



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

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Classification Screening for Marbled crayfish (marmorkrebs), *Procambarus virginalis* or *Procambarus fallax forma virginalis*

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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>). 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: marbled crayfish (marmorkrebs)

Scientific name: *Procambarus virginalis* or *Procambarus fallax forma virginalis*

Brief description: Marbled crayfish are a medium sized crayfish with a distinct marbled pattern. They typically grow ten to 13 centimeters long, and reproduce parthenogenetically (meaning the female can reproduce without requiring male fertilization). Though closely related to the *Procambarus fallax* crayfish native to the southeastern United States, the marbled crayfish recently arose as a distinct species through captive breeding. Marbled crayfish display rapid growth, extended breeding periods, higher reproductive rates, and potentially greater environmental tolerances (GLANSIS 2018). These crayfish are very popular in the North American pet trade (Faulkes 2015).

Present classification in Minnesota: unlisted nonnative species

Proposed classification: prohibited invasive species

Current distribution of species: There is no native distribution of marbled crayfish. There are established populations in Madagascar, Germany, Czech Republic, Slovakia, Hungary, Croatia, and

Ukraine (Chucholl et al., 2012; Jones et al., 2009; Liptak et al., 2016; Lokkos et al., 2016; Novitsky & Son, 2016; Patoka et al., 2016). There are no established populations in the United States (USFWS 2018).

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. There are no indigenous populations of marbled crayfish. These crayfish arose from captive breeding and only occur in wild populations due to accidental or intentional release. The sexually reproducing form, *Procambarus fallax*, is native to southern Georgia and Florida (CABI 2018).
- 1.2. **Does the species naturally expand from its historic range into Minnesota?** No. Marbled crayfish do not have a natural range as they are not native to any location.

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?

Marbled crayfish could be introduced to Minnesota by the following pathways:

- **Fishing:** It is possible that marbled crayfish would be introduced to Minnesota through fishing. Minnesota does not allow importation of live crayfish or crayfish eggs without a permit. Likewise, crayfish cannot be sold for live bait (Minnesota Rules, part 6259.0900 (2011)). However, enforcement of these regulations can be tricky, especially when online vendors can sell crayfish on websites like eBay. It is possible that an angler could buy a marbled crayfish from online, use it as live bait and/or accidentally release it while fishing in Minnesota.
- **Aquaria:** Marbled crayfish could be introduced to Minnesota through aquarium pet trade. Marbled crayfish are a popular crayfish in the aquarium and pet trade. They were likely first introduced to the North American pet trade in the early 2000s, and as such, may already exist in captivity in Minnesota (Faulkes 2015). A study of the crayfish trade in North America revealed that marbled crayfish account for almost half (48.5%) of the individual crayfish sold online, more than twice as many as the next commonly sold crayfish species (Faulkes 2015). Marbled crayfish are also used to feed ornamental turtles that may be kept in open ponds.

As marbled crayfish can produce hundreds of offspring, aquarium hobbyists may release unwanted or excess crayfish into the wild. Human-mediated release is believed to be the origin of the wild populations of marbled crayfish in Europe, so it is reasonable to assume that this species could experience similar introduction, whether accidental or intentional, in Minnesota (Chucholl et al. 2012).

- **Aquaculture:** It is unlikely that marbled crayfish could be introduced to Minnesota through aquaculture. Marbled crayfish could potentially enter Minnesota with a permit, however only dead crayfish or crayfish that cannot survive in Minnesota can be sold for bait and aquarium sales, respectively. Even then, they would likely not be allowed to be cultured for aquariums because there is a possibility that they could survive in Minnesota. In a bait aquaculture, the crayfish are required to be processed/killed before leaving the processing facility (Minnesota Rules, part 6259.0900 (2011)).
- **Food markets:** It is unlikely for marbled crayfish to enter Minnesota through food markets. In Madagascar, humans may have spread marbled crayfish because they are a popular, cheap food source. However, it is still considered a low-value food and therefore may not be nearly as popular in the United States (Jones et al. 2009). Additionally, Minnesota’s food aquaculture for

crayfish is relatively underdeveloped compared to crayfish producers in the southern United States (Gunderson & Kapuscinski 2014).

How certain is this answer? Moderately certain; supported by peer-reviewed literature and grey literature; the status of Marbled crayfish in captivity in Minnesota is unknown.

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? If introduced, marbled crayfish could naturalize in Minnesota.

Marbled crayfish are a warm-water crayfish that tend to prefer slow-moving or calm water habitats. In regions with these conditions, such as Madagascar, marbled crayfish are considered “perfect invaders,” quick to naturalize and spread (Chucholl et al. 2012). However, Marbled crayfish have been reported in a variety of habitats including: gravel pits, drainage ditches, rice paddies, ornamental garden ponds, lakes, rivers, and swamps; and have been found in multiple European countries including: Germany, Italy, the Czech Republic, Slovakia, Sweden, the Netherlands, and more (Chucholl et al. 2012, USFWS 2018).

