



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

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Classification Screening for snakehead fish species, *Channa* spp. and *Parachanna* spp.

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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: Snakehead fish species

Scientific name: *Channa* spp. and *Parachanna* spp.

Brief description: The *Channidae* family is made up of the *Channa* and the *Parachanna* genera with 38 validated species (Conte-Grand et al. 2017). Species in this family can breathe air, only live in freshwater, and range in adult length from 7 inches to longer than six feet. In the past, snakeheads have been imported to the United States via food markets and aquarium trade. Three snakehead species have become established in the United States in Florida, Maryland, Pennsylvania, Virginia, Arkansas and Hawaii (Courtenay & Williams 2004; Fuller et al. 2017), living in a variety of habitats including lakes, ponds, rivers, and streams. *Channidae* adults are predators, preferring to feed on other fish, as well as crustaceans, frogs, and small birds and reptiles. Spawning season varies by species but

mostly occurs in the summer months June through August. Most build nests where the larva will stay and be guarded by one or both parents (Courtenay & Williams 2004).

Present classification in Minnesota: northern snakehead fish (*Channa argus*) is a prohibited invasive species; other species in the genera *Channa* and the *Parachanna* are unlisted nonnative species

Proposed classification: Prohibited invasive species

Current distribution of species: The *Channa* genus of the snakehead family are native to South, East, and Southeast Asia and parts of Russia (Courtenay & Williams 2004). The *Parachanna* genus is native to central West Africa around the equator (Courtenay & Williams 2004). *Channa* have been introduced to Japan, parts of Asia beyond its natural range, Europe, and the United States. Several species have established in the United States in Florida, Maryland, Pennsylvania, Virginia, Arkansas and Hawaii (Courtenay & Williams 2004; Fuller et al. 2017).

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. No species in the *Channidae* family is naturally present or reproducing in Minnesota.

1.2. Does the species naturally expand from its historic range into Minnesota? No. *Channa* and *Parachanna*’s natural range is in Asia and Africa, respectively. Three *Channa* species, northern snakehead, blotched snakehead, and bullseye snakehead have historic ranges of established populations in Arkansas, Florida and the eastern United States. They are expanding in their ranges in those states and regions. They have not expanded into Minnesota but have the potential to do so.

How certain are these answers? 1.1. Reasonably certain, USGS records show no previous *Channa* or *Parachanna* presence or establishment in Minnesota; 1.2. 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?

Channa and *Parachanna* species could be introduced to Minnesota by the following pathways:

- **Fishing:** Snakehead species could potentially enter Minnesota through fishing. There is some interest in the eastern U.S. to allow snakehead gamefish status because they are challenging to catch and valued for cooking (Shollenberger et al. 2019). Recreational fisheries are beginning to appear in Southeast Asia (67 FR 48855 2002) Minnesota law only prohibits northern snakehead, so there is potential for other snakehead species to enter Minnesota via fishermen for sport-fishing.
- **Aquaria:** Snakehead species could be introduced to Minnesota via aquaria. Previous to 2002, snakehead species could be bought in pet stores (USGS 2004). Their unique shapes and colors

are attractive qualities, but due to their high cost, piscivorous diet, rapid growth, and large adult size, there is only a small niche of interested U.S. aquarists. Illegal pet trade and online stores still offer snakehead species. In 2003, a single giant snakehead specimen that was found in Wisconsin's Rock River near Janesville. It was captured by Wisconsin's Department of Resources where they suspected it was released by an aquarist (Courtenay & Williams 2004; Associated Press 2003). Two northern snakeheads were released by an aquarist into a pond in Crofton, Maryland in 2002, where they spawned hundreds of babies (Wood 2012; Kiehl 2002). There is potential for a Minnesota aquarist to purposefully or accidentally release their pet snakehead.

