



Minnesota Department of Natural Resources (DNR) Classification Summary for Invasive Species

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Classification Screening for Earthworms in the genus *Amyntas* and the genus *Metaphire* (jumping worms)

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Introduction

This document is a guide to the Minnesota DNR’s authority under *Minnesota Statutes*, chapter 84D, to designate invasive species as prohibited or regulated invasive species. The conclusions and recommendations in this document are for information purposes only and do not require the DNR or any other entity to take a specific action.

More information about classifications of invasive species can be found on the [DNR website](http://www.dnr.state.mn.us/invasives/laws.html) (<http://www.dnr.state.mn.us/invasives/laws.html>) and in *Minnesota Statutes*, [chapter 84D](https://www.revisor.mn.gov/statutes/?id=84D) (<https://www.revisor.mn.gov/statutes/?id=84D>). Prohibited, regulated, and unregulated species are listed in Minnesota Rules, [chapter 6216](https://www.revisor.mn.gov/rules/?id=6216) (<https://www.revisor.mn.gov/rules/?id=6216>).

How to fill out this classification screening

For more detailed guidance on completing this document, see the DNR's "Guidance for Invasive Species Classification Summaries". The following is a brief guide:

- Fill out the Species Summary section with the species name and a brief description of the species and its current regulatory status in Minnesota.
- Answer the questions in the Eligibility Screening section to determine whether the species is eligible for regulation under *Minnesota Statutes*, chapter 84D.
- If the species is eligible for regulation under *Minnesota Statutes*, chapter 84D, continue to answer the questions in the Classification Screening section and characterize the certainty of the answer for each question.
- At the end of the classification screening questions, summarize the most important points from the answers and judge the overall certainty of the screening.
- Finally, you should make a recommendation for classifying the species, based on the findings of the classification screening.
- Update the table of contents when the document is completed.

Species Summary

Common name: jumping worms

Scientific name: *Amyntas* spp., *Metaphire* spp.

Brief description: Earthworms in the *Amyntas* genus are native to Asia. *Amyntas agrestis*, *A. cortices*, and *A. loveridgei* have been found in Minnesota as of November 2016. *A. tokioensis* and *A. hilgendorfi* (recently reclassified as *Metaphire hilgendorfi*) are potentially in the state as well (Ramsey County), but there is a need to collect samples to send to experts for verification (Lee Frelich, University of Minnesota, personal communication). Ryan Hueffmeier (University of Minnesota - Duluth) has also verified an established *Amyntas* population in Dakota County. Reports of *Amyntas* can be viewed on the EDDMapS website through both their [list](#) and [map](#) pages. As of September 26, 2018, reports have been made in Anoka, Hennepin, Olmsted, and Ramsey counties. Due to reclassification of some *Amyntas* species as *Metaphire* species, this classification summary will encompass both genera.

Present classification in Minnesota: unlisted nonnative species

Proposed classification: prohibited invasive species

Eligibility Screening

These three questions determine whether the DNR has authority to regulate the species under *Minnesota Statutes*, chapter 84D.

1. Is the species an aquatic plant or wild animal? For the purposes of this question, “species” includes “subspecies, genotypes, cultivars, hybrids, or genera” (*Minnesota Statutes*, section 84D.04 subd. 1).
 - Choose Yes or No; if yes, continue.
2. Is the species a pathogen or terrestrial arthropod regulated under *Minnesota Statutes*, sections 18G.01 to 18G.15? (*Minnesota Statutes*, section 84D.14(1))
 - Choose Yes or No; if no, continue.
3. Is the species a mammal or bird defined as livestock in statute? (*Minnesota Statutes*, section 84D.14(1)).
 - Choose Yes or No; if no, continue.

Classification Screening

Is it nonnative?

To be classified as an invasive species under *Minnesota Statutes*, the species must be “nonnative”; that is, not “native” as defined in *Minnesota Statutes*, section 84D.01, subd. 11. This has two components.