Marbled crayfish have displayed tolerance to cold waters. Reports from Europe suggest that marbled crayfish can establish populations in temperate regions. However, some laboratory experiments suggest that marbled crayfish cannot survive low temperature or ice-over conditions. In one study, when exposed to cold (2-3 degrees Celsius) water temperatures for prolonged (55-141) days, all but one specimen of Marmorkreb died (Veselý et al. 2015). Due to marbled crayfish unique reproductive strategy, in theory only one living individual is required to start a population.

Marbled crayfish have traits associated with invasive species, such as the abilities to grow and reproduce rapidly. In conditions of 68-77 degrees Fahrenheit, females begin their reproductive cycles at the age of 141-255 days. In a single marbled crayfish lifetime of two to three years, an individual will go through about seven reproductive cycles laying 45 to 416 eggs each cycle (CABI 2018). Their high reproductive rate could allow for the establishment of acclimated individuals.

Additionally, marbled crayfish are tolerant of drying and low oxygen environments for short periods of time. Based on these tolerances and previous observations, marbled crayfish are able to migrate over land, thereby increasing their potential range beyond their initial point of introduction (Chucholl et al. 2012).

Due to its climate match score (Figure 1), its history of establishment in European temperate regions, and its reproductive advantages, it is possible that marbled crayfish could become

naturalized in Minnesota if introduced. The probability of naturalization is likely higher for southwestern regions of Minnesota than northern regions.

How certain is this answer? Moderately certain, supported by some peer-reviewed literature.

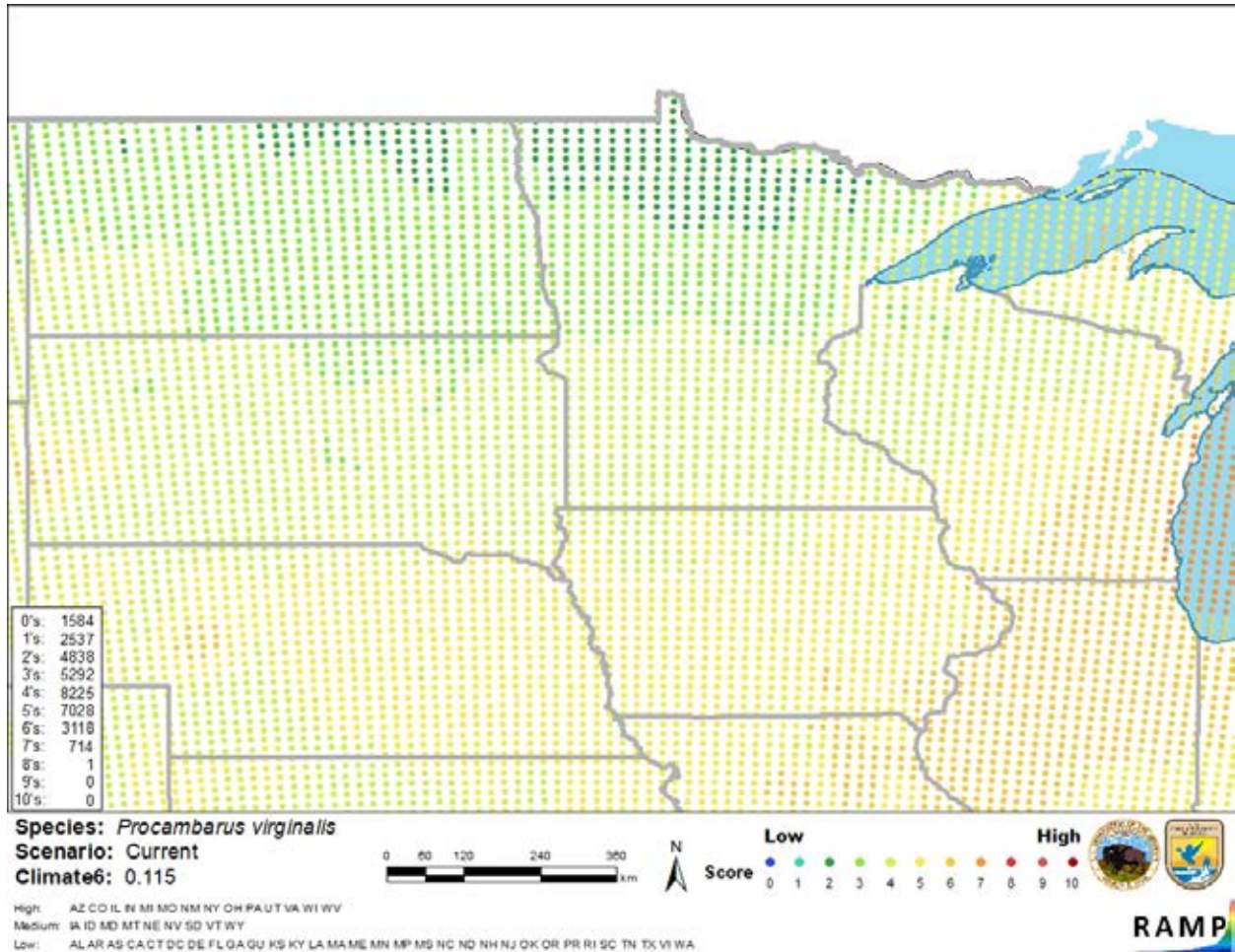


Figure 1. Risk Assessment Mapping Program (RAMP; Sanders et al. 2014) climate risk assessment for the *Procambarus virginialis* in Minnesota and neighboring states. Assessment was conducted in 2019 using GBIF data, USGS NAS Database (Nico et al. 2019), and literature sources. 0 = Lowest Match, 10 = Highest match.

