability vectors of both current and future unknown AIS, some stakeholders find that felt sole waders provide superior traction and angler safety. They maintain that a ban of felt-soled waders would compromise anglers' safety in streams with rocky bottoms. Therefore, a ban of felt-soled waders is not recommended at this time.

Background

Minnesota Statute, section 84D.01 subdivision 9a defines an “invasive species” in the state as “a nonnative species that: (1) causes or may cause economic or environmental harm or harm to human health; or (2) threatens or may threaten natural resources or the use of natural resources in the state.

Minnesota trout streams, like other waterbodies in the state, are vulnerable to harm caused by aquatic invasive species (AIS). The alga *Didymosphenia geminata* (aka didymo or rock snot) is native to the northern hemisphere; it was first recorded in Canada in the late 1800s, but reports of habitat-altering impacts were not reported until the 1990s. Didymo can form thick mats, smothering the bottom of coldwater streams for several months, over large spatial areas (Spaulding and Elwell 2007). Didymo is documented in eight streams in northeast Minnesota (Mark Edlund, Science Museum of MN, personal communication). Because Didymo’s historic range appears to include the north shore of Lake Superior, the species would be included in the definition of “native species” in Minnesota Statutes, section 84D.01 subd. 11 and does not meet the statutory definition of “invasive species.” Research is also being conducted to determine if the didymo found in northeast Minnesota streams may be a non-native strain of didymo. For the purpose of this report, didymo is included as one of the AIS with a particular impact on trout streams.

Potamopyrgus antipodarum (New Zealand mud snail) is an AIS found in many western trout streams and are now found in Wisconsin and Michigan (Geist et al. 2021). New Zealand mud snail has a competitive advantage over native invertebrates because of their ability to eat multiple food sources, with few predators outside of their natural range (Geist et al. 2021).

Both didymo and New Zealand mud snails (as well as many other AIS) are emerging threats to coldwater streams in Minnesota. Additionally, habitat changes related to climate change (increased water temperature and changing stream flow) increase the suitability of trout streams for invasive species (Bell et al. 2021).

Prevention of AIS introduction and spread is critical to reduce the probability of establishment of new populations of AIS. Once introduced, control methods are very limited or non-existent. While trout streams are less vulnerable to some of the common pathways of AIS spread (e.g., bait containers, live wells, docks) than other waterbodies in the state are, new populations of AIS are related to recreational use of coldwater streams in other places (Bothwell et al. 2009, Kilroy and Unwin 2011). Fishing-related gear, including watercraft, boots, and waders are possible vectors to move AIS to other waters (Alonso et al. 2016, Hosea and Finlayson 2005, Richards et al. 2004, Stockton and Moffitt 2013, Schisler et al. 2008).

Felt-soled waders can provide a suitable environment for survival of AIS even while not in water and are difficult to clean (Kilroy et al. 2006, Root and O’Reilly 2012), making them a high probability vector for spread of invertebrates and microscopic organisms to new waters (Bothwell et al. 2009, Gates et al. 2008, 2009, Stockton and Moffitt 2013, Waterkeyen et al. 2010).

Heat, freezing, or select chemical solutions are effective methods to disinfect gear. However, disinfection using these treatments is challenging for anglers when traveling between streams in a day because of a lack of accessibility to heat sources, cold sources, or an immersion bath for chemical treatment. While specific chemicals (e.g., chlorine bleach, quaternary ammonium compounds, Virkon Aquatic, copper sulfate) are known to kill invasive invertebrates and microbes (Hosea and Finlayson 2005, Root and O’Reilly 2012, Stockton and Moffitt 2013), they have potential to damage gear, cause environmental pollution, and/or are not labelled for treating AIS on angling gear (García et al. 2001,

Jacks et al. 2009, Hosea and Finlayson 2005). If chemical treatment is used, a bath application is recommended as spraying gear does not provide complete coverage (Hosea and Finlayson 2005, Jacks et al. 2009, Schisler et al. 2008).