- **Aquaculture:** There is potential for snakehead species to enter Minnesota through aquaculture. Despite the fact that in many states it's illegal to possess or transport live snakehead specimen, a person may want to cultivate snakehead for food purposes. Snakehead is valued in various ethnic food markets. In Hawai'i there is a market for snakehead meat and blotched snakehead is legally cultured and sold at live fish markets. On the United States mainland, there are small groups interested in potentially cultivating snakehead for food in the eastern United States (Courtenay et al. 2004; Shellenberger et al. 2019). Due to its value as a food and illegal importation status, some could release snakehead to create their own local stock (Courtenay & Williams 2004).
- **Food market:** Snakehead species could enter Minnesota in a live fish market. Five species of snakeheads are highly valued for food including northern snakehead, blotched snakehead, Chinese snakehead, bullseye snakehead, and chevron snakehead (Herborg et al. 2007). Snakehead hardiness, temperature tolerance, and ability to breathe air assist in their live transport (67 FR 48855 2002). In 2002, the Lacey Act prohibited possession and foreign importation of all snakehead species. Despite this, illegal live sale at food markets and illegal shipments still occur (Herborg et al. 2007).

How certain is this answer? Moderately certain; supported by peer-reviewed studies.

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. There are 38 validated species in the snakehead family (Conte-Grand et al. 2017). Herborg et al. (2007) found that snakehead species potential North American distributions were correlated to thermal factors. All

species in this family have a range of thermal tolerances from strictly tropical to cold temperate. Species that would naturalize in Minnesota would likely be the species in the *Channa* genus, as *Parachanna*'s temperature preference is strictly tropical (Courtenay & Williams 2004). There are 12 species known to tolerate tropical or subtropical to warm temperate, one tolerates warm temperate, and one can live in both warm to cold temperate (67 FR 62193 2002). Warm and cold temperature species would likely spread to, survive, and naturalize in Minnesota. Sub-tropical to warm temperature species could survive during Minnesota summer then potentially survive in artificially heated waters (i.e., bodies of water near power plants or heated reservoirs) as the temperature drops during fall and winter. If they did survive, they could potentially use our waterways to then spread to more southern states.

Herborg et al. (2007) modeled potential North American distributions of 10 snakehead species. Northern snakeheads and rainbow snakeheads have the potential of living in Minnesota. Additionally, bullseye, chevron, Chinese, and Niger snakeheads were projected to live in most of Mexico up to ~35°N latitude. Minnesota is between 43° N and 49° N latitudes. This study showed that beyond Northern snakeheads, which easily could naturalize in Minnesota, one other snakehead species could naturalize and four other species have potential to establish if introduced to Minnesota. Our modeling with the Risk Assessment Mapping Program (RAMP; Sanders et al. 2014) was completed for the entire genus of *Channa* (Figure 1).

