Bluespotted Sunfish (*Enneacanthus gloriosus*)
Ecological Risk Screening Summary

U.S. Fish & Wildlife Service, January 2023
Revised, March 2023
Web Version, 3/4/2025

Organism Type: Fish
Overall Risk Assessment Category: Uncertain

Photo: pmk00001. Licensed under Creative Commons BY-NC 4.0 International. Available: https://inaturalist-open-data.s3.amazonaws.com/photos/53266762/original.jpg (January 2023).

1 Native Range and Status in the United States

Native Range
From NatureServe (2023):

"The native range includes coastal lowlands (Coastal Plain and lower and middle Piedmont) from extreme southern New York (lower Hudson River drainage) south to southern and extreme western Florida, lower Tombigbee River (Alabama), and Biloxi Bay system of Mississippi (Lee et al. 1980, Jenkins and Burkhead 1994, Ross 2001)."

According to Fuller et al. (2023a), *Enneacanthus gloriosus* is native to the following States: Alabama, Delaware, Florida, Georgia, Louisiana, Maryland, Mississippi, New Jersey, New York, North Carolina, Pennsylvania, South Carolina, and Virginia.

Status in the United States

From NatureServe (2023):

"The native range includes coastal lowlands (Coastal Plain and lower and middle Piedmont) from extreme southern New York (lower Hudson River drainage) south to southern and extreme western Florida, lower Tombigbee River (Alabama), and Biloxi Bay system of Mississippi (Lee et al. 1980, Jenkins and Burkhead 1994, Ross 2001). Introduced and established in small parts of the Finger Lakes drainage in New York (Werner, Copeia 1972:878–879; Smith 1985) and in the lower Mississippi River basin in Mississippi (Ross 2001)."

According to Fuller et al. (2023a), nonindigenous occurrences of *Enneacanthus gloriosus* have been reported in the following States. Range of observation years, number of watersheds (8-digit hydrologic unit), and population status where reported (one or more watersheds) are given in parentheses.

- Maryland (1977; 1; Unknown)
- Mississippi (1987-1991; 1; Established)
- New York (1916-1986; 2; Established)
- Pennsylvania (1970-1994; 2; Established)

From Fuller et al. (2023b):

"This species has been introduced into the Big Black River drainage in Mississippi (Peterson and Ross 1987; Ross and Brenneman 1991); discovered in the Jamesville Reservoir, south of Syracuse, New York, in 1971 (Werner 1972; Lee et al. 1980 et seq.; Smith 1985), collections also were made in 1916 from Oneida Lake, just north of Syracuse (Smith 1985) and may represent an early introduction or a relict population [extirpated]. It has been introduced to the Susquehanna River in Pennsylvania, where it has been collected from Mountain Creek in Cumberland County, Stony Creek in Dauphin County, Lake Winola in Wyoming County, and Harvey's Lake in Luzerne County (Denoncourt et al. 1975), and Bald Eagle Lake (Cooper 1983)."

"The origin of the Pennsylvania fish is unknown. They may be either natural populations or accidental introductions."

Individuals of *Enneacanthus gloriosus* were found for sale in the United States (e.g., Jonah's Aquarium 2023; Live Aquaponics 2023; Wild Fish Tanks 2023; Zimmerman's Fish 2023).

Regulations

Enneacanthus gloriosus is regulated in Hawaii (HDOA 2019) and New Jersey (NJFW 2022). It is regulated at the genus (*Enneacanthus*) or family (Centrarchidae) level in Arizona (Arizona

Game and Fish Commission 2022), New Mexico (NMDGF 2010), and New Hampshire (NHFG 2022). Please refer back to state agency regulatory documents for details on the regulations, including restrictions on activities involving this species. While effort was made to find all applicable regulations, this list may not be comprehensive. Notably, it does not include regulations that do not explicitly name this species or its genus or family, for example, when omitted from a list of authorized species with blanket regulation for all unnamed species.