1. Is the species nonnative in Minnesota?

- 1.1. **Is the species naturally present or reproducing in Minnesota?** No. *Amyntas* and *Metaphire* spp. are native to Asia (Hendrix et al. 2008, Chang et al. 2017). *Amyntas agrestis* was first recorded in the United States in Maryland in 1939 (Gates 1982). *Metaphire hilgendorfi* was first reported in the United States in New York in 1948 (Chang et al. 2017).
- 1.2. **Does the species naturally expand from its historic range into Minnesota?** No. *Amyntas* spp. are native to Asia (Hendrix et al. 2008). It is thought that *Amyntas* (and other earthworms) were spread in North America through human actions such as trade in potted plants, earthmoving activities, compost activities, mulch activities, and anglers using earthworms as bait (Hendrix et al. 2008, Snyder et al. 2011).

How certain are these answers? Very certain, supported by peer-reviewed literature.

Likelihood of introduction

This is a criterion for classification of an invasive species under Minnesota Statutes, section 84D.04, subd. 2(1). The terms “introduce” and “introduction” are defined in Minnesota Statutes, section 84D.01.

2. Is the species likely to be introduced to Minnesota if it is allowed to enter or exist in the state?

Yes. *Amynthas* spp. have already been introduced to Minnesota. Specimens have been identified by researchers at the University of Minnesota (L. Frelich and R. Hueffmeier, personal communication 2016). Dr. Frelich’s first observation of *A. agrestis* was in Loring Park in Minneapolis in 2006. *Amynthas* species have also been documented on the University of Minnesota St. Paul campus and have been present there since 2007 (L. Frelich, personal communication 2017). *Amynthas* produce cocoons (egg casings) in late summer and early autumn. It is believed that the adult worms are killed by freezing temperatures during the winter while the cocoon stage survives through the winter to initiate a new generation the following year. Cocoons hatch in early spring and adults mature in summer. Movement of worms or soil can spread worms and their cocoons. *Amynthas* could continue to arrive by direct purchase through the internet, as a contaminant in purchased worms of other species, in the growing medium of field and container-grown plants, or as a contaminant in compost, mulch, or soil on equipment. *Amynthas* can live in commercial mulch and are present in 20% of mulched garden beds in Vermont and New Hampshire (Bellitürk et al 2015).

How certain is this answer? Very certain.

Likelihood of survival

This is a criterion for classification of an invasive species under Minnesota Statutes, section 84D.04, subd. 2(2). The term “naturalize” is defined in Minnesota Statutes, section 84D.01 as “to establish a self-sustaining population...in the wild.”

3. Is the species likely to naturalize in Minnesota if it were introduced? Yes. We already have evidence of self-sustaining populations in Minnesota (L. Frelich and R. Hueffmeier, personal communication 2016). *Amynthas* have an annual life cycle. They produce cocoons (egg cases) in late summer and early autumn and overwinter in the cocoon stage; cocoons hatch in early spring and adults mature in summer (Ikeda 2015). Therefore, *Amynthas* are able to survive a variety of conditions including cold winter temperatures (Görres et al 2016). Moore et al. (2018) predict that all of Minnesota is suitable in terms of climate. Research in the eastern and Midwestern United States has found that *Amynthas* and *Metaphire* species can co-occur with one another and their ranges are expanding (Chang et al. 2018). In Wisconsin there are reports that *A. agrestis* and *A. tokioensis* can naturalize and replace European earthworms (Laushman et al. 2018).

4. How certain is this answer? Very certain; experts have observed populations persisting and expanding over 11 years in the state.

Potential negative impacts

For a nonnative species to be defined as “invasive” under Minnesota Statutes, section 84D.01, subd. 9a, the species must: cause, or have the potential to cause economic or environmental harm, harm to human health; or threaten or have the potential to threaten the use of natural resources in the state. This question has four components: economic, environmental, health, and natural resources.

