

Big Water Crayfish (*Cambarus robustus*)

Ecological Risk Screening Summary

U.S. Fish and Wildlife Service, November 2023

Revised, December 2023

Web Version, 7/24/2024

Organism Type: Crayfish

Overall Risk Assessment Category: Uncertain



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Available: <https://nas.er.usgs.gov/queries/FactSheet.aspx?speciesID=207> (December 2023).

1 Native Range and Status in the United States

Native Range

From Durland Donahou et al. (2023a):

“The range extends from the eastern Midwest of the U.S. to the Northeast, from Michigan to New York (west of the Hudson River) and south to Tennessee (Hobbs, 1989).”

From Cordeiro et al. (2010):

“This widespread species' range centres around the Great Lakes-Ohio River drainages in northeastern America (Taylor *et al.* 2005).”

“Native: Canada (Ontario [...]); United States (Connecticut, Indiana, Kentucky, Michigan, New York, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia)”

Status in the United States

According to Cordeiro et al. (2010), *Cambarus robustus* is native to the following States: Connecticut, Indiana, Kentucky, Michigan, New York, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia.

From Loughman et al. (2017):

“Currently, we consider *C. robustus* to be limited in its distribution to the Laurentian Great Lakes region, the Northern Appalachians and the northern-most portion of the Central Appalachians in Ohio, Pennsylvania, and West Virginia (Fetzner & Thoma 2014; ZJL, personal observations).”

According to Durland Donahou et al. (2023a), nonindigenous occurrences of *Cambarus robustus* have been reported in the following States, with range of years, establishment status, and hydrologic units where reported in parentheses:

- Connecticut (1953-2017; established in Saugatuck drainage, Farmington River drainage, Housatonic drainage, and Shetucket River drainage)
- Massachusetts (1978-2009; established in Farmington River drainage, Housatonic drainage, Shetucket River drainage, Westfield River drainage, Narragansett drainage, and Outlet Connecticut River drainage)
- Michigan (2015; unknown status in Thunder Bay drainage and Manistee drainage)
- New York (1978-2016; established in Lower Hudson drainage, Seneca drainage, and Hudson-Hoosic drainage)
- Vermont (2010; collected in White River drainage)

No records of *Cambarus robustus* in trade in the United States were found.

Regulations

From Durland Donahou et al. (2023b):

“There are no regulations specific to this species [in the Great Lakes region]. However, Pennsylvania restricts the sale, possession, introduction and transportation of all crayfish species; Wisconsin prohibits all non-native crayfish; and Minnesota prohibits the importation of all crayfish into the state.”

In addition to those States mentioned by Durland Donahou et al. (2023b), the following States also regulate the import, transport, or possession of all members of the crayfish family

Cambaridae: Arizona (Arizona Game and Fish Commission 2022), Florida (except *Procambarus clarkii* and *Orconectes virilis*; FFWCC 2022), Hawaii (HDOA 2019), New Mexico (except native species; NMDGF 2023), Oregon (ODFW 2022), Utah (Utah DWR 2023), and Washington (WFDW 2022).

While effort was made to find all applicable regulations, this list may not be comprehensive.

Means of Introductions within the United States

From Durland Donahou et al. (2023a):

“Probable bait release (Lodge et al. 2000)”

Remarks

This ERSS was previously published in June 2015. Revisions were completed to incorporate new information and conform to updated standards.

From Durland Donahou et al. (2023a):

“*Cambarus robustus* is a species complex. A recently published study describes three new species within this complex. More information about the species complex can be found in the study, Loughman et al. (2017). As it is unclear which species within the species complex the introduced specimens are, all introduced specimens are treated as *C. robustus*.”

“*Cambarus robustus* may be confused with *C. [bartonii] bartonii*, which has a shorter rostrum and a smaller maximum size (Massachusetts Division of Fisheries and Wildlife 2015).”

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From ITIS (2023):

Kingdom Animalia
Subkingdom Bilateria
Infrakingdom Protostomia
Superphylum Ecdysozoa
Phylum Arthropoda
Subphylum Crustacea
Class Malacostraca
Subclass Eumalacostraca
Superorder Eucarida
Order Decapoda
Suborder Pleocyemata
Infraorder Astacidea
Superfamily Astacoidea
Family Cambaridae

Genus *Cambarus*
Species *Cambarus robustus* Girard, 1852

According to DecaNet editors (2023), *Cambarus robustus* is the current valid name for this species.