Six states (Alaska, Maryland, Missouri, Nebraska, South Dakota, and Rhode Island) and Yellowstone National Park have banned felt-soled waders and boots to reduce the risk of transporting and introducing AIS to waters. Banning gear to prevent the spread of AIS is recommended by some experts (Bothwell et al. 2009, Gates et al. 2008, Kilroy and Unwin 2011, Root and O'Reilly 2012, Spaulding and Elwell 2007)

Anglers use felt-soled waders and boots to prevent slips and falls in streams with rocky, slippery substrates. Boots with studded soles, which are currently available, offer an alternative to felt soles and do not have the same porous texture as felt, making them less hospitable for invasive species and easier to effectively clean (Kilroy et al. 2006). However, many anglers find that felt provides superior traction to other alternatives on uneven, slippery substrates (John Lenczewski, personal communication). Waders using interchangeable felt soles are available and may be a viable option for anglers to reduce the likelihood of spreading AIS.

Current Minnesota law intended to prevent AIS spread

There are currently several Minnesota laws aimed at preventing or reducing the spread of invasive species in the state via water-related equipment. Included are:

Minnesota Statutes, chapter 84D Chapter 84D.

Minnesota Statutes, section 84D.01 includes the following definitions:

Subdivision 18a. **Water-related equipment.** "Water-related equipment" means a motor vehicle, boat, watercraft, dock, boat lift, raft, vessel, trailer, tool, implement, device, or any other associated equipment or container, including but not limited to portable bait containers, live wells, ballast tanks except for those vessels permitted under the Pollution Control Agency vessel discharge program, bilge areas, and water-hauling equipment that is capable of containing or transporting aquatic invasive species, aquatic macrophytes, or water.

Subdivision 19. **Watercraft.** "Watercraft" means a contrivance used or designed for navigation on water and includes seaplanes.

Minnesota Statutes, section 84D.10 includes the following: Watercraft and water-related equipment requirements and prohibitions:

Subdivision 1. Launching prohibited. A person may not place or attempt to place into waters of the state water-related equipment, including aquatic plant harvesting or control equipment that has aquatic macrophytes or prohibited invasive species attached except as provided in this section.

Subdivision 4. Persons transporting water-related equipment. (a) When leaving a water of the state, a person must drain water-related equipment holding water and live wells and bilges by removing the drain plug before transporting the water-related equipment. For the purposes of this paragraph, "transporting" includes moving water-related equipment over land between connected or unconnected water bodies but does not include moving water-related equipment within the immediate area required for loading and preparing the water-related equipment for transport over land.

Additionally, the MNDNR has a [webpage](#) dedicated to education for anglers and wader users related to felt-soled boot use, including recommendations to prevent the spread of aquatic invasive species.

Work group meetings

Outreach was made to the following trout groups to receive input on prevention of AIS in trout streams:

- MN Trout Unlimited (MN TU)
- MN TU Twin Cities Chapter
- MN TU WinCres Chapter (Winona-LaCrescent)
- MN TU Hiawatha Chapter (Rochester)
- Lake Superior Steelhead Association
- Minnesota Steelheader
- Izaak Walton League Duluth Chapter
- Trout Fishing author and guide, Carl Haensel
- Grand Portage Band of Lake Superior Chippewa
- Fond du Lac Band of Lake Superior Chippewa

Most trout angling groups expressed concern about AIS and appreciate the importance of AIS prevention. Often the habitat projects they work on include an AIS component. Trout angling groups in southeast MN focused on impacts of terrestrial riparian vegetation and a few aquatic plants. These groups did not voice concerns about banning felt-soled waders, as they are rarely used in southeast MN. For groups with an interest in northeast MN, especially tributaries to Lake Superior, there was an awareness of the potential of didymo to negatively impact trout habitat but also a lack of support for banning felt-soled waders and wading shoes. All initial commenters acknowledged that preventing the spread of AIS is important and requires all groups and MN DNR to work together. If any proposed bans to fishing gear are suggested, the groups think it should go through the rule making process, allowing for public input.

DNR hosted a virtual public meeting to discuss proposed recommendations. Invitations to this meeting were sent to all the angling groups identified previously. Representatives from MN Trout Unlimited, Lake Superior Steelhead Association, and Arrowhead Fly Anglers attended the virtual meeting with MN DNR staff.

Comments from trout angling groups focused on three areas: (1) the need to address the potential for all types of wading gear to spread didymo and other AIS, (2) the need to allow the continued use of felt-soled waders due to safety concerns and felt's superior traction on very slippery rocks of North Shore streams, and (3) to focus on public education on how AIS is spread and prevention techniques.

Recommendations to reduce the spread of AIS in trout streams

Based on published literature, scientific review, and initial trout angling group input, the following list of recommendations for statutory and programmatic changes to reduce the risk of aquatic invasive species contamination in Minnesota trout streams was developed.

