Greater European Peaclam (*Pisidium amnicum*)

Ecological Risk Screening Summary

U.S. Fish and Wildlife Service, December 2022
Revised, January 2023
Web Version, 3/7/2025

Organism Type: Mollusk
Overall Risk Assessment Category: Uncertain

Photo: Amy Benson - USGS. Public domain. Available: https://nas.er.usgs.gov/queries/greatLakes/FactSheet.aspx?Species_ID=129&Potential=N&Type=0&HUCNumber=DGreatLakes (December 2022).

1 Native Range and Status in the United States

Native Range

From Kipp et al. (2019a):

"[…] widely distributed in Eurasia and North Africa between Naples [Italy], Siberia [Russia], and Algiers [Algeria] (Mackie 2000, Por et al. 1986, Vincent et al. 1981)."

From NatureServe (2022):

"The native range of this species is Palearctic […]"

From Rassam et al. (2021):

“Morocco, it was reported in the present study only from a reservoir outlet.”

Status in the United States

From Kipp et al. (2019b):

“[…] was first recorded in the Great Lakes drainage in 1897 near the mouth of the Genesee River at Lake Ontario [New York]. It has also been recorded from other areas in Lake Ontario, Lake Huron, Lake Erie, Lake Michigan, and Lake Superior (Clarke 1981, Grigorovich et al. 2003, Heard 1962, Mackie 2000, Mackie et al. 1980, Mills et al. 1993). Also, Lake Champlain, and Hudson River in New York.”

From Kipp et al. (2019a):

“Established where recorded, but at low densities in some regions […] (Clarke 1981, Grigorovich et al. 2003, Mackie et al. 1980, Mills et al. 1993).”

From NatureServe (2022):

“[…] present as an introduced species in the Great Lakes and St. Lawrence drainages systems of North America (Mackie 2007, Grigorovich et al. 2003).”

From Mills et al. (1993):

“[…] widespread in the eastern Great Lakes, in the St. Lawrence River, Lake Champlain, Pennsylvania, and New Jersey (Herrington 1962, Burch 1975a).”

Simpson et al. (2022) lists *Pisidium amnicum* as “Invasive (category D2) in the United States. Category D2 are those species with a “self-sustaining population outside of captivity or cultivation, that causes or is likely to cause harm.”

No records of *Pisidium amnicum* in trade in the United States were found.

Regulations

No species-specific regulations on possession or trade were found within the United States.

Means of Introductions within the United States

From Mills et al. (1993):

“[…] was probably introduced through shipping activities into Lake Ontario.”

Remarks

No additional remarks.

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

According to Bouchet (2015), *Pisidium amnicum* (O. F. Müller, 1774) is the current valid name for this species.

From ITIS (2022):

Kingdom Animalia
Subkingdom Bilateria
Infrakingdom Protostomia
Superphylum Lophozoa
Phylum Mollusca
Class Bivalvia
Subclass Heterodonta
Order Veneroida
Superfamily Corbiculoidea
Family Pisidiidae
Genus Pisidium
Species *Pisidium amnicum* (O. F. Müller, 1774)

Size, Weight, and Age Range

From Kipp et al. (2019a):

"[…] varies from 8.8 to 11.9 mm in length (Herrington 1962, Holopainen 1979, Holopainen et al. 1997, Vincent et al. 1981)."

"[…] can live up to 3 years, mature at 4 mm (sexually mature as early as 3 months old in Europe) […] Lifespan is typically 1–3 years (Araujo and Ramos 1999, Araujo et al. 1999, Holopainen 1979, Holopainen et al. 1997, Vincent et al. 1981)."

Environment

From Kipp et al. (2019a):

"Found in freshwater lakes and slow-moving rivers with soft bottoms; water temperatures of 1–21ºC. *Pisidium amnicum* is typically a rheophilic species in its native range but can also occur in lakes. It prefers sand but has also been recorded on mud and gravel. It can survive anoxic conditions under ice cover but may be limited in some upper river reaches where temperatures do not exceed 15–17ºC […]. *Pisidium amnicum* is capable of closing its shell to induce anoxia, metabolic quiescence, and anaerobiosis, and can survive for 200 days at 0ºC. It occurs down to 30 m in Europe but only down to 10 m in the Great Lakes."

From NatureServe (2022):

"[…] prefer the sandy bottoms of large bodies of water (Herrington 1962). In Europe it appears to prefer clean waters of large and small rivers, brooks, ditches and lakes, among aquatic plants or in the mud […]."

Climate

No information was found on climate requirements for *Pisidium amnicum*.

Distribution Outside the United States

Native

From Kipp et al. (2019a):

"[…] widely distributed in Eurasia and North Africa between Naples [Italy], Siberia [Russia], and Algiers [Algeria] (Mackie 2000, Por et al. 1986, Vincent et al. 1981)."

From NatureServe (2022):

"The native range of this species is Palearctic […]"

From Rassam et al. (2021):

"Morocco, it was reported in the present study only from a reservoir outlet."

Introduced

No records were found of introduction of *Pisidium amnicum* in the wild outside the United States.

Means of Introduction Outside the United States

No records were found of introduction of *Pisidium amnicum* in the wild outside the United States.

Short Description

From Kipp et al. (2019a):

"This small bivalve has a height to length ratio of 0.74–0.81 and is relatively long, oval shaped, and heavily striated with a shiny yellow or brown epidermis. The beaks are located towards the posterior by about 2/3 of the total shell length. Inside the shell, the cardinal teeth are closer to the anterior lateral teeth than to the posterior lateral teeth, the 2nd cardinal tooth is a thick peg covered by the thinner 4th cardinal, and the 3rd cardinal curves around the 2nd cardinal. In live specimens there is only an anal siphon (Clarke 1981, Herrington 1962, Mackie et al. 1980, Pennak 1989)."