Means of Introductions within the United States

From Fuller et al. (2023a):

"The presence of this species in the Jamesville Reservoir is probably due to an aquarium release sometime between 1951 and 1966 (Werner 1972). However, it is theoretically possible that the species migrated up from the Hudson River, through the Erie or Barge Canal, to Oneida Lake, then up the Chittenango River and Butternut Creek into Jamesville Reservoir. Although Werner (1972) states that no specimens have ever been collected in the intervening area, there is a collection from Oneida Lake dating back to 1916; the only other collection in the Great Lakes basin (Smith 1985). These fish may either represent a relict population or an introduction earlier than what was calculated in Jamesville Reservoir (Smith 1985). One factor against the canal migration hypothesis is that there is a 2–3 m-high weir with which a fish moving upstream from Oneida Lake to Jamesville Reservoir would have to contend (Werner 1972). Jamesville Reservoir was created in 1874, the same year the Erie Canal opened (Werner 1972). […] Because this species is sometimes kept as an aquarium species, aquarium release is a possible means of introductions in Pennsylvania (Denoncourt et al. 1975). Unknown means of introduction for the Big Black River drainage, Mississippi."

Remarks

No additional remarks.

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From ITIS (2023):

Kingdom Animalia
  Subkingdom Bilateria
    Infrakingdom Deuterostomia
      Phylum Chordata
        Subphylum Vertebrata
          Infraphylum Gnathostomata
            Superclass Actinopterygii
              Class Teleostei
                Superorder Acanthopterygii
                  Order Perciformes
                    Suborder Percoidei
                      Family Centrarchidae

Genus *Enneacanthus*
Species *Enneacanthus gloriosus* (Holbrook, 1855)

According to Fricke et al. (2023), *Enneacanthus gloriosus* is the current valid name for this species.

Size, Weight, and Age Range

From Froese and Pauly (2022):

"Max length : 9.5 cm TL [total length] male/unsexed; [Page and Burr, 1991]; common length : 6.9 cm TL male/unsexed; [Hugg and Hugg, 1996]"

From Fuller et al. (2023a):

"Maximum body size […] 85 mm TL in New England, 77 mm TL in Georgia and Florida, and 58.4mm in Mississippi (Snyder 1999)."

From Warren (2009):

"Typically reach 19 to 34 mm TL at age 1. Large individuals measure 52 to 63 mm TL (maximum 99mm TL) and at least in northern populations reach age 5+ (Breder and Redmond 1929; Fox 1969; Werner 1972; Snyder and Peterson 1999). In southern populations, individuals rarely live to age 4+ (Fox 1969, Snyder and Peterson 1999)."

Environment

From NatureServe (2023):

"This species is common over sand or mud in pools and backwaters of heavily vegetated sluggish creeks and medium-sized rivers, and similar situations in ponds, lakes, and small impoundments (Lee et al. 1980, Jenkins and Burkhead 1994); in some areas it inhabits moderate-gradient headwaters with pools and runs and cover consisting of submerged plants or tree roots (Jenkins and Burkhead 1994). Habitat includes slightly brackish waters along the coast, but this fish is more numerous tidal and nontidal freshwater habitats."

From Froese and Pauly (2022):

"Freshwater; demersal; pH range: 7.0 – 7.5; dH range: 8 – 12. […] 10°C - 22°C [Riehl and Baensch 1991; assumed to be aquarium temperature]; […]"

Climate

From Froese and Pauly (2022):

"Temperate; […] 42°N - 25°N"

Distribution Outside the United States

Native

The native range of *Enneacanthus gloriosus* is entirely within the United States, see Native Range in section 1.

Introduced

According to Fuller et al. (2023a) and Cudmore-Vokey and Crossman (2000), one record was found of *Enneacanthus gloriosus* on the Canadian side of Lake Ontario but the population status for this record is listed as "extirpated."

Means of Introduction Outside the United States

No information was found regarding means of introduction for *Enneacanthus gloriosus* in the wild outside of the United States.

Short Description

From Fuller et al. (2023a):

"[…] has a single dorsal fin, spines present in the dorsal and anal fins, three anal spines, a rounded caudal fin, a dark, vertical bar below each eye, middle and rear dorsal spines of approximately equal length, 18 or less scale rows around caudal peduncle, light spots on sides (blue to white in life), and vertical bars that are generally lacking, but if present, indistinct and numbering five or less."