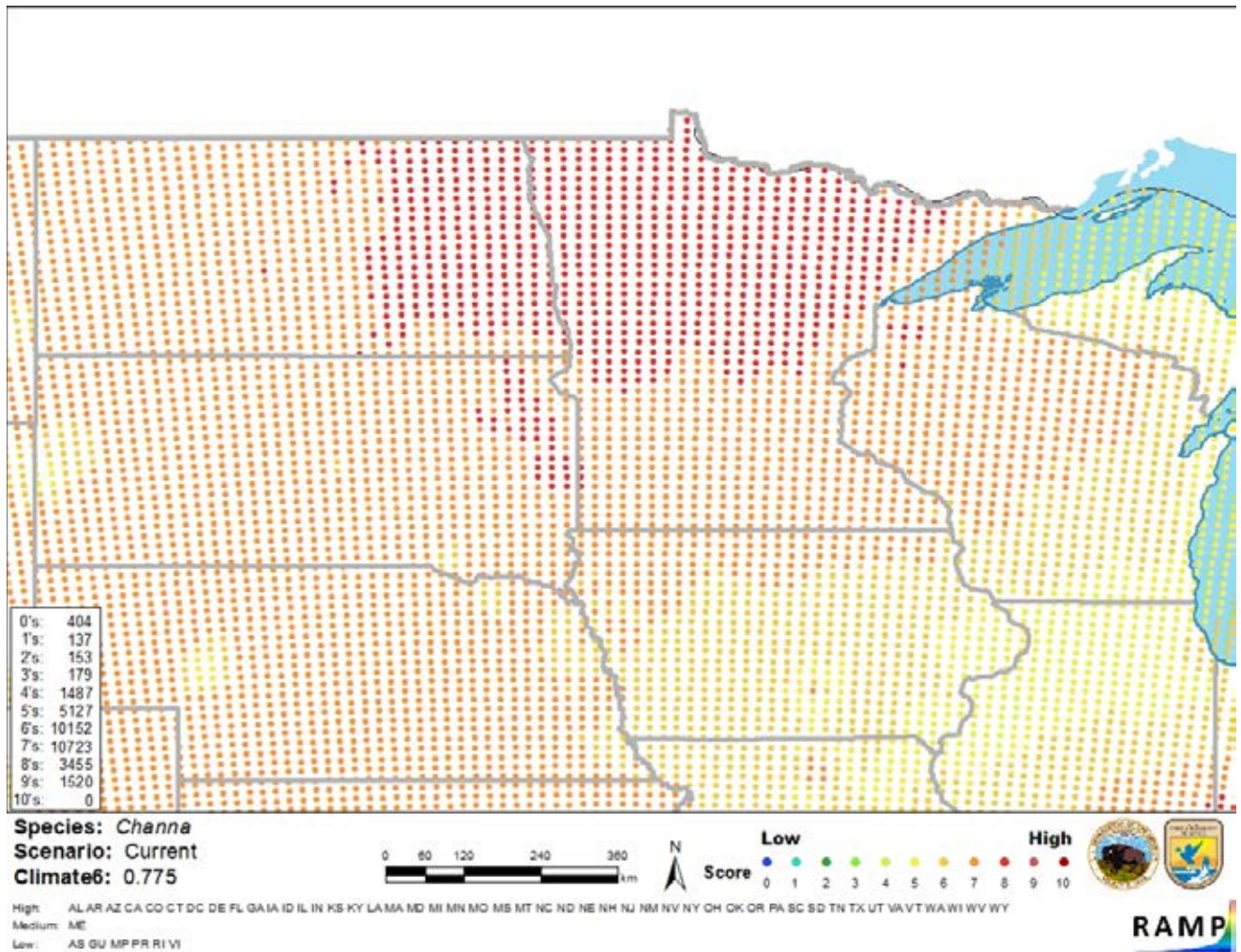


Figure 1. Risk Assessment Mapping Program (RAMP; Sanders et al. 2014) climate risk assessment for the genus *Channa* in Minnesota and neighboring states. Assessment was conducted in 2019 using GBIF data, USGS NAS Database (Nico et al. 2019), and literature sources.