Size, Weight, and Age Range

From Cordeiro et al. (2010):

“The maximum life span of this species is four years (Hamr and Berrill 1985). This species has a carapace length of 34 mm to 45 mm.”

From Durland Donahou et al. (2023a):

“**Size:** Up to 6 cm carapace length (Hamr and Berrill 1985).”

Environment

From Cordeiro et al. (2010):

“[...] can also be found in roadside ditches (Jezerinac 1991) indicating a tolerance to some level of pollution. This species has some tolerance to water acidification (Berrill *et al.* 1985) and copper pollution (Taylor *et al.* 1995).”

From Michigan State University (2023):

“[...] tolerate a wide range of water temperature and pH.”

Climate

No information was found on climate used by *Cambarus robustus*.

Distribution Outside the United States

Native

Part of the native range of *Cambarus robustus* is located within the United States. See section 1 for a full description of the native range.

From Cordeiro et al. (2010):

“Native: Canada (Ontario [...])”

Introduced

According to Cordeiro et al. (2010), *Cambarus robustus* has been introduced in Quebec, Canada. Insufficient information was found to confirm population establishment in Quebec.

From Guiaşu (2009):

“In some of my own work on the distributions of, and interactions among, the surface water *Cambarus* species of Ontario, I found that *C. robustus* may be currently expanding its range northward, into parts of central Ontario [...]”

Means of Introduction Outside the United States

From Guiaşu (2009):

“[...] in a recent report, Dubé & Desroches (2007) mentioned that it is not known if the current presence of *Cambarus robustus* in the Saint Lawrence River, within the province of Quebec, is due to a natural range expansion by this species, or to deliberate (or accidental) introductions of this crayfish by humans.”

Short Description

From Durland Donahou et al. (2023a):

“The overall body color is greenish-brown. This species possesses large, strong chelae and a long, narrow rostrum (Guarino et al. 2012; Massachusetts Division of Fisheries and Wildlife 2015). The corners of the rostrum are rounded and the chelae have two rows of bumps on the margin of the palm (Guarino et al. 2012). *C. robustus* are a large species of crayfish with carapace lengths of more than 5 cm (2 inches) (Guarino et al. 2012).”

Biology

From Durland Donahou et al. (2023a):

“*Cambarus robustus* are a large crayfish that prefer fast flowing water and rocky substrate (Guiaşu, 2002), although they may also be found in larger precambrian shield lakes (Hamr and Berrill, 1984). [...] Mating occurs in summer with the majority of females in berry by July. Males typically molt following breeding in September or early October. Males do not usually survive to spawn more than once (Hamr and Berrill, 1985). Small juvenile *C. robustus* are typically filter feeders when they become free living; adults have a broader diet consisting of vegetation, aquatic insects, and smaller crayfish (Hamr, 1998).”

From Cordeiro et al. (2010):

“Reproduction takes place in summer and the young hatch in August (Hamr and Berrill 1985). Individuals normally mature after two years, however some may not reach maturity until three years of age (Hamr and Berrill 1985).”

Human Uses

From Durland Donahou et al. (2023b):

“Big Water Crayfish can be captured for human consumption, and they are a commonly used bait species (Guiaşu, 2002). However, their overall economic contribution is small. *C. robustus*

do not have any reported recreational value. They are not used as a control agent. *C. robustus* do not have any value for medicinal or research purposes. They are not reported to remove toxins or pollutants from the water or have any other positive ecological impact.”

Diseases

No information available. **No information was found associating *Cambarus robustus* with any diseases listed by the World Organisation for Animal Health (2023).**

Threat to Humans

No information was found on threats to humans from *Cambarus robustus*.

3 Impacts of Introductions

No information available on observed impacts of introduction of *Cambarus robustus*. The following quotations describe potential impacts of introduction of *C. robustus*.

From Durland Donahou et al. (2023a):

“Unknown [impact of introduction]. However, Guiasu and Dunham (1999) found that, in its native range, *C. robustus* exhibited dominant aggressive behavior towards *Cambarus bartonii bartoni* during direct encounters.”