Biology

From Kipp et al. (2019a):

"Densities in Europe have reached around 1000–3300 clams per m^2. […] It is hermaphroditic, ovoviviparous, and can undergo cross-fertilization. […] In Europe it is often semelparous, reproducing once in a lifetime. In the St. Lawrence River, it is iteroparous, reproducing twice, once at age 2 and once at age 3. Recruitment takes place when water temperatures reach 15–20ºC. Maturation of individuals and egg-laying occur between July and October, and eggs are brooded for around 9–10 months. The number of embryos per adult varies from 5–29. […] Pill clams are filter feeders (suspension feeders on algae and bacteria), living in the sediments and obtaining nutrition from the substrate and the water column. This species especially favors diatoms (Holopainen 1979, Mackie 2000)."

From Sousa et al. (2008):

"[…] sites with high organic matter and low conductivity supported higher abundance of *P. amnicum*. Organic matter is likely to be an important factor influencing the distribution of *P. amnicum* because this clam utilizes pedal feeding to extract organic matter from the interstitial water and sediment […]"

Human Uses

No information was found on human uses of *Pisidium amnicum*.

Diseases

No information was found associating *Pisidium amnicum* with any diseases listed by the World Organization of Animal Health (2022).

From Kipp et al. (2019a):

"Adult clams in particular can be hosts to digenean parasites in Eurasia, such as: *Bunodera lucipercae*, *Palacerochis crassus*, *Phyllodistomum elongatum*, and *Crepidostomum* sp."

Threat to Humans

No information was found on threats to humans from *Pisidium amnicum*.

3 Impacts of Introductions

No information regarding documented impacts from introductions was found. However, there was some information available regarding potential impacts.

From Kipp et al (2019b):

"A recent report by Trebitz et al. (2010) speculated that significant adverse impacts from *P. amnicum* are not expected based on the limited extent of populations in both Lake Superior for the past 20 years and elsewhere in the Great Lakes."

"The impacts of this species are currently unknown, as no studies have been done to determine how it has affected ecosystems in the invaded range. The absence of data does not equate to lack of effects. It does, however, mean that research is required to evaluate effects before conclusions can be made."

4 History of Invasiveness

The History of Invasiveness for *Pisidium amnicum* is classified as Data Deficient. *Pisidium amnicum* has established populations outside of its native range (notably the Great Lakes and surrounding areas of the United States). There is no clear, convincing, reliable documentation of the impacts (or lack of impacts) that it may have. No evidence was found to suggest that the species is in trade.

5 Global Distribution

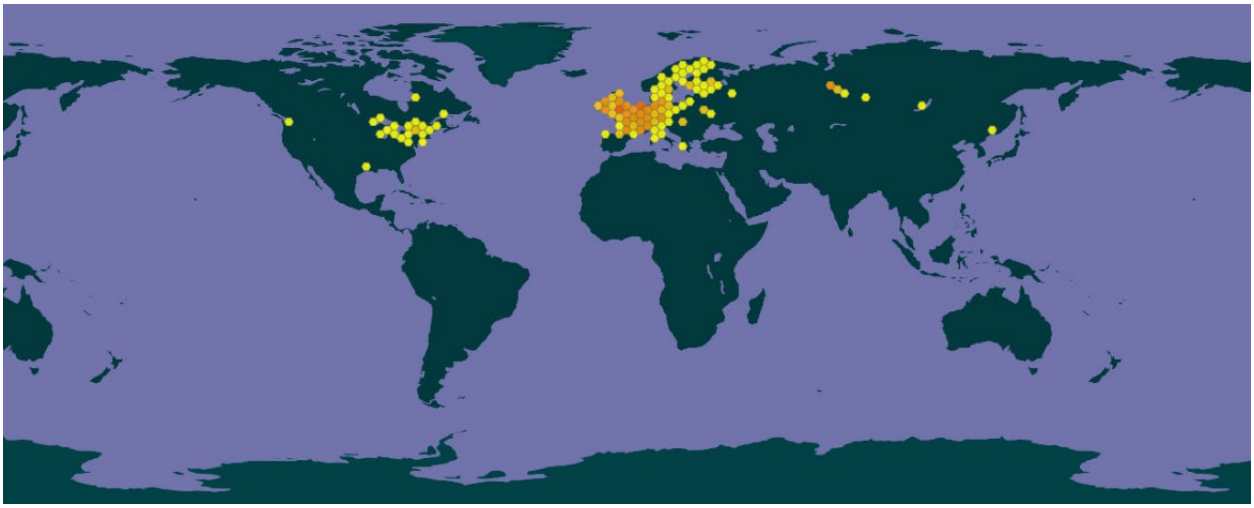

Figure 1. Known global distribution of *Pisidium amnicum*. Observations are primarily reported from *P. amnicum*'s native range in the Palearctic region in Eurasia and in known introduced locations from Northeastern United States and Southeastern Canada. Map from GBIF (2022). Reported occurrences in Washington and Louisiana (United States) were excluded from the climate matching analysis as these occurrences are outside the described distribution of the species in North America. The northernmost point in Canada was not used in the climate matching analysis as there was a discrepancy between the recorded coordinates and collection location.

Kipp et al (2019a) report this species in Algeria but no georeferenced location was available.

An observation from Morocco was provided in Rassam et al. (2021) which reported this species in a reservoir outlet.