Action: Implement a public education campaign focusing on the potential for wading gear to spread AIS and effective measures all wading anglers can take to reduce the risk.

- Potential Prevention Impacts: Waders and wading shoes are known pathways for AIS introduction to stream ecosystems. Relatively easy, inexpensive, and effective methods of cleaning wading gear are available. This option is likely to have the greatest impact on reducing the risk of spreading AIS, barring banning high-risk gear.
- Challenge: A funding source is needed for this action.

Action: Ban the use of felt-soled waders throughout Minnesota.

- Potential Prevention Impacts: Felt-soled waders are a known pathway for AIS introduction to streams. An immediate ban would remove this pathway as a potential vector for AIS spread. This option would address this high-risk vector.
- Challenges:
 - Safety. Felt-soled waders help reduce slipping on wet, rocky terrain. Improvements to increase traction in rocky substrates have been made to rubber soled wading boots in recent years. Rubber soled waders are more durable, longer lasting, easier to clean, and some models can include the addition of studs to further increase safety. However, some anglers who have used both materials find that felt still provides superior traction, especially in North Shore streams.
 - Economic concerns. An immediate ban on felt-soled waders may have an economic impact to businesses that sell waders, as well as anglers. A phased-approach focusing first on communication and education, followed by a ban of sales/use of felt-soled waders after a certain number of years would allow stakeholders time to adjust to using legal alternatives.
 - Enforcement. Additional enforcement efforts would be needed to better understand the compliance rates of stakeholders selling or using felt-soled waders.
 - Does not address risks of spreading AIS via other types of wading gear.

Action: Targeted ban on use of felt-soled waders in high priority streams, or high-priority stream reaches.

- Potential Prevention Impacts: A ban of felt-soled waders in select streams would remove this pathway of AIS spread to high-priority streams.
- Challenges:
 - Partial effectiveness. A partial ban would impact a select number of identified streams, leaving other streams susceptible.
 - Enforcement. A partial ban would be difficult to enforce without an appropriate increase of enforcement activity at identified streams.

Action: Create a dedicated funding source (e.g., AIS surcharge on trout stamps) to increase education, outreach, and prevention efforts for stakeholder activities.

- Potential Prevention Impacts: A dedicated funding source for trout stream education, outreach, and prevention efforts would provide managers with secure funds to design, purchase, and post informational signs at key locations. Funding could be used to enhance existing outreach by developing targeted information campaigns focused on preventing the spread of AIS by cleaning all gear. It could also be used to encourage stakeholders to purchase recommended alternatives to felt soles. Dedicated funding could be used to explore and implement equipment decontamination stations or fund inspection efforts. Experience has shown that the pairing of education alongside cleaning stations helps to increase compliance.

- Challenges:
 - It is difficult to quantify the impact increased education and outreach efforts would have. The risks posed by felt-soled waders have been known for years, and safe alternatives currently exist. There are challenges to thoroughly clean felt-soled waders and cleaning techniques may not address all AIS risks. Funding could be used to help evaluate the effectiveness of created programs.
 - Implementation of equipment decontamination stations would likely require a high level of oversight. Stations would require maintenance and users of the stations would need to be educated on the proper use of the cleaning stations. There are also limited decontamination options available to managers that would address all species of concern.
 - Trout anglers are already required to purchase a trout stamp.

Action: Establish a requirement that felt-soled waders are dried for an appropriate length of time before being used in a separate water body.

- Potential Prevention Impacts: A dry time requirement is the simplest of the known decontamination options for felt-soled waders. A dry time long enough to address all species of concern would greatly reduce the risk of spreading AIS via felt-soled waders.
- Challenges:
 - Setting an appropriate dry time. Not all AIS react to drying the same way, and some species can tolerate extended periods of dryness. As an example, a 5-day dry time requirement would be effective to treat New Zealand mud snails (Alonso et al. 2012). However, air drying is not recommended for treatment of didymo-infested gear (Kilroy et al. 2006, Root and O'Reilly 2012).
 - Enforceability. A dry time requirement would be difficult to enforce, and there is no straightforward way to prove that a legal dry time requirement has been met.
 - Upstream spread of AIS. A dry time requirement would not address felt-soled waders as a pathway of spread from infested reaches of a stream to non-infested upper reaches of the same stream.
 - Economic. Some stakeholders would be required to own multiple sets of waders.