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 of marbled crayfish have not been well studied. Anecdotal observations from Madagascar suggest that marbled crayfish “destroyed fishing” for locals, however the extent or method by which marbled crayfish impacted local fisheries was not described (CABI 2018). In Minnesota, marbled crayfish could disrupt fisheries or native crayfish harvesting by competing for resources with native species on which some industries rely.

How certain is this answer? Uncertain, economic impacts of marbled crayfish have not been well studied.

4.2. Does the species cause, or may it cause, environmental harm? Environmental impacts of marbled crayfish have not been well studied. Most impacts are estimated based on marbled crayfish’s biological life history traits. Due to their “ability to found large populations from single animals, marbled crayfish introductions have a significant potential to endanger indigenous crayfish species through competition or pathogen transmission” (Lyko 2017). Evidence from Madagascar suggests that marbled crayfish may threaten native fishes and aquatic-based crops such as rice (CABI 2018). Observations of interactions between captive marbled crayfish and other crayfish species also suggest that marbled crayfish can outcompete other crayfish (USFWS 2018). Furthermore, marbled crayfish, though omnivorous, consume substantial amounts of plant matter (Chucholl et al. 2012). Therefore, in Minnesota, marbled crayfish could likely harm native fish and crayfish species, damage native aquatic plants, and disrupt aquatic ecosystems.

How certain is this answer? Uncertain, environmental impacts of marbled crayfish have not been well studied.

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, no documentation on negative impacts to human health were found.

4.4. Does the species threaten, or may it threaten, the use of natural resources in the state? Wild rice may be impacted if marbled crayfish consume or disrupt rice crops as has been seen in Madagascar (CABI 2018). Crayfish harvesting may be impacted if marbled crayfish outcompete native crayfish.

How certain is this answer? Uncertain, little research has been conducted.

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? Marbled crayfish may compete with native crayfish species and disrupt aquatic food chains due to their “fast growth rate, very high fecundity, and extended breeding period, all of which might give [them] an additional competitive advantage” (Chucholl et al. 2012). Wild rice crops within the 1854 ceded territory could be further endangered by the introduction of the omnivorous marbled crayfish. The magnitude of the marbled crayfish’s impacts are uncertain as invasions have occurred relatively recently and are still being investigated for potential short and long term impacts.

How certain is this answer? Uncertain; little research has been conducted.

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? No. Cold temperature and ice cover may limit marbled crayfish populations if they were to enter Minnesota. Velsely et al. (2015) demonstrated that marbled crayfish have a very low survival rate in cold waters for prolonged periods. However, if they are able to establish in temperate Europe, they will likely be able to establish in Minnesota.

There are no known effective mechanical or chemical methods for controlling or eradicating marbled crayfish in the wild. Due to its relatively new status as a distinct species, few eradication efforts have been attempted in areas where marbled crayfish are considered invasive (CABI 2018). Their reproductive strategy means that marbled crayfish do not need to maintain a minimum population size—as long as there is one reproducing individual, a population can establish. This “resilience against small population size renders eradication of established marbled crayfish populations even more difficult or even impossible” (Chucholl et al. 2012). It is possible to minimize spread of marbled crayfish by not moving or releasing individuals between or into new water bodies.

How certain is this answer? Reasonably uncertain; lack of literature concerning marbled crayfish removal.

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.

- Other considerations:
 - On May 4, 2018, the Great Lakes St. Lawrence Governors & Premiers announced five additions to the list of “least wanted” aquatic invasive species; marbled crayfish was one of those species.
- It is listed on the European Union’s list of “Invasive Alien Species of Union Concern.” Species on this list are agreed upon by member countries as requiring prevention and control (USFWS 2018. European Commission Environmental webpage).
- There is growing interest in using marbled crayfish as a research model (Gutekunst et al. 2018). This could cause the wider distribution of marbled crayfish for use in labs and potentially cause more accidental introductions.
- Regulations in other jurisdictions:
 - Marbled crayfish are prohibited in Missouri and Tennessee and are illegal to import or keep in several countries in Europe (CABI 2018).

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: Marbled crayfish are crayfish that could invade and negatively impact Minnesota waters. As the only known parthenogenic decapod, a single released specimen could establish a population. They are likely to be introduced to Minnesota through the online pet trade and have the potential to naturalize and spread in central and southern Minnesota. As a relatively new invasive species, little is known about the potentially negative impacts marbled crayfish have on ecosystems. Likewise, there are no established eradication methods for marbled crayfish. Regulating marbled crayfish could minimize the risk of further introduction via human pathways. Minnesota currently has rules in place regulating aquarium sales of crayfish in the state.

How certain is this classification summary, overall? Moderately 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: Designate as a 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
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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