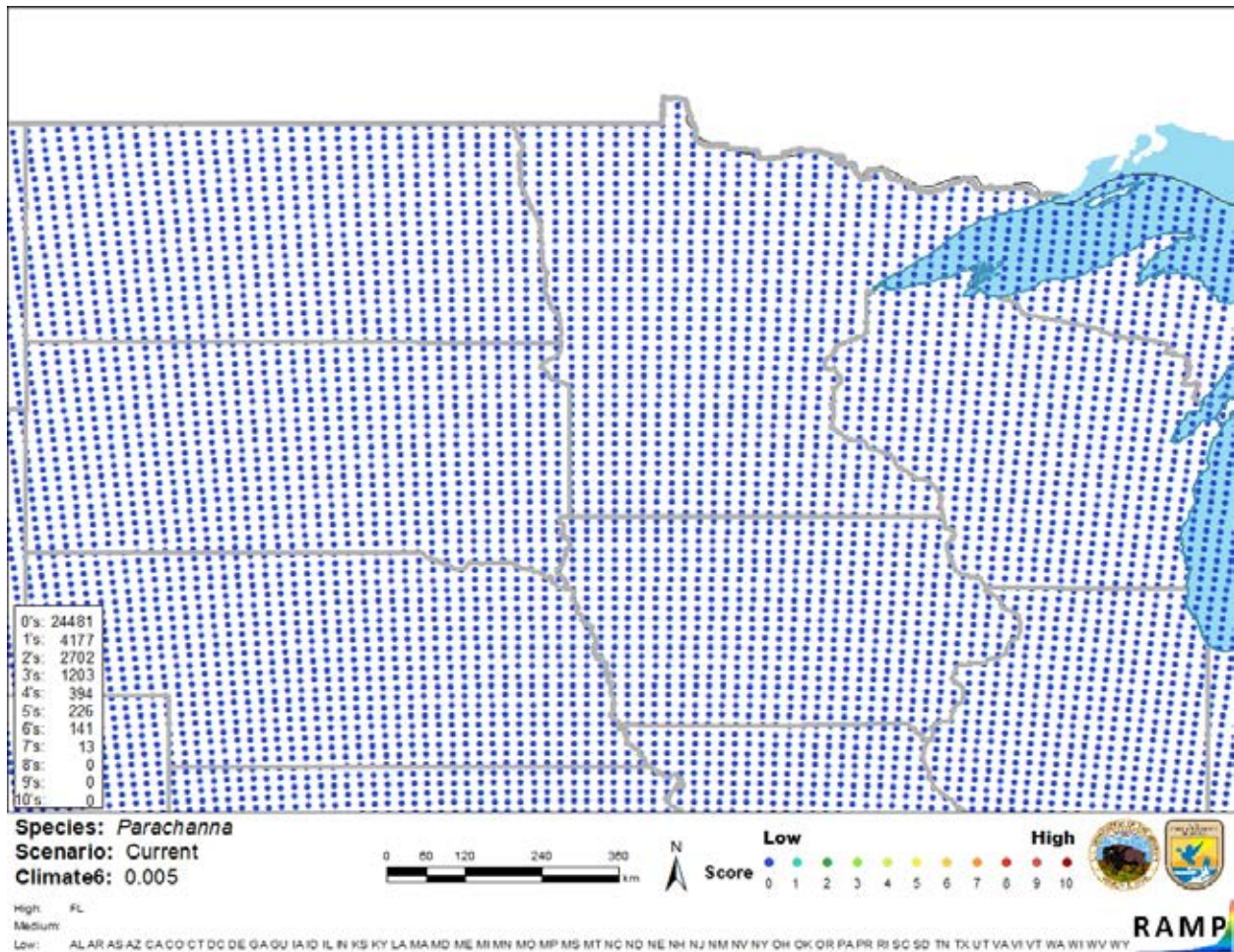


Figure 2. Risk Assessment Mapping Program (RAMP; Sanders et al. 2014) climate risk assessment for the genus *Parachanna* in Minnesota and neighboring states. Assessment was conducted in 2019 using GBIF data.

The snakehead family possesses several environmental tolerances that may help them spread to and establish in Minnesota. Preferred habitats vary by species, but in general snakeheads occur in streams and rivers (Courtenay & Williams 2004). Some can live in ponds, ditches, swamps and lakes. Snakehead species are generally able to survive in aquatic environments with low to no oxygen because they breathe air after their juvenile stage. They are able to live in a wide variety of pH ranges depending on the species (Courtenay & Williams 2004). Data from snakehead fisheries does not indicate an outstanding reproductive potential, but the fact that they do not have natural predators in the U.S. and that snakeheads guard their young potentially gives them an edge over native fish populations (Courtenay & Williams 2004).

How certain is this answer? Reasonably certain, supported by grey literature and peer-reviewed articles.

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? Potentially. Introduction of snakehead species may cause economic harm because it could compete with or prey on popular game fish species or commercially fished fish species. If this competition decreases native fish populations, that would cause decreased stock for stakeholders and commercial fisherman.

If northern snakehead popularity grows, stakeholders may push for gamefish status for snakeheads which would likely have a largely negative impact on commercially-important and native sport fish.

Eradication and control efforts are expensive. The total cost of eradication of snakehead from a single pond in Crofton, Maryland was \$110,000.

How certain is this answer? Reasonably certain, supported by peer-reviewed articles.

4.2. Does the species cause, or may it cause, environmental harm? Yes. Snakeheads will compete with native species at all life stages and consume smaller native fish in adult stages. Northern snakehead were observed feeding on pumpkinseed, bluegill, white perch, and killifish in the Potomac River (NSWG 2006), other snakehead species will also likely target forage fish. Snakeheads do not have natural predators in Minnesota. Their establishment would alter food webs and likely create unpredictable effects on the native communities (Courtenay & Williams 2004).