From Durland Donahou et al. (2023b):

“*C. robustus* are a large and aggressive species of crayfish; Dunham (1999) found in a laboratory experiment that they were dominant over size matched *Cambarus bartonii*. This may suggest that outside of its native range, *C. robustus* might outcompete native crayfish for food and habitat. *C. robustus* is an omnivorous multi-trophic feeder throughout its life, which may allow it to alter predator-prey interactions. Big Water Crayfish are not known to hybridize with any native populations. Outside of their native range have not been found to negatively affect water quality or alter the physical components of the ecosystems they inhabit. Furthermore, the Freshwater Invertebrate Invasiveness Scoring Kit (FI-ISK) ranked *C. robustus* as low risk (Tricario et al., 2010).”

C. robustus is part of a regulated category of species in several U.S. States. All non-native crayfish are regulated in Pennsylvania, Wisconsin, and Minnesota. All species or nonnative species in Family Cambaridae are regulated in the following U.S. States: Arizona, Florida, Hawaii, New Mexico, Oregon, Utah, and Washington.

4 History of Invasiveness

The History of Invasiveness for *Cambarus robustus* is classified as Data Deficient. This species has been reported as introduced and established outside of its native range. Established, nonnative populations are found in Ontario, Connecticut, Massachusetts, and New York. Introductions have also been reported in Michigan, Vermont, and Quebec. Behavioral observations from a laboratory setting indicate potential negative impacts on native crayfish

where *C. robustus* is introduced. However, none of the available information meets the standard of clear, convincing, and reliable documentation of negative impacts of introduction required for a determination of High History of Invasiveness.

5 Global Distribution



Figure 1. Reported global distribution of *Cambarus robustus*. Map from GBIF Secretariat (2023). Occurrences are reported throughout the Great Lakes Basin, Ohio River Basin, and Mid-Atlantic region. The reported occurrence in Asia is a coordinate error and was not used to select source points for the climate matching analysis. Reported occurrences in southwest Tennessee, Kansas, New Jersey, eastern Virginia, and central Quebec do not represent confirmed established populations and were also excluded from the climate matching analysis.