4. Is the nonnative species an invasive species as defined under Minnesota law?

4.1. Does the species cause, or may it cause, economic harm? Economic impacts are not well studied. *Amynthas* can have impacts to turf grass, gardens, and natural areas. *Amynthas* can cause economic impacts by damaging turf grass, sod farms, nursery container stock, the composting and mulch industries, and residential gardens, and also by adding the cost of pesticides or other control measures to the affected industries and landscape areas. Individual homeowners may see economic impacts when plants are killed or unable to survive in their yards. The forest products industry may see impacts if *Amynthas* impacts to soils make tree regeneration more challenging. The horticulture industry may be impacted as nonnative earthworms, including *Amynthas* spp., can be moved around locally and long-distance through the sale of field and container-grown plants and the movement of compost and mulch. The maintenance requirements and performance of residential and commercial landscapes may also be impacted.

How certain is this answer? Uncertain.

4.2. Does the species cause, or may it cause, environmental harm? *Amynthas* species can cause environmental harm where they are established. Minnesota forests are understood to not have had earthworms from the last glaciation until European settlement introduced nonnative earthworms. There have been an extensive number of studies on the impacts of nonnative European earthworms in Minnesota. These studies have found that nonnative earthworms dramatically change soil properties by removing the litter layer and impacting soil chemistry, soil organisms, and plant communities (Hendrix et al. 2008, Hendrix and Bohlen 2002).

In a Wisconsin study, *Amynthas agrestis* and *A. tokiosensis* were found to reduce forest and prairie surface litter by 84-95%, and to increase total soil carbon, nitrogen, and phosphorus (Qui and Turner 2017). The authors note: “Effects were observed in both forest and prairie soils, with stronger effects in forests. Effects were most pronounced late in the growing season when earthworm biomass likely peaked. Depletion of the litter layer and rapid mineralization of nutrients by non-native Asian jumping worms may make ecosystems more susceptible to nutrient losses, and effects may cascade to understory herbs and other soil biota”.

Amynthas may differ in their effects from European earthworms. Greiner et al. (2012) note that *Amynthas* have an annual life cycle, inhabit the upper litter layer (epigeic), and have greater

dietary flexibility than European earthworms; they are also large and live at greater densities than European earthworms. These factors could combine for impacts on Minnesota ecosystems that are even greater than the negative impacts caused by nonnative European earthworms.

Snyder et al. (2011) noted that “Once introduced, *Amyntas* spp. can have significant impacts on soil structure and processes. For example, in forests in New York, USA, *A. gracilis* increased soil N-mineralization and nitrification, reduced forest floor organic matter content, and increased microbial biomass (Burtelow et al. 1998; Steinberg et al. 1997)”.

Ikeda et al. (2015) note that “*Amyntas agrestis* shows strong invasiveness, as its density is sometimes 10 times greater than the other non-native species, it negatively affects native millipedes and other non-native earthworms by changing soil microbial community composition. Thus, it appears that this species may have potential to continue to expand its distribution range in the future, and this suggests that development of control strategies will be of critical importance to managing these invasions”.

How certain is this answer? Reasonably certain.

4.3. Does the species cause, or may it cause, harm to human health? No; no documentation of harm to human health has been found.

How certain is this answer? Reasonably certain.

4.4. Does the species threaten, or may it threaten, the use of natural resources in the state? The use of natural resources in the forestry industry may be affected if *Amyntas* make tree regeneration more difficult.

How certain is this answer? Uncertain.

Natural resource impacts

This is a criterion for classification of an invasive species under Minnesota Statutes, section 84D.04, subd. 2(3).

5. Would the species have potential adverse impacts in Minnesota, in particular on: native species, outdoor recreation, commercial fishing, and other uses of natural resources in the state?

- Choose Yes or No; if yes, continue to 5.1.