Biology

From NatureServe (2022):

"A few studies indicate that microcrustaceans and midge larvae are important foods, with various other invertebrates sometimes also eaten (Cooper 1983)."

"Multiple batch spawner (Snyder and Peterson 1999). Spawning season extended from at least July to early September in New Jersey, May-June in Potomac River in Virginia, April-September in Mississippi (Snyder and Peterson 1999); gravid females April-October in Florida."

"Eggs are laid on the bottom or among plants in a solitary nest made by the male in a small territory (Cooper 1983)."

From Fuller et al. (2023a):

"*Enneacanthus gloriosus* is an opportunistic forager in areas with submerged aquatic vegetation and exhibits no seasonal pattern of prey consumption (Snyder and Peterson 1999). Bluespotted sunfish is planktivorous, feeding primarily on cyclopoid copepods, cladocerans, chironomid larvae, and ostracods, or similar invertebrate assemblages throughout their range (Snyder and Peterson 1999). […] Snyder (1999) also found that bluespotted sunfish in Florida and Mississippi spawned during their first year of life at <30 mm TL, whereas specimens from New

England were found to spawn in their second year between 40 and 50 mm. These fish have been found to adopt a crepuscular feeding pattern in both laboratory and field observations (Casterlin and Reynolds 1980)."

Human Uses

From Warren (2009):

"The bluespotted sunfish […] has attracted the attention of aquarists. A perusal of Internet sites indicates that the species is regarded as an adaptable aquarium fish […]. The species is actively sold and traded by enthusiast and retailers."

Diseases

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

According to Poelen et al. (2014), *Enneacanthus gloriosus* hosts the following parasites: *Gyrodactylus* sp., *Gyrodactylus caroleae*, *Neoechinorhynchus cylindratus*, *Phyllodistomum pearsei*, *Urocleidus adsimulatus*, *U. anchorae*, and *U. carolinensis*.

Threat to Humans

From Froese and Pauly (2022):

"Harmless"

3 Impacts of Introductions

Although *Enneacanthus gloriosus* has been reported as introduced beyond its native range, no information was found regarding any impacts from those introductions.

The importation, possession, and/or trade of *Enneacanthus gloriosus* is regulated in the following States (see section 1): Arizona (Arizona Game and Fish Commission 2022), Hawaii (Hawaii Department of Agriculture 2019), New Hampshire (New Hampshire Fish and Game Department 2022), New Jersey (New Jersey Division of Fish and Wildlife 2022), and New Mexico (New Mexico Department of Game and Fish 2010).

4 History of Invasiveness

The History of Invasiveness for *Enneacanthus gloriosus* is classified as Data Deficient. Although established nonnative populations of *E. gloriosus* have been found outside of its native ranges, there was no information found regarding impacts of introduction. *E. gloriosus* also appears to be available from retail vendors in the United States. However, there were no records found quantifying the duration or number of individuals in trade.
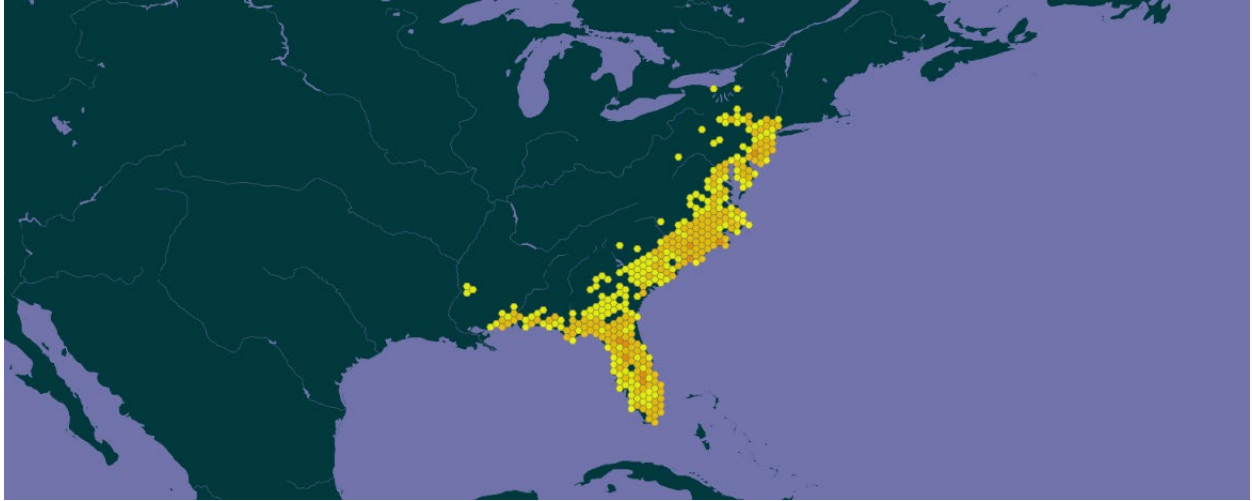
5 Global Distribution