6 Distribution Within the United States

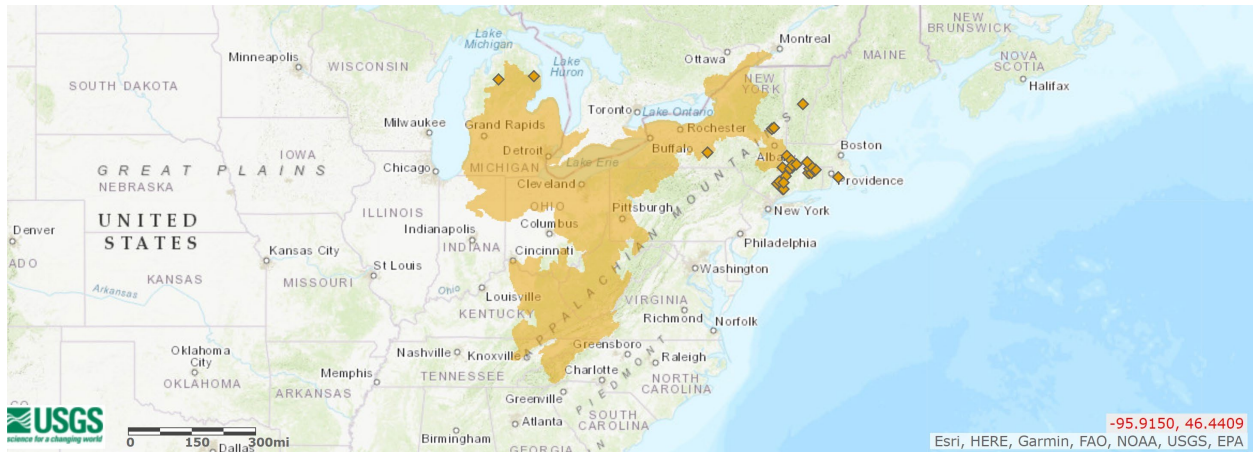


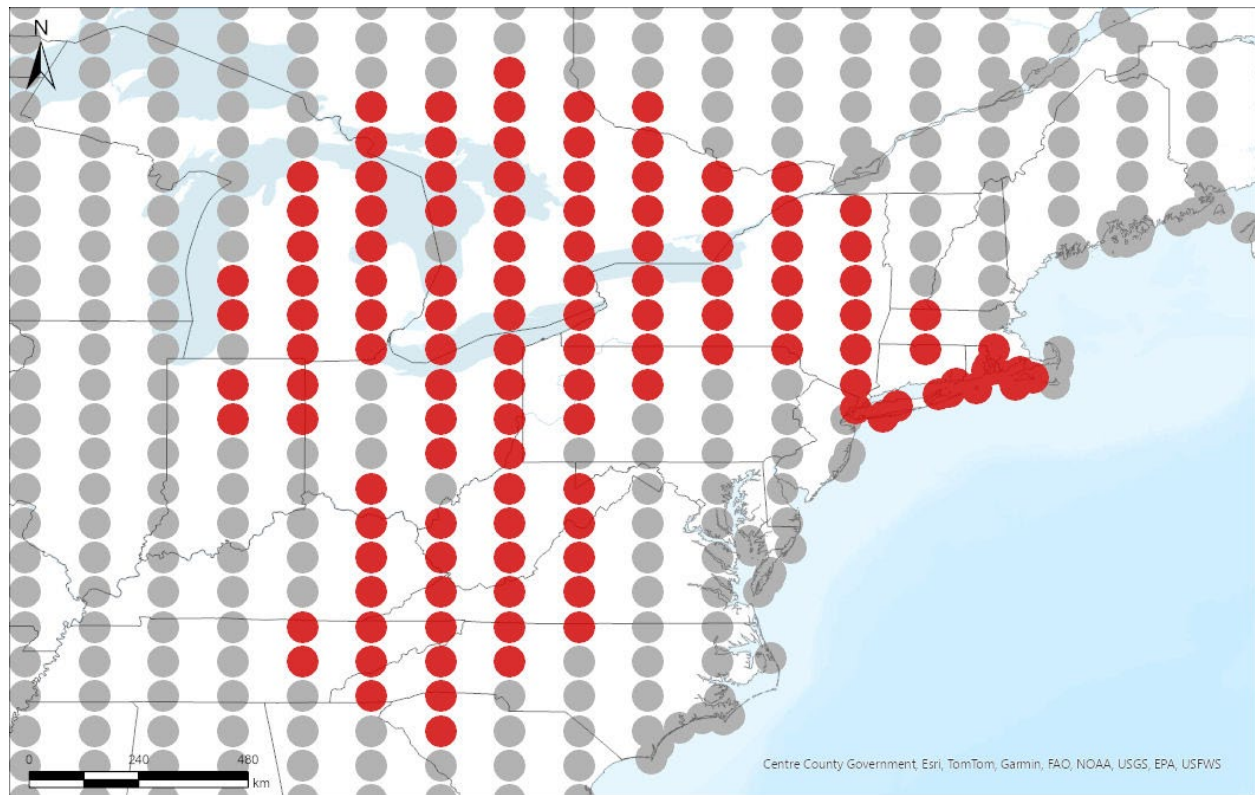
Figure 2. Reported distribution of *Cambarus robustus* in the United States. Map from Durland Donahou et al. (2023a). Orange shading indicates the native range of *C. robustus* while orange points represent reported nonnative occurrences. Reported occurrences in Michigan and Vermont were excluded from the climate matching analysis due to uncertainty over population establishment in those States.

7 Climate Matching

Summary of Climate Matching Analysis

The climate match for *Cambarus robustus* is high in its native range within the Great Lakes Basin, Ohio River Basin, and the Mid-Atlantic region of the United States. However, high climate match also extended outside the native range toward the Midwest, southern United States, and further northeast into Maine. A high climate match was also found in small, scattered areas of the Rocky Mountains. Medium match was found in the Great Plains, Rocky Mountains, and along the Gulf Coast, while low match found along the Pacific Coast, in much of the Great Basin, along the U.S.-Mexico border, and in southern Florida. The overall Climate 6 score (Sanders et al. 2023; 16 climate variables; Euclidean distance) for the contiguous United States was 0.601, indicating that Yes, there is establishment concern for this species outside its native range. 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 *Cambarus robustus* (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.



Species: *Cambarus robustus*

Selected Climate Stations ●



RAMP

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Figure 3. RAMP (Sanders et al. 2023) source map showing weather stations in northeastern North America selected as source locations (red; United States, Canada) and non-source locations (gray) for *Cambarus robustus* climate matching. Source locations from GBIF Secretariat (2023). Selected source locations are within 100 km of one or more species occurrences, and do not necessarily represent the locations of occurrences themselves.