Action: Create a tagging system to dedicate felt-soled waders to certain streams.

- Potential Prevention Impacts: A tagging system would reduce the risks of spreading AIS by limiting the streams where a pair of waders can be used.
- Challenges:
 - Costs. A tagging system would need to be created to issue and monitor tags on a recurring basis. This system would also increase the labor costs required to administer the program.
 - Limited protection. A tagging system could be used to increase protections to high priority non-infested streams, but this system would not reduce the risks of further spreading AIS between streams infested with different AIS. This system would not address new infestations or unknown AIS infestations and users could inadvertently spread AIS from one stream to another or from downstream infested water to non-infested water upstream.
 - Enforcement. Tagging waders for use in specific streams would require more enforcement to monitor compliance.
 - Economic. Some stakeholders would be required to own multiple sets of waders.

Action: Increase additional early detection efforts, research, and assessment of AIS in Minnesota trout streams.

- Potential Prevention Impacts: This information could be used to identify high-risk areas that could be included on DNR online trout maps used by anglers.
- Challenges:
 - Effectiveness. This action would rely on anglers taking voluntary steps to minimize the risk of spreading AIS.
 - Cost. Managers would need increased staffing and equipment for increased early detection monitoring.

References

- Alonso Á, G Valle-Torres, and P Castro-Díez. 2012. Survival of an invasive aquatic snail to overland translocation in non-aquatic media: implications for spreading. *Limnologica* 57:60-65.
- Bell DA, RP Kovach, CC Muhlfeld, R Al-Chokhachy, TJ Cline, DC Whited, DA Schmetterling, PM Lukacs, and AR Whitely. 2021. Widespread declines of native trout in the northern Rocky Mountains, USA. *Scientific Advances* 7: eabj5471.
- Bothwell ML, DR Lynch, H Wright, and J Deniseger. 2009. On the boots of fishermen: the history of didymo blooms on Vancouver Island, British Columbia. *Fisheries* 34:382-388.
- García MT, I Ribosa, T Guindulain, J Sánchez-Leal, J Vives-Rego. 2001. Fate and effect of monoalkyl quaternary ammonium surfactants in the aquatic environment. *Environmental Pollution* 111:169-175.
- Gates KK, CS Guy, AV Zale, and TB Horton. 2008. Adherence of *Myxobolus cerebralis* myxospores to waders: implications for disease dissemination. *North American Journal of Fisheries Management* 28:1453-1458.
- Gates KK, CS Guy, AV Zale, and TB Horton. 2009. Angler awareness of aquatic nuisance species and potential transport mechanisms. *Fisheries Management and Ecology* 16:448-456.
- Geist JA, Ethaiya D, Tiegs SD. 2022. Coupling gear contamination trials and angler surveys to minimize spread of invasive New Zealand mud snails *Potamopyrgus antipodarum*. *North American Journal of Fisheries Management* 42: 1081–1093
- Geist JA, JL Mancuso, MM Morin, KP Bommarito, EN Bovee, D Wendell, B Burroughs, MR Luttenton, DL Strayer, and SD Tiegs. 2021. The New Zealand mud snail (*Potamopyrgus antipodarum*): autecology and management of a global invader. *Biological Invasions* 24:905-938.
<https://doi.org/10.1007/s10530-021-02681-7>
- Hosea RC and B Finlayson. 2005. Controlling the spread of New Zealand mud snails on wading gear. Administrative Report 2005-02. Department of Fish and Game, State of California, Rancho Cordova, CA.
- Jacks S, S Sharon RE Kinnunen, DK Britton, D Jensen, SS Smith. 2009. Chapter 13: Controlling the spread of invasive species while sampling. *In* Standard Methods for Sampling North American Freshwater Fishes, SA Bonar, WA Hubert, DW Willis, eds. American Fisheries Society, Bethesda, MD. doi: <https://doi.org/10.47886/9781934874103>
- Kilroy C, A Lagerstedt, A Davey, and K Robinson. 2006. Studies on the survivability of the invasive diatom *Didymosphenia geminata* under a range of environmental and chemical conditions. National Institute of water and Atmospheric Research. Client Report no. CHC2006-116.
- Kilroy C and M Unwin. 2011. The arrival and spread of the bloom-forming, freshwater diatom, *Didymosphenia geminata*, in New Zealand. *Aquatic Invasions* 6:249-262.
- Parkinson, H., J. Mangold, and C. McLane. 2016. Biology, ecology, and management of Curlyleaf Pondweed (*Potamogeton crispus*). Montana State University Extension, Boseman, Montana.
- Richards DC, P O'Connell, DC Shinn. 2004. Simple control method to limit the spread of the New Zealand mudsnail *Potamopyrgus antipodarum*. *North American Journal of Fisheries Management* 24:114-117.
- Root S and CM O'Reilly. 2012. Didymo Control: increasing the effectiveness of decontamination strategies and reducing spread. *Fisheries* 37:440-448.
- Schisler GJ, NKM Vieira, PG Walker. 2008. Application of household disinfectants to control New Zealand mudsnails. *North American Journal of Fisheries Management* 28:1172-1176. DOI: 10.1577/M07-028.1
- Spaulding SA and L Elwell. 2007. Increase in Nuisance Blooms and Geographic Expansion of the Freshwater Diatom *Didymosphenia geminata*. Open-File Report 2007-1425. U.S. Geological Survey, Reston, VA.
- Stockton KA and CM Moffitt. 2013. Disinfection of three wading boot surfaces infested with New