Figure 1. Known global distribution of *Enneacanthus gloriosus*. Observations are reported from the United States. Map from GBIF Secretariat (2023). Points in Lake Ontario and Oneida Lake in New York were excluded as they were not found to represent established populations.

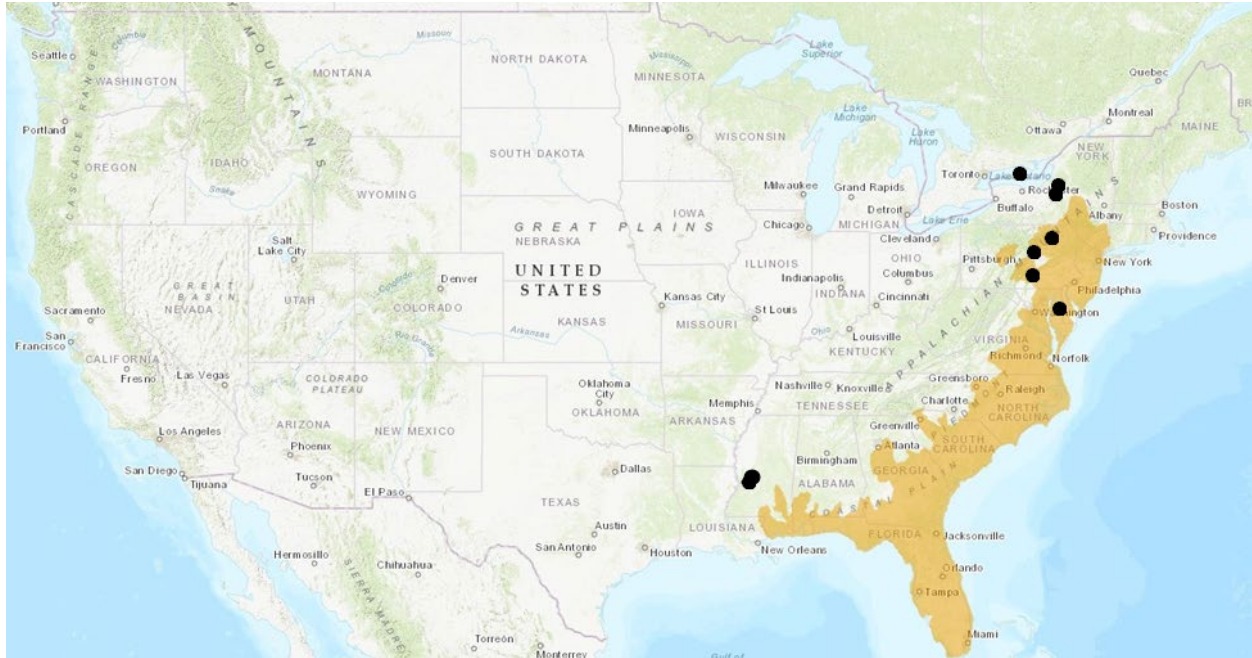# 6 Distribution Within the United States

Figure 2. Reported distribution of *Enneacanthus gloriosus* in the United States. Map adapted from Fuller et al. (2023a). Native range for *E. gloriosus* is indicated by the orange shading. Nonnative observations are represented by the black circles. Points in Lake Ontario and Oneida Lake in New York are not indicative of established populations and were excluded from the climate matching analysis.

7 