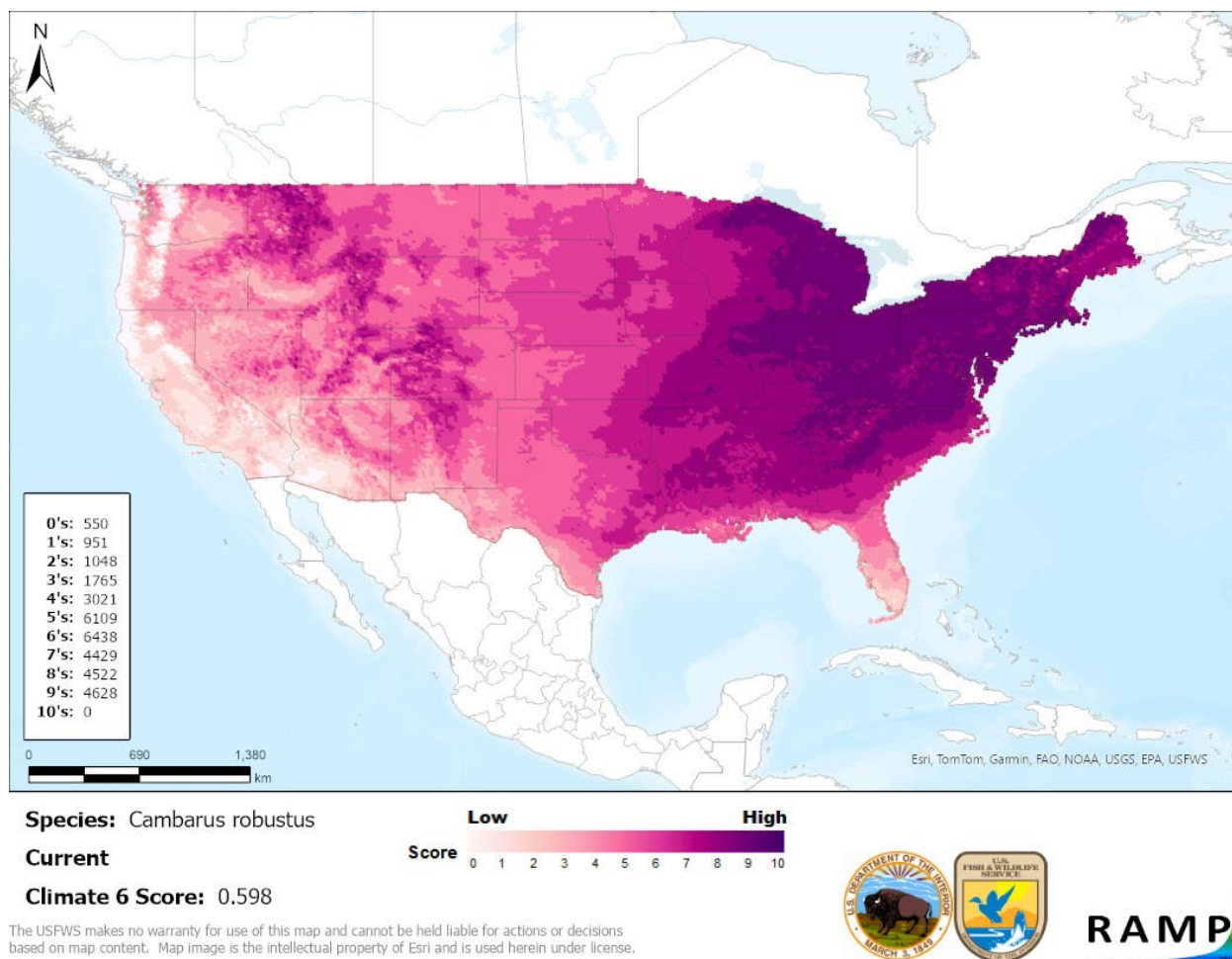


Figure 4. Map of RAMP (Sanders et al. 2023) climate matches for *Cambarus robustus* in the contiguous United States based on source locations reported by GBIF Secretariat (2023). Counts of climate match scores are tabulated on the left. 0/Pale Pink = Lowest match, 10/Dark Purple = Highest match.