6 Distribution Within the United States

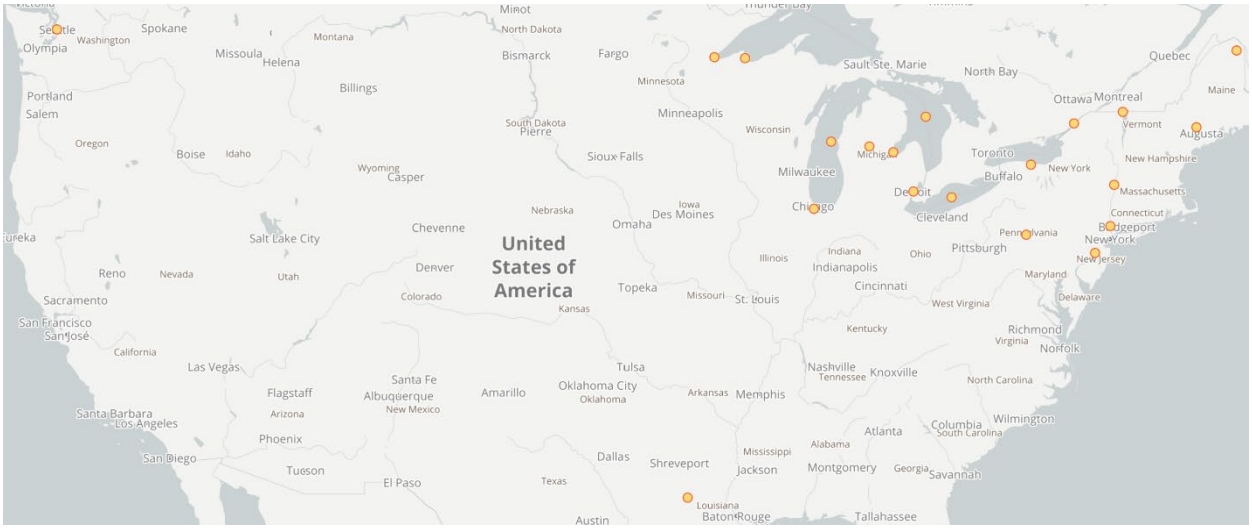

Figure 2. Reported distribution of *Pisidium amnicum* in the United States. Map from GBIF-US (2022). Observations are reported from the Great Lakes, St. Lawrence River, and Hudson River watersheds; Washington; and Louisiana. Reported occurrences in Washington and Louisiana of the United States were excluded from the climate matching analysis as these occurrences are outside the described range of the species in North America.

7 Climate Matching

Summary of Climate Matching Analysis

The climate match for *Pisidium amnicum* to the contiguous United States was highest in the Midwest and Northeast, especially around the Great Lakes. The climate match was medium across most of the remainder of the United States. There were small areas of low match in the Pacific Northwest, Desert Southwest, Gulf Coast, and southern Florida. The overall Climate 6 score (Sanders et al. 2023; 16 climate variables; Euclidean distance) for the contiguous United States was 0.855, indicating that Yes, there is establishment concern for this species. The Climate 6 score is calculated as: (count of target points with scores ≥ 6)/(count of all target points). Establishment concern is warranted for Climate 6 scores greater than or equal to 0.002 based on an analysis of the establishment success of 356 nonnative aquatic species introduced to the United States (USFWS 2024).

Projected climate matches in the contiguous United States under future climate scenarios are available for *Pisidium amnicum* (see Appendix). These projected climate matches are provided as additional context for the reader; future climate scenarios are not factored into the Overall Risk Assessment Category.

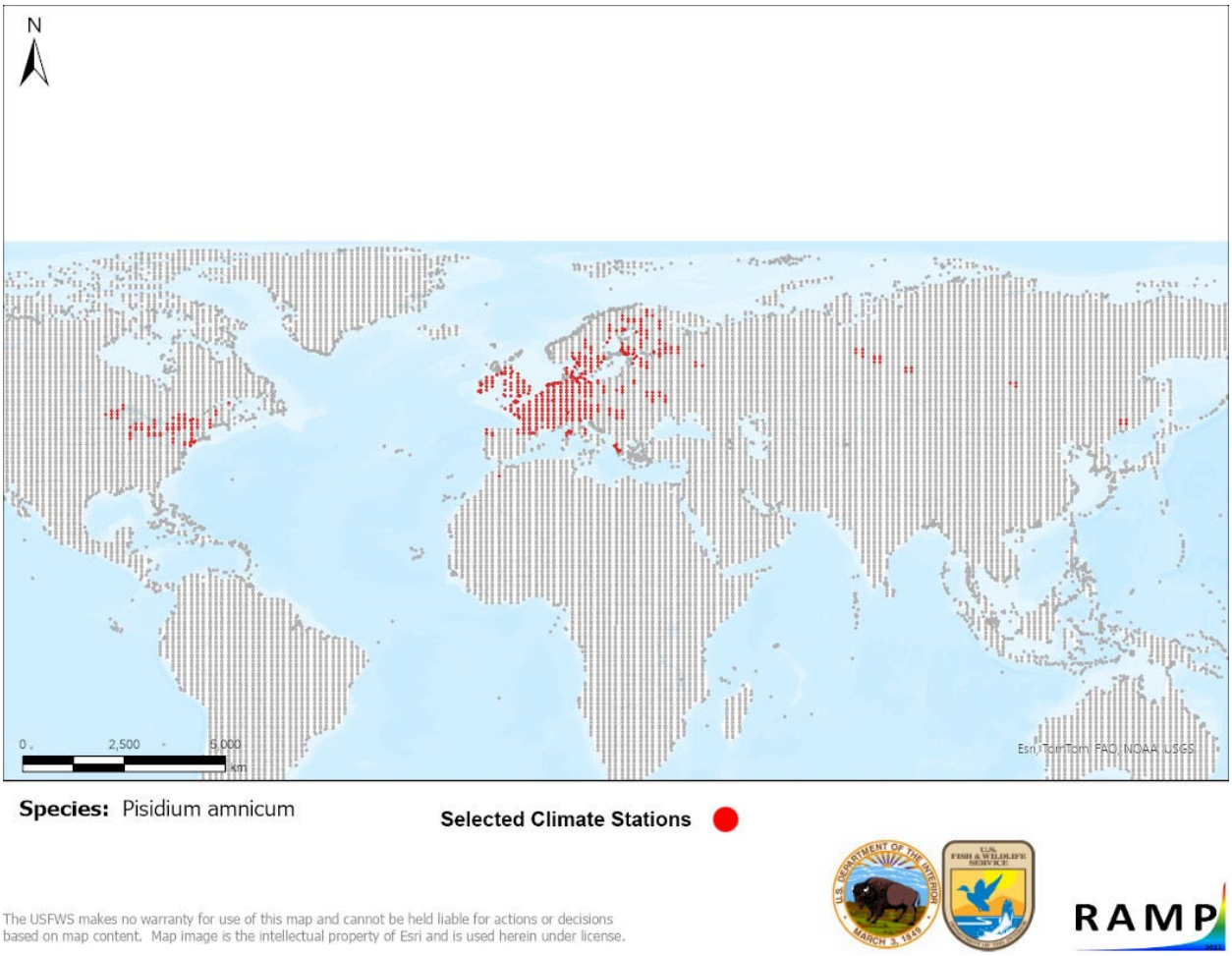

Figure 3. RAMP (Sanders et al. 2023) source map showing weather stations in Northeast United States, Western Europe, and parts of Russia and selected as source locations (red; United States, United Kingdom, Netherlands, France, Germany, Russian Federation, Morocco, Switzerland, Estonia, Ireland, Austria, and Sweden) and non-source locations (gray) for *Pisidium amnicum* climate matching. Source locations from Rassam et al. (2021) and GBIF Secretariat (2022). Selected source locations are within 100 km of one or more species occurrences, and do not necessarily represent the locations of occurrences themselves.

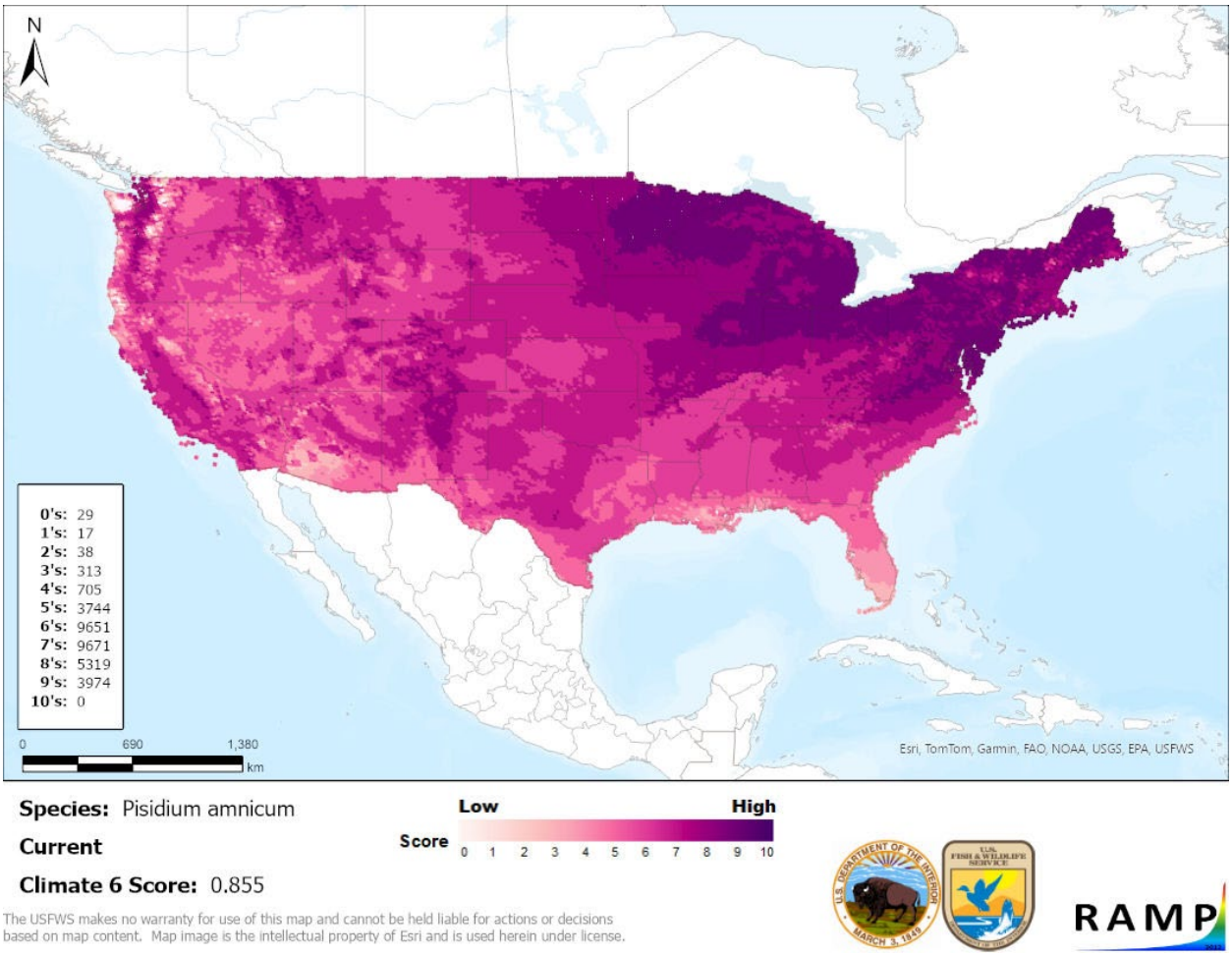

Figure 4. Map of RAMP (Sanders et al. 2023) climate matches for *Pisidium amnicum* in the contiguous United States based on source locations reported by GBIF Secretariat (2022) and Rassam et al. (2021). Counts of climate match scores are tabulated on the left. 0/Pale Pink = Lowest match, 10/Dark Purple = Highest match.

8 Certainty of Assessment

The Certainty of Assessment for *Pisidium amnicum* is classified as Low. There was information available regarding the species' biology, ecology, and distribution. The description of the species' range was general and broad; there may be sections of the native range not represented in the climate matching analysis. Information regarding introductions and establishment was available but there was no information found regarding impacts or lack of impacts.