5.2. If so, what would be the magnitude of these adverse impacts? *Amyntas* spp. have potential adverse impacts on native species (Hendrix and Bohlen 2002, Greiner et al. 2012, Qui and Turner 2017). The magnitude of these impacts is uncertain, but research has shown that *Amyntas* spp. can have significant impacts on native ecosystems (e.g., reduced duff layer and changes in nutrient cycling leading to broader impacts in forests) and the impacts could be

great in heavily infested areas. The species may also impact natural resources-dependent industries like forestry or recreation.

How certain is this answer? Reasonably certain.

Management options

This is a criterion for classification of an invasive species under Minnesota Statutes, section 84D.04, subd. 2(4).

6. Would we be able to eradicate, or control the spread of, the species once it is introduced in Minnesota? There are no known methods for controlling invasive earthworms in the wild. There are no examples of nonnative earthworms being controlled in natural settings. Chemical treatments (e.g., Sevin/carbaryl) that would kill earthworms would kill other soil organisms as well. Ikeda et al. (2015) did an experiment with fire and found that fire did not decrease the number of earthworms directly, but that fire in the fall did decrease the viability of cocoons. It is possible to minimize the long-distance spread of *Amyntas* by not moving potentially infested soils or other materials. In areas besides natural settings, such as in nursery and landscape containers and smaller production and landscape areas, it is likely that the same pesticides that work on European earthworms would work on *Amyntas*, but the costs and efficacy in these areas has not been specifically investigated. These include imidacloprid, saponins, chlorophyrifos, carbaryl, and benomyl (Lee Frelich, University of Minnesota, personal communication December 2018, Katagi and Ose 2015, Datta et al. 2016, Potter 2012, Pelosi et al. 2014).

How certain is this answer? Reasonably certain.

Other relevant information

This is a criterion for classification of an invasive species under Minnesota Statutes, section 84D.04, subd. 2(5). Information that may be included here includes, but is not limited to: economic impacts; regulations in other jurisdictions; and ongoing monitoring programs.

7. Are there other criteria the DNR commissioner deems appropriate? If so, discuss.

Amyntas species are “restricted invasive species” in Wisconsin under their NR40 Rule (Section NR40.05(3)). They were first classified as “prohibited invasive species” in 2009, but the classification was subsequently changed when it was determined that the worms were more widely distributed in the state than was originally thought. The law indicates that you may not transfer (including buying or selling), transport or introduce (including importation into the state) any restricted species. This differs from the “prohibited invasive species” status in Wisconsin which prohibits “possession.” As a “restricted invasive species” Wisconsin citizens are not required to remove or destroy them. Restricted species may be transported for the purpose of control or disposal (without a permit). Section 40.05(3)(b) allows for some level of incidental transportation if

the person have taken precautions to prevent/minimize the spread such as following Best Management Practices guidelines. In Wisconsin, the green industry has developed a set of Best Management Practices guidelines for the nursery and landscape industry. Wisconsin does not yet have guidelines for composters, soil haulers, and other activities that may spread nonnative earthworms including *Amyntas* spp. The status of Wisconsin regulation was provided in a personal communication from Kelly Kearns of the Wisconsin Department of Natural Resources (Nov. 2016).

Regulating *Amyntas* in Minnesota would not affect angling as European earthworm species are sold for bait in Minnesota. However, *Amyntas* worms are available online where they are sometimes marketed as bait for anglers. There would need to be outreach to worm retailers on how to identify *Amyntas* species.

Regulating *Amyntas* may have impacts on the horticulture industry including nursery production, landscape services, compost and mulch production and sales, and garden center operations. Minnesota could follow Wisconsin's example and work on Best Management Practices related to *Amyntas*. In Wisconsin, there are some nurseries that had *Amyntas*. Some nurseries caught it early and pulled all affected pots, disposed of the soil and sterilized the roots of exposed plants, and repotted the plants in clean soil (Kelly Kearns, personal communication, Nov. 2016). Wisconsin's focus is on best management practices.