8 Certainty of Assessment

There is high-quality information available about the biology and ecology of *Cambarus robustus*. Records of nonnative introductions and established populations were found, but direct studies of impacts of these introductions have not been conducted. Furthermore, the species as historically described is now recognized to be a species complex, and it is unknown to which species within this complex the introduced populations belong. Therefore, the Certainty of Assessment for *Cambarus robustus* is classified as Low.

9 Risk Assessment

Summary of Risk to the Contiguous United States

Cambarus robustus, Big Water Crayfish, is a large crayfish that is native to the Great Lakes and Ohio River drainages in the northeastern and midwestern United States. Introductions have been reported in Ontario, Quebec, Vermont, Connecticut, Michigan, Massachusetts, and New York.

There was no information found regarding this species in trade, although bait release is suspected as a pathway for nonnative introductions. No research has been conducted on the impacts of *Cambarus robustus* where introduced, therefore, the History of Invasiveness is Data Deficient. The climate matching analysis for the contiguous United States indicates establishment concern for this species outside its native range. The climate match was predicted to be high in regions adjoining the native range as well as in scattered areas of the Rocky Mountains. The Certainty of Assessment for this ERSS is Low due to an insufficient amount of information regarding the impacts of introductions and uncertainty about the taxonomic identification of introduced populations. The Overall Risk Assessment Category for *Cambarus robustus* 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: None**
- **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.

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11 Literature Cited in Quoted Material

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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 GBIF Secretariat (2023).

Under the future climate scenarios (figure A1), on average, high climate match for *Cambarus robustus* was projected to occur in the Appalachian Range, Great Lakes, Mid-Atlantic, and Northeast regions of the contiguous United States. Areas of low climate match were projected to occur in California, the Northern Pacific Coast, Southern Florida, and Southwest regions. Areas of high match contracted and shifted northward with increasing time and from SSP3 to SSP5. The Climate 6 scores for the individual future scenario models (figure A2) ranged from a low of 0.203 (model: UKESM1-0-LL, SSP5, 2085) to a high of 0.535 (model: GFDL-ESM4, 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 (0.598, 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 all time step and climate scenarios only minor or no increases in the climate match were observed, relative to the current match. Of all the regions of the contiguous United States, only the climate match to the Colorado Plateau appeared to increase, even minorly, across all future climate scenarios. At the 2085 time step, areas within the Appalachian Range, Gulf Coast, and Southeast saw a large decrease in the climate match relative to current conditions. Additionally, areas within California, the Colorado Plateau, Great Basin, Great Lakes, Mid-Atlantic, Northeast, Northern Plains, Southern Atlantic Coast, Southern Plains, Southwest, and Western Mountains saw a moderate decrease in the climate match relative to current conditions, particularly under scenario SSP5, 2085. Additional, very small areas of large or moderate change may be visible on the maps (figure A3).