When the blotched snakehead was introduced to Madagascar it threatened and displaced the endemic cichlid genus *Paratilapia* and threatened frog population in Madagascar’s the central highlands (Raminosoa 1987; Courtenay et al. 2004). Introduction of predatory snakeheads may endanger Minnesota’s threatened fish and frogs.

Snakeheads are known to carry several species of parasites, however no studies have examined the potential transfer of pathogens to native North American fishes (67 FR 48855 2002).

How certain is this answer? Reasonably certain, supported by peer-reviewed articles.

- 4.3. Does the species cause, or may it cause, harm to human health?** Potentially. Human health could be impacted by snakehead introduction. Chevron snakeheads can carry a helminth parasite that causes gnathostomiasis. From the snakehead, the parasite could potentially be spread to other freshwater fish, eels, frogs, birds, and reptiles. When raw or undercooked meat from infected animals is eaten by humans, humans become infected as well.

How certain is this answer? Reasonably certain, supported by peer-reviewed articles.

- 4.4. Does the species threaten, or may it threaten, the use of natural resources in the state?** Yes. One of the major concerns of establishment of northern snakehead in the Potomac River is the threat to the largemouth bass fishery. Saylor et al. (2012) observed significant dietary overlap as well as similar habitat preference in northern snakeheads and largemouth bass, increasing chances of competition if either prey or habitat is a limiting resource. Additionally, Love & Newhard (2012) modeled the snakehead population in the Potomac River and found that increased co-occurrence of largemouth bass and northern snakeheads or the loss of aquatic vegetation lead to a decrease in the largemouth bass population. These studies indicate that northern snakeheads would likely endanger both recreational and commercially important fish in Minnesota through competition or predation (NSWG 2006).

All snakeheads are predators and are documented to have aggressive predation habits in native and introduced habitats. Examples include: the giant snakehead which is known to kill more fish than it consumes (Courtenay & Williams 2004), blotched snakeheads removal of Madagascar's endemic cichlid fish from the central highlands (Courtenay et al. 2004), and spotted snakeheads devastation of India's native fish (Talwar and Jhingran 1992). Introduction of any species of snakehead in Minnesota will likely lead to adverse effects on the state's natural resources overall.

How certain is this answer? Reasonably certain, supported by peer-reviewed articles.

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.

5.1. If so, what would be the magnitude of these adverse impacts? An introduced species from the snakehead family has potentially adverse impact on native species, commercial fishing, and outdoor recreation. While specific impacts may be reliant on what species is introduced, all snakehead species are predators and introduction of non-native predators often come with top-down food-web changes through predation, competition, and unforeseen effects of food-web alteration (Courtenay & Williams 2004). Introduction of snakeheads to Minnesota would also likely threaten endangered or vulnerable Minnesotan fish and frog species through competition and predation, respectively.

For many of the tropical to subtropical snakehead species, their survival and subsequent impacts will be limited by the temperature of their habitat. If they are able to enter artificially heated waters, they may be able to establish and alter the food web dynamics of that water. Otherwise, they would likely die out from the cold or attempt to move south through connected waterways. Subtropical to warm and cold temperate snakehead have a greater probability of surviving and establishing in central to southern Minnesota, creating long term, adverse impacts.

Outdoor recreation may be hindered if a media scare occurs in Minnesota as it did in Maryland when snakehead were found. This media scare included false claims that the fish can survive out of water for days and that it could walk significant distances. This generated fear and may have discouraged people from visiting water bodies. People may fear snakehead aggression as one report from Delaware describes a child reaching too close to a snakehead nest and the snakehead lunged and bit the child (Howard 2016). Outdoor recreation may also be hindered by changes to aquatic environments due to food web alteration (Courtenay & Williams 2004).

How certain is this answer? Reasonably uncertain, supported by peer-reviewed literature. Competition and predation will likely occur between snakehead and native fish but the magnitude is largely unknown.

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. Currently, there are no effective methods of eradication for the snakehead family. Control methods that do exist are costly and have non-target impacts.