Regulating *Amyntas* would likely have impacts on the vermiculture industry in Minnesota. While *Amyntas* are not currently widely used in vermiculture in Minnesota, it would necessitate that people who sell earthworms learn how to identify *Amyntas* so that they do not sell *Amyntas*. *Amyntas* species are sold online and sometimes marketed as a good composting worm. *Amyntas* has identifiable characteristics that make it possible to train someone to distinguish earthworms in the genus *Amyntas* from other earthworm species.

Regulating *Amyntas* would have impacts on the composting industry and municipal compost sites. Sites would need to determine what to do with infested leaf mulch and compost. If people pick up infested leaf mulch, *Amyntas* could be spread throughout the area. In essence, any activity that involves the movement of soil or organic matter has the potential to move non-native earthworms from place to place and all industries that involve the movement of such materials could be affected by regulation.

Summary

Summarize the findings of the screening form, including whether the species is nonnative and invasive as defined by Minnesota Statutes, chapter 84D, and characterize the overall certainty of the answers provided above.

Note that certain answers in the screening form may indicate that the species is not a good candidate for designating as a prohibited or regulated invasive species under *Minnesota Statutes*, chapter 84D:

- If you answered “Yes” to **either** 1a or 1b, the species is not “nonnative” as defined under *Minnesota Statutes*, chapter 84D; consider regulation under other authorities.
- If you answered “No” to **all** of 4a, 4b, 4c, and 4d, then the species is nonnative but may not be “invasive” as defined under *Minnesota Statutes*, chapter 84D; consider whether proposed introductions of this species should follow *Minnesota Rules*, part 6216.0290.

Summary: Minnesota is at high risk of negative ecological impacts from all earthworms because no earthworms are native to the state. *Amyntas* species are known to have strong negative impacts on native ecosystems. Currently, *Amyntas* species are not believed to be widely distributed in the state. Regulating *Amyntas* now can help prevent new introductions to the state. Earthworms disperse slowly on their own. Wisconsin’s risk assessment estimated that *A. agrestis* can move more than 12 meters/year on its own (Boone 2007). Preventing human-mediated introduction and spread can reduce the spread of *Amyntas* and other invasive earthworm species in the state and negative impacts to Minnesota’s ecosystems.

How certain is this classification summary, overall? Reasonably certain.

Recommendation

The DNR may choose to recommend whether to designate the species as a prohibited invasive species, a regulated invasive species, or whether the species should be an unlisted nonnative species (Minnesota Statutes, section 84D.06). Briefly justify this recommendation and include any additional information such as recommended deadlines for updating this screening form and revisiting this decision and gaps in our knowledge that could be addressed by researchers.

Recommendation: Minnesota is at high risk of negative impacts from *Amyntas* and *Metaphire* species. Regulating *Amyntas* and *Metaphire* species now could help prevent new introductions and movement in the state. Regulating *Amyntas* and *Metaphire* species will affect industries in Minnesota that sell worms or move materials that could be infested with *Amyntas*. In 2018 the DNR reached out to these industries to provide identification information along with best management practices. To prevent additional introductions and spread of jumping worms, the DNR proposes listing earthworms in *Amyntas* genus and *Metaphire* genus as Prohibited Invasive Species.

Appendix

Qualitative uncertainty ratings

Uncertainty rating	Description	Abbreviation
Very certain	As certain as I am going to get	VC
Reasonably certain	Reasonably certain	RC

Uncertainty rating	Description	Abbreviation
Moderately certain	More certain than not	MC
Reasonably uncertain	Reasonably uncertain	RU
Very uncertain	A guess	VU

Uncertainty ratings from: “Generic Nonindigenous Aquatic Organisms Risk Analysis Review Process”, Risk Assessment and Management Committee report to the Aquatic Nuisance Species Task Force, 1996. Available [online](http://www.anstaskforce.gov/Documents/ANSTF_Risk_Analysis.pdf) (www.anstaskforce.gov/Documents/ANSTF_Risk_Analysis.pdf; accessed February 14, 2020).

Version notes

References to Minnesota Statutes are to the 2019 version.

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