Zealand Mudsnaills. *North American Journal of Fisheries Management* 33:529-538.

DOI:10.1080/02755947.2013.768569

Waterkeyn A, B Vanschoenwinkel, S Elsen, M Anton-Pardo, P Grillas, and L Brendonck. 2010.

Unintentional dispersal of aquatic invertebrates via footwear and motor vehicles in a

Mediterranean wetland area. *Aquatic Conservation: Marine and Freshwater Ecosystems* 20:580-

587. DOI: 10.1002/aqc.1122

Appendix A. Trout angling group comments on aquatic invasive species prevention in trout streams

Initial comments from trout anglers along the North Shore were summarized in general four categories: need for prevention education; lack of scientific evidence to ban wading equipment; safety; and financial cost.

Education to prevent spread

- There needs to be more work on messaging for prevention. While messaging won't ever get 100% compliance there has been a great neglect in discussion how stream fishing gear can be a vector for AIS.
- There should be more discussion on all fishing gear and how it may transfer AIS, including shoelaces.
- There should be a 5-year program on public education of prevention techniques with a review of effectiveness after this period. A ban on felt-soled waders won't replace MN DNR responsibility to educate users of stream resources.
- There are easy, effective decontamination measures to prevent the spread of AIS on waders and wading shoes, but the DNR has failed to provide any guidance to anglers and the public regarding these options. The fishing regulation booklet contains nothing.
- The Fisheries Section webpages contain no information on decontamination of fishing gear.
- If MN DNR can demonstrate that the use of felt-soled waders are in fact a significant culprit in spreading AIS in Minnesota and that alternatives to a statewide ban on all felt-soled waders are not as effective in preventing AIS, then some trout organization would support a phased ban. Educate in prevention and then set a sunset date on the future.

Lack of scientific evidence

- The need for a ban is not supported by scientific studies. Trout Unlimited's national team of scientists opined that banning felt-soled waders would not be effective to prevent the spread of AIS in Minnesota. There are effective and inexpensive methods which all wading anglers, not just those using felt-soled waders, can easily use.
- The Fisheries Section webpage contains nothing about spread of AIS in trout streams, other than a single link to a didymo study, which tentatively concludes that didymo is native to the North Shore environmental factors, not waders, are causing blooms.
- Why have other Midwestern states not banned felt-soled waders if the threat is so high?
- One state, Wyoming, put the ban on felt soles into effect only to repeal it a couple years later as not being affective.

Safety

- Several members commented on the safety aspect of using felt-soled waders. They felt there needs to be a discussion of reasonable alternatives that will not jeopardize the safety of North Shore anglers, especially in April and May. Felt soles provide significantly greater traction on North Shore stream than other options. Cleats do not work nearly as well as felt-soled waders.
- One steelhead group stated that steelhead anglers on the North Shore (and probably other places) are getting older on average and the safety in using felt soles on the slick bedrock bottoms of our streams is reassuring to older anglers.

Financial cost

- Outfitters have invested a lot of money into felt-soled waders. A phased approach would be best way to allow outfitters to prepare for transition to non-felt-soled waders.
- A ban would cause substantial financial hardship on many anglers, given the expense and useful life of waders.