A potential chemical control is the piscicide Rotenone. Rotenone was used to eradicate northern snakehead found in a 4-acre pond in Crofton, Maryland. This eradicated all the northern snakehead in the pond as well as all other fish in the pond. Rotenone is nonselective and likely negatively affects all snakehead species, however the concentration and amount used should be determined for each unique case. Further studies are needed to find minimum lethal dose for each species that could invade the U.S. (Lazur et al. 2006).

Draining could potentially be used for the physical eradication of snakeheads in smaller, closed bodies of water. This method was used in Pine Lake, Wheaton, MD in 2004 after a fisherman removed a single female snakehead from Pine Lake. Before draining the Maryland DNR removed bass, sunfish, and trout from the lake. These fish were then returned after the draining (The Washington Times 2004). No other snakehead was found during the drain. Similar to the Rotenone, using this method is costly to other fish in the body of water even with the DNR removing many fish and returning them. Additionally, because snakeheads are obligate or facultative air-breathers and able to walk short distances, this method will require the use of barriers and a secondary method to kill the snakehead.

Electrofishing and netting are physical methods to control snakehead populations. This would be ineffective to control for all snakehead species across their various size classes, but still has potential as a control method.

Courtenay & Williams (2004) note that control methods in smaller bodies of water are dependent on factors like amount of vegetation and accessibility to the water body. In larger bodies of water like lakes or river systems eradication is nearly impossible.

How certain is this answer? Reasonably certain, grey literature is available for previous cases of eradication and control, along with some peer-reviewed articles.

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:

- A 2017 study suggests there is higher species diversity within the snakehead family than currently recognized (Conte-Grand et al.). This may lead to further taxonomic changes that could render narrow legislation ineffective.
- Snakehead species that are unable to naturalize in Minnesota due to climate restrictions may be able to use our interconnected river systems to travel to and establish in southern states where they could naturalize.

Regulations in other jurisdictions:

- The entire snakehead family is listed as Injurious Wildlife under the Lacey Act (18 U.S.C. § 42(a)(1)), which bans the import of injurious species into the United States and its territories. A court ruling in 2017 “struck down the longstanding interpretation of the U.S. Fish and Wildlife Service (USFWS) that Title 18 also prohibited the shipment of injurious species across state lines” (Otts 2017); however, the U.S. Fish and Wildlife Service may still prohibit interstate transport of state-regulated species. Therefore, listing all snakehead fish species as prohibited invasive species in Minnesota will help to prevent its introduction and spread in the U.S. and to our neighboring jurisdictions.
- Illinois, Indiana, Iowa, Michigan, North Dakota, Ohio, Pennsylvania, and Wisconsin prohibit all species in the Channidae family (Great Lakes Commission, Memo dated December 14, 2017; Iowa Admin. Code r. 571-90.2; NDCC § 20.1-17; Wis. Admin. Code § NR 40.04). Ontario also prohibits all species in the Channidae family.
- South Dakota prohibits four species in the Channidae family including giant snakehead, northern snakehead, blotched snakehead, and bullseye snakehead (S.D. Admin. R. 41:10:04.01).

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: The snakehead family is comprised of the African *Parachanna* species and the Asian *Channa* species. There are currently 38 validated species, ranging in size from seven inches to longer than six feet. All 38 species are freshwater predators, able to survive out of water for short periods of time. Of the two genera, *Channa* spp. have a greater thermal tolerance range and are more likely able to establish in Minnesota. More than one species in this genera has the potential to establish in Minnesota. These species pose a danger to Minnesota’s natural resources. Previous literature of snakehead introductions outside of its natural range indicate aggressive competition and predation on native species and commercially fished species. Species of *Channa* can also carry the tropical parasite that causes gnathostomiasis which can spread to humans through consumption of uncooked meat. Other species of the snakehead family that could not survive Minnesota’s winter water temperatures could swim downstream and establish in warmer states.

How certain is this classification summary, overall? Very certain, supported by grey literature and peer-reviewed literature.

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 snakehead fish 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
Moderately certain	More certain than not	MC
Reasonably uncertain	Reasonably uncertain	RU

Uncertainty rating	Description	Abbreviation
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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