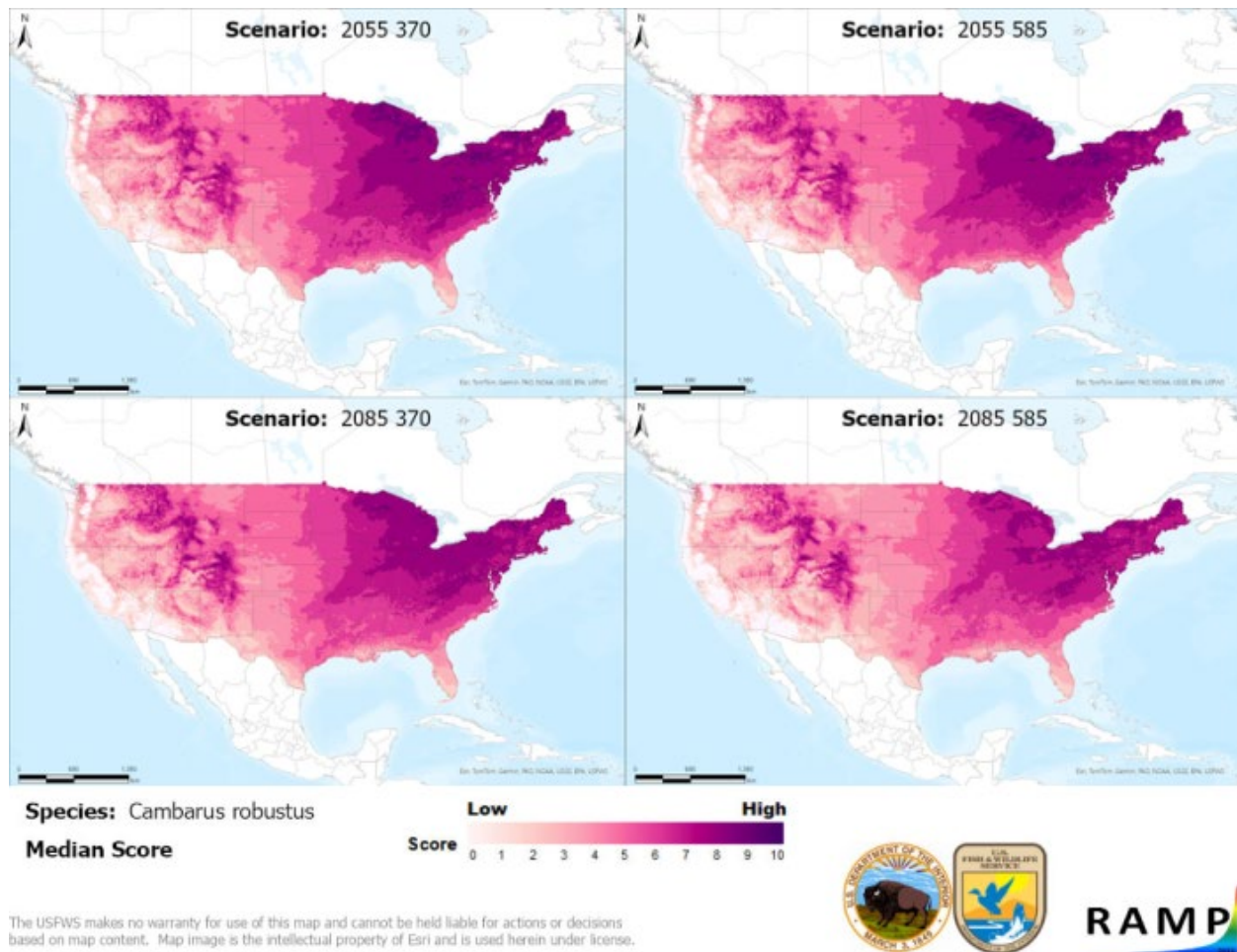


Figure A1. Maps of median RAMP (Sanders et al. 2023) climate matches projected under potential future climate conditions using five global climate models for *Cambarus robustus* in the contiguous United States. Climate matching is based on source locations reported by GBIF Secretariat (2023). Shared 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.

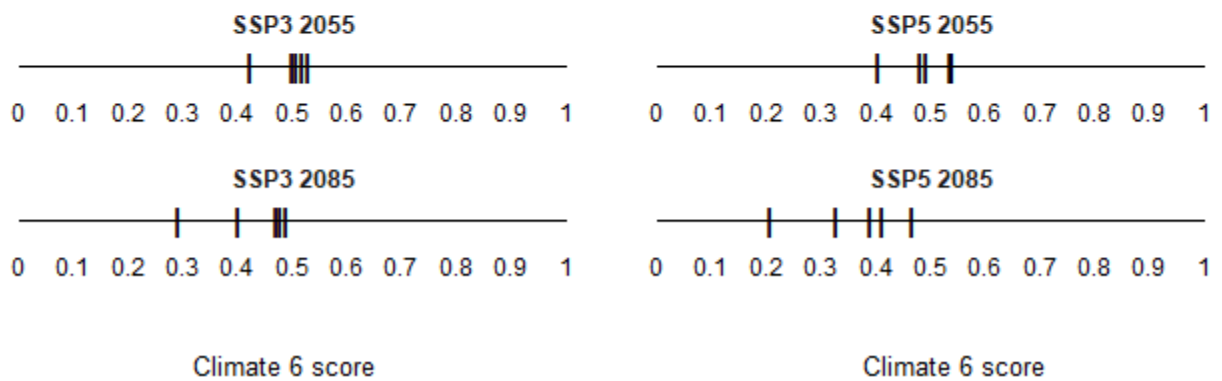


Figure A2. Comparison of projected future Climate 6 scores for *Cambarus robustus* in the contiguous United States for each of five global climate models under four combinations of Shared Socioeconomic Pathway (SSP) and time step. SSPs used (from left to right): SSP3, SSP5 (Karger et al. 2017, 2018; 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.