9 Risk Assessment

Summary of Risk to the Contiguous United States

Pisidium amnicum, Greater European Peaclam, is a mollusk that is native to the Palearctic region. The native range is described as encompassing most of Europe to Siberia in Russia and northern Africa. *P. amnicum* is a small clam that prefers soft bottoms of lakes, rivers, and streams. It has been introduced to the Great Lakes, Hudson River, and St. Lawrence River in the

United States and Canada. *P. amnicum* was likely introduced to the contiguous United States through shipping in the early 1900s. Impacts from those introduced populations have not yet been documented. The History of Invasiveness for *Pisidium amnicum* is classified as Data Deficient due to the lack of clear, convincing, reliable characterizations of impacts or lack of impacts. The climate matching analysis for the contiguous United States indicates establishment concern for this species. The climate match for *Pisidium amnicum* to the contiguous United States was highest in the Midwest and Northeast, especially around the Great Lakes. The Certainty of Assessment is classified as Low due to the lack of information regarding impacts from introductions and possible gaps in the representation of the native range in the climate matching analysis. The Overall Risk Assessment Category for *Pisidium amnicum* in the contiguous United States is Uncertain.

Assessment Elements

- **History of Invasiveness (see section 4): Data Deficient**
- **Establishment Concern (see section 7): Yes**
- **Certainty of Assessment (see section 8): Low**
- **Remarks, Important additional information: No additional remarks**
- **Overall Risk Assessment Category: Uncertain**

10 Literature Cited

Note: The following references were accessed for this ERSS. References cited within quoted text but not accessed are included below in section 11.

Bouchet P. 2015. *Pisidium amnicum* (O.F. Müller, 1774). World Register of Marine Species. Available: https://www.marinespecies.org/aphia.php?p=taxdetails&id=594808 (December 2022).

GBIF Secretariat. 2022. GBIF backbone taxonomy: *Pisidium amnicum* (O.F.Müller, 1774). Copenhagen: Global Biodiversity Information Facility. Available: https://www.gbif.org/species/2286691 (December 2022).

GBIF-US. 2022. Species occurrences: *Pisidium amnicum* (O.F. Müller, 1774). Available: https://doi.org/10.15468/dl.re67hx (December 2022).

[ITIS] Integrated Taxonomic Information System. 2022. *Pisidium amnicum* (O.F. Müller, 1774). Reston, Virginia: Integrated Taxonomic Information System. Available: https://www.itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=81401#null (December 2022).

Kipp RM, Benson AJ, Larson J, Fusaro A. 2019a. *Pisidium amnicum* (Müller, 1774). Gainesville, Florida: U.S. Geological Survey, Nonindigenous Aquatic Species Database. Available: https://nas.er.usgs.gov/queries/FactSheet.aspx?SpeciesID=129 (December 2022).

Kipp RM, Benson AJ, Larson J, Fusaro A. 2019b. *Pisidium amnicum* (Müller, 1774). Gainesville, Florida: U.S. Geological Survey, Nonindigenous Aquatic Species Database, and Ann Arbor, Michigan: NOAA Great Lakes Aquatic Nonindigenous Species Information System. Available: https://nas.er.usgs.gov/queries/greatLakes/FactSheet.aspx?Species_ID=129&Potential=N&Type=0&HUCNumber=DGreatLakes (December 2022).

Mills EL, Leach JH, Carlton JT, Secor CL. 1993. Exotic species in the Great Lakes: a history of biotic crises and anthropogenic introductions. Journal of Great Lakes Research 19:1–54.

NatureServe. 2022. NatureServe Explorer: an online encyclopedia of life, version 7.1. Arlington, Virginia: NatureServe. Available: https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.120394/Pisidium_amnicum (December 2022).

Rassam H, Ghamizi M, Benaissa H, Clewing C, Albrech C. 2021. The fingernail clams (Bivalvia: Veneroida: Sphaeriidae) of Morocco: Diversity, distribution and conservation status. Biodiversity Data Journal 9:e73346

Sanders S, Castiglione C, Hoff M. 2023. Risk Assessment Mapping Program: RAMP. Version 5.0. U.S. Fish and Wildlife Service.

Simpson A, Fuller P, Faccenda K, Evenhuis N, Matsunaga J, Bowser M. 2022. United States Register of Introduced and Invasive Species. Version 2.0. Reston, Virginia: U.S. Geological Survey. Available: https://doi.org/10.5066/P9KFFTOD (December 2022).

Sousa R, Morais P, Antunes C, Guilhermino L. 2008. Factors affecting *Pisidium amnicum* (Müller, 1774; Bivalvia: Sphaeriidae) distribution in the River Minho Estuary: consequences for its conservation. Estuaries and Coasts 31:1198–1207.

[USFWS] U.S. Fish and Wildlife Service. 2024. Standard operating procedure: how to prepare an “Ecological Risk Screening Summary.” Version 3. Available: https://www.fws.gov/media/standard-operating-procedures-how-prepare-ecological-risk-screening-summary-2024 (March 2025).

World Organisation for Animal Health. 2022. Animal diseases. Paris: World Organisation for Animal Health. Available: https://www.woah.org/en/what-we-do/animal-health-and-welfare/animal-diseases/ (December 2022).

11 Literature Cited in Quoted Material

Note: The following references are cited within quoted text within this ERSS, but were not accessed for its preparation. They are included here to provide the reader with more information.

Araujo R, Ramos MA. 1999. Histological description of the gonad, reproductive cycle, and fertilization of *Pisidium amnicum* (Muller, 1774) (Bivalvia: Sphaeriidae). Veliger 42(2):124–131.

Araujo R, Ramos MA, Molinet R. 1999. Growth pattern and dynamics of a southern peripheral population of *Pisidium amnicum* (Muller, 1774) (Bivalvia: Sphaeriidae) in Spain. Malacologia 41:119–137.

Burch JB. 1975a. Freshwater Sphaeriacean clams (Mollusca: *Pelecypoda*) of North America. Hamburg, Michigan: Malaco1ogical Publications.

Clarke AH. 1981. Les Mollusques d'eau douce du Canada. Musée national des sciences naturelles, Musées nationaux du Canada. (French translation by A. La Rocque.)

Grigorovich IA, Korniushin AV, Gray DK, Duggan IC, Colautti RI, MacIsaac HJ. 2003. Lake Superior: an invasion coldspot? Hydrobiologia 499(1-3):191–210.

Heard WH. 1962. The Sphaeriidae (Mollusca: Pelecypoda) of the North American Great Lakes. American Midland Naturalist 67:194–198.

Herrington HB. 1962. A revision of the Sphaeriidae of North America (Mollusca: Pelecypoda). University of Michigan. Museum of Zoology Miscellaneous Publications.

Holopainen IJ. 1979. Population dynamics and production of *Pisidium* species (Bivalvia, Sphaeriidae) in the oligotrophic and mesohumic lake Pääjärvi, southern Finland. Archiv für Hydrobiologie 54(4):466–508.

Holopainen IJ, Lamberg S, Valtonen ET, Rantanen J. 1997. Effects of parasites on life history of the freshwater bivalve, *Pisidium amnicum*, in eastern Finland. Archiv fur Hydrobiologie 139(4):461–477.

Mackie GL. 2000. Ballast water introductions of Mollusca. Pages 219–254 in Claudi R, Leach JH, editors. Nonindigenous freshwater organisms: vectors, biology and impacts. Boca Raton, Florida: CRC Press.

Mackie GL. 2007. Biology of freshwater Corbiculid and Sphaeriid clams of North America. Volume 15, number 3. Columbus: Ohio Biological Survey Bulletin New Series.

Mackie GL, White DS, Zdeba TW. 1980. A guide to freshwater mollusks of the Laurentian Great Lakes with special emphasis on the genus *Pisidium*. Duluth, Minnesota: U. S. Environmental Protection Agency, Office of Research and Development, Environmental Research Laboratory.

Pennak R. 1989. Fresh-water invertebrates of the Unites States: Protozoa to Mollusca. 3rd edition. New York: John Wiley & Sons.

Por FD, Bromley HJ, Dimentman Ch, Herbst GN, Ortal R. 1986. River Dan, headwater of the Jordan, an aquatic oasis of the Middle East. Hydrobiologia 134:121–140.

Trebitz AS, West CW, Hoffman JC, Kelly JR, Peterson GS, Grigorovich IA. 2010. Status of non-indigenous benthic invertebrates in the Duluth-Superior Harbor and the role of sampling methods in their detection. Journal of Great Lakes Research 36:747–756.

Vincent B, Vaillancourt G, Lafontaine N. 1981. Cycle of development, growth, and production of *Pisidium amnicum* (Mollusca: Bivalvia) in the St. Lawrence River (Quebec). Canadian Journal of Zoology 59:2350–2359.

Appendix

Summary of Future Climate Matching Analysis

Future climate projections represent two Shared Socioeconomic Pathways (SSP) developed by the Intergovernmental Panel on Climate Change (IPCC 2021): SSP5, in which emissions triple by the end of the century; and SSP3, in which emissions double by the end of the century. Future climate matches were based on source locations reported by Rassam et al. (2021) and GBIF Secretariat (2022).

Under the future climate scenarios (figure A1), on average, high climate match for *Pisidium amnicum* was projected to occur in the Great Lakes and Northeast regions of the contiguous United States. Areas of low climate match were projected to occur in southern Florida. The areas of high match contracted northward from time step 2055 to time step 2085 under both SSP3 and SSP5. The Climate 6 scores for the individual future scenario models (figure A2) ranged from a low of 0.265 (model: UKESM1-0-LL, SSP5, 2085) to a high of 0.780 (model: MPI-ESM1-2-HR, SSP5, 2055). All future scenario Climate 6 scores were above the Establishment Concern threshold, indicating that Yes, there is establishment concern for this species under future scenarios. The Climate 6 score for the current climate match (0.855, figure 4) falls above the range of scores for future projections. The time step and climate scenario with the most change relative to current conditions was SSP5, 2085, the most extreme climate change scenario. Under one or more time step and climate scenarios, areas within the Southwest saw a moderate increase in the climate match relative to current conditions. No large increases were observed regardless of time step and climate scenarios. Under one or more time step and climate scenarios, areas within the Appalachian Range, Great Lakes, Gulf Coast, Mid-Atlantic, Northeast, Northern Plains, Southeast, and Southern Plains saw a large decrease in the climate match relative to current conditions. Additionally, areas within California, the Colorado Plateau, Great Basin, Northern Pacific Coast, Southern Atlantic Coast, Southern Florida, Southwest, and Western Mountains saw a moderate decrease in the climate match relative to current conditions. Additional, very small areas of large or moderate change may be visible on the maps (figure A3). The magnitude and extent of decreased climate match was greater in time step 2085 than in time step 2055 under both SSP3 and SSP5; it was also greater under SSP5 at time step 2085 than under SSP3.

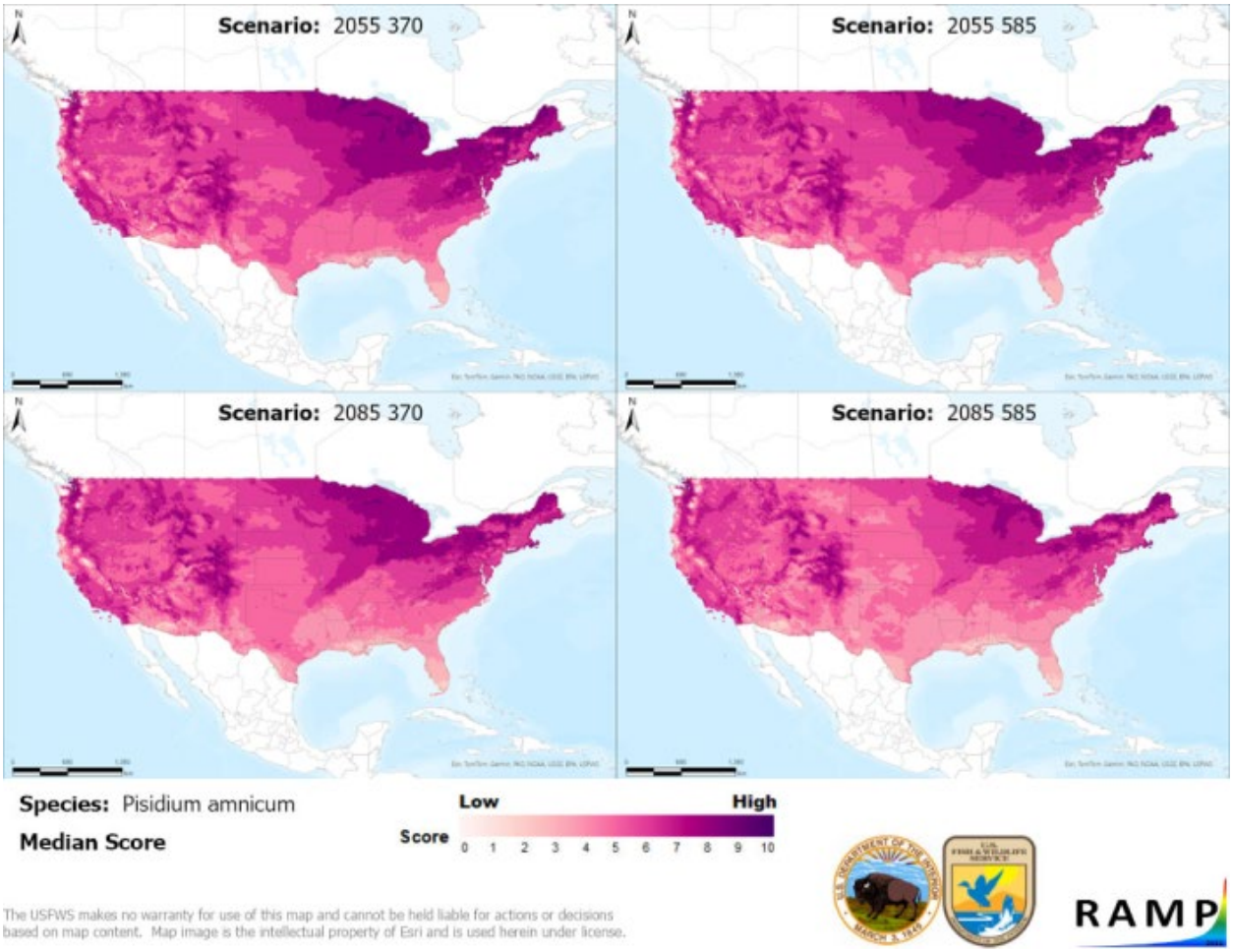

Figure A1. Maps of median RAMP (Sanders et al. 2023) climate matches projected under potential future climate conditions using five global climate models for *Pisidium amnicum* in the contiguous United States. Climate matching is based on source locations reported by Rassam et al. (2021) and GBIF Secretariat (2022). Shared Socioeconomic Pathways (SSPs) used (from left to right): SSP3, SSP5 (IPCC 2021). Time steps: 2055 (top row) and 2085 (bottom row). Climate source data from CHELSA (Karger et al. 2017, 2018); global climate models used: GFDL-ESM4, UKESM1-0-LL, MPI-ESM1-2-HR, IPSL-CM6A-LR, and MRI-ESM2-0. 0/Pale Pink = Lowest match, 10/Dark Purple = Highest match.

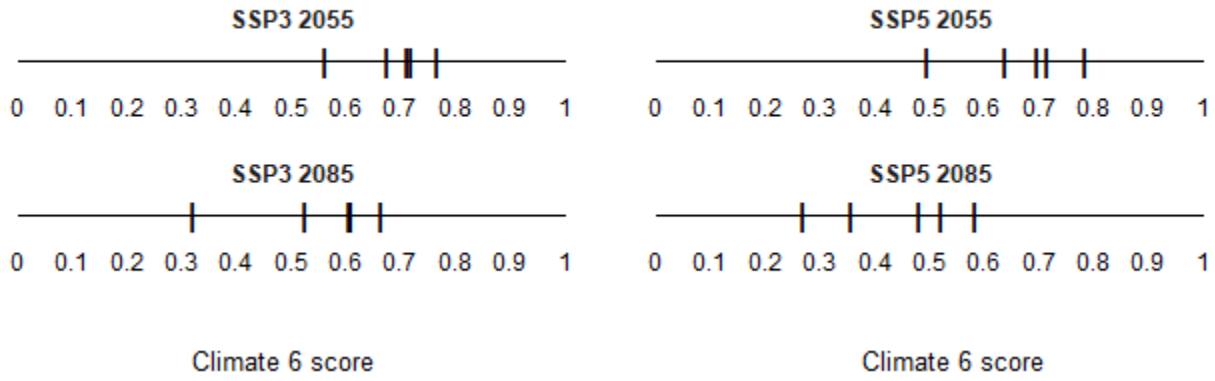

Figure A2. Comparison of projected future Climate 6 scores for *Pisidium amnicum* in the contiguous United States for each of five global climate models under four combinations of Shared Socioeconomic Pathway (SSP) and time step. SSPs used (from left to right): SSP3, SSP5 (Karger et al. 2017, 2018; IPCC 2021). Time steps: 2055 (top row) and 2085 (bottom row). Climate source data from CHELSA (Karger et al. 2017, 2018); global climate models used: GFDL-ESM4, UKESM1-0-LL, MPI-ESM1-2-HR, IPSL-CM6A-LR, and MRI-ESM2-0.

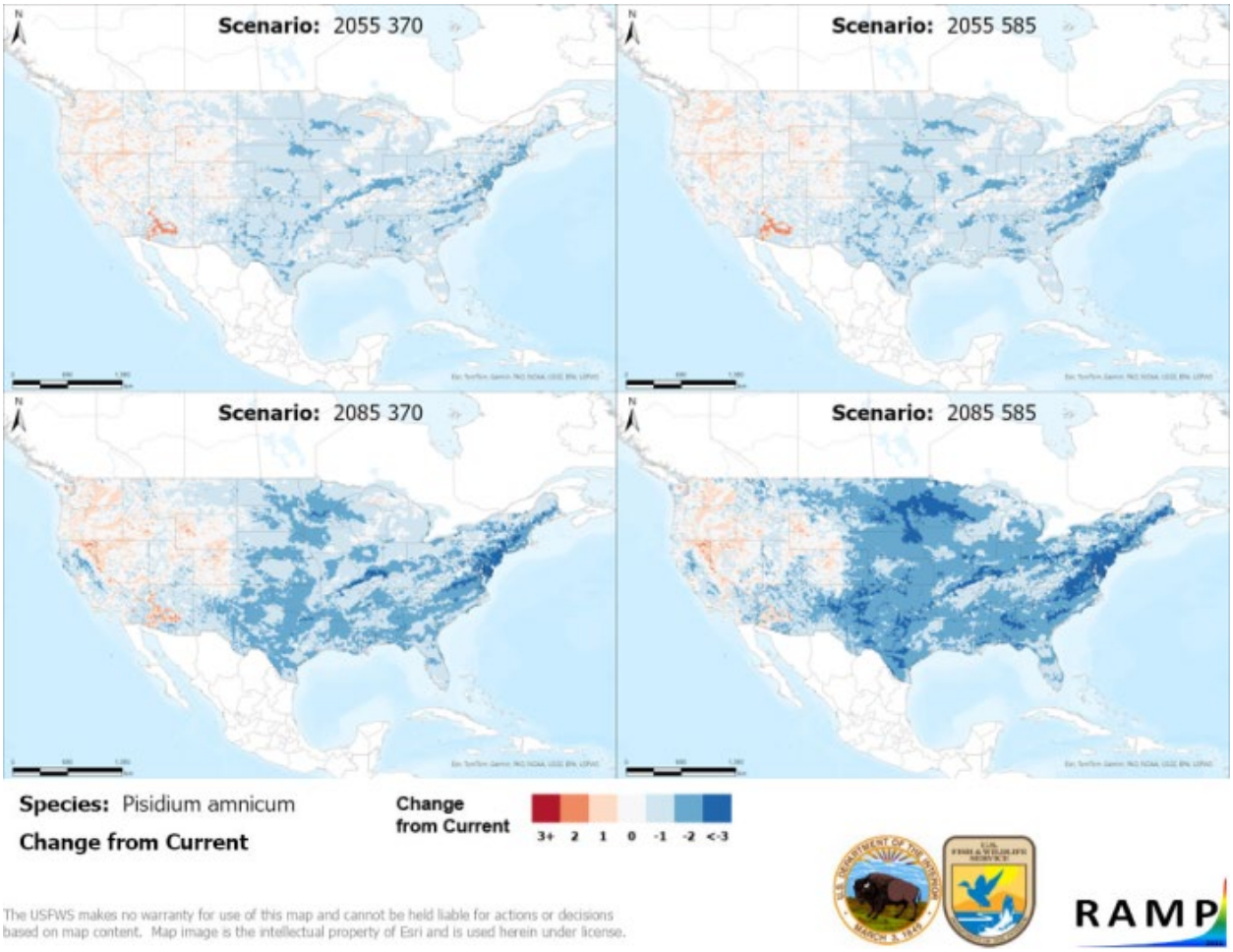

Figure A3. RAMP (Sanders et al. 2023) maps of the contiguous United States showing the difference between the current climate match target point score (figure 4) and the median target point score for future climate scenarios (figure A1) for *Pisidium amnicum* based on source locations reported by Rassam et al. (2021) and GBIF Secretariat (2022). Shared Socioeconomic Pathways (SSPs) used (from left to right): SSP3, SSP5 (IPCC 2021). Time steps: 2055 (top row) and 2085 (bottom row). Climate source data from CHELSA (Karger et al. 2017, 2018); global models used: GFDL-ESM4, UKESM1-0-LL, MPI-ESM1-2-HR, IPSL-CM6A-LR, and MRI-ESM2-0. Shades of blue indicate a lower target point score under future scenarios than under current conditions. Shades of red indicate a higher target point score under future scenarios than under current conditions. Darker shades indicate greater change.

Literature Cited

GBIF Secretariat. 2022. GBIF backbone taxonomy: *Pisidium amnicum* (O.F.Müller, 1774). Copenhagen: Global Biodiversity Information Facility. Available: https://www.gbif.org/species/2286691 (December 2022).

[IPCC] Intergovernmental Panel on Climate Change. 2021. Climate change 2021: the physical science basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press.

Karger DN, Conrad O, Böhner J, Kawohl T, Kreft H, Soria-Auza RW, Zimmermann NE, Linder P, Kessler M. 2017. Climatologies at high resolution for the Earth land surface areas. Scientific Data 4:170122.

Karger DN, Conrad O, Böhner J, Kawohl T, Kreft H, Soria-Auza RW, Zimmermann NE, Linder HP, Kessler M. 2018. Data from: Climatologies at high resolution for the earth's land surface areas. EnviDat. Available: https://doi.org/10.16904/envidat.228.v2.1.

Rassam H, Ghamizi M, Benaissa H, Clewing C, Albrech C. 2021. The fingernail clams (Bivalvia: Veneroida: Sphaeriidae) of Morocco: Diversity, distribution and conservation status. Biodiversity Data Journal 9:e73346

Sanders S, Castiglione C, Hoff M. 2023. Risk Assessment Mapping Program: RAMP. Version 5.0. U.S. Fish and Wildlife Service.