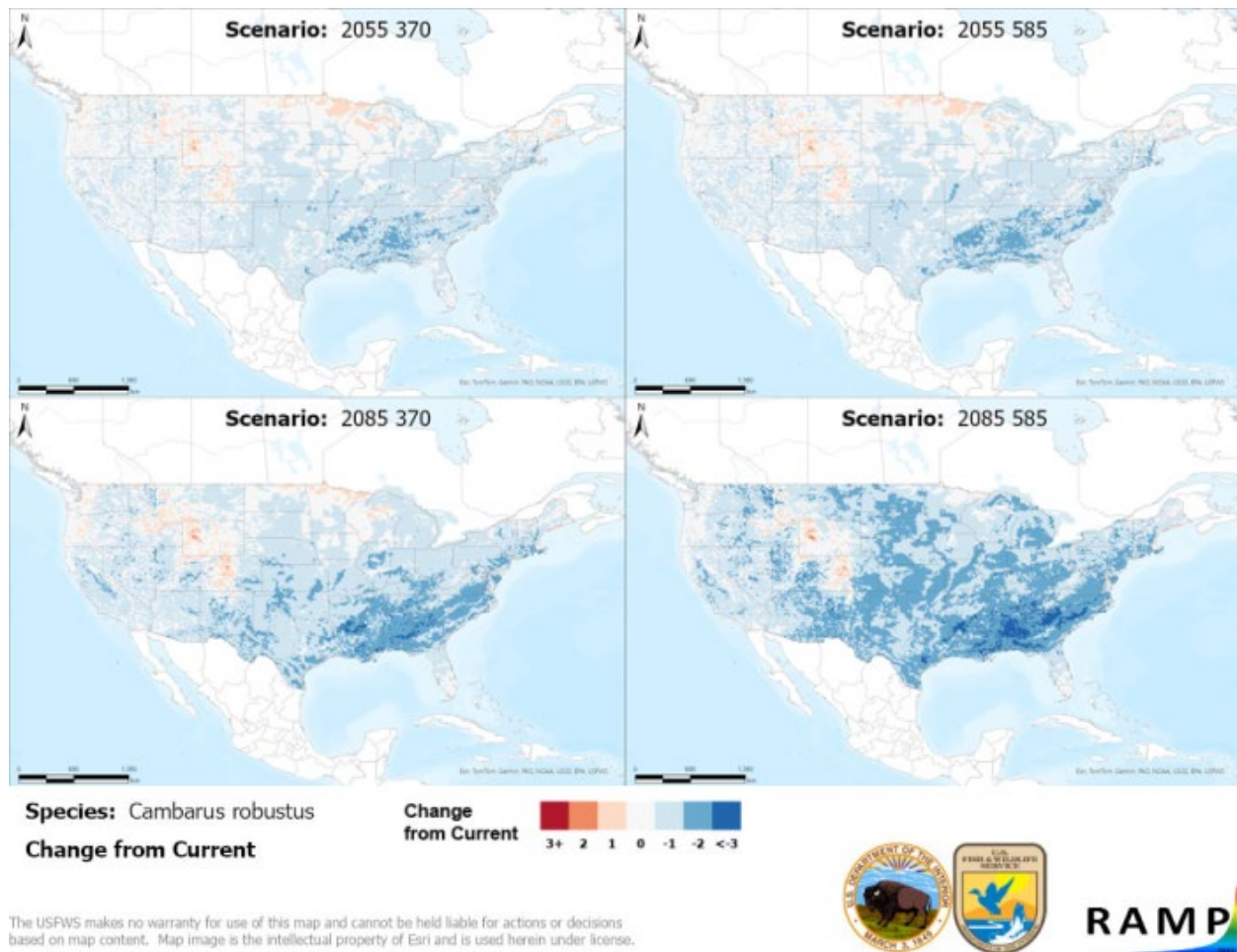


Figure A3. RAMP (Sanders et al. 2023) maps of the contiguous United States showing the difference between the current climate match target point score (figure 4) and the median target point score for future climate scenarios (figure A1) for *Cambarus robustus* based on source locations reported by GBIF Secretariat (2023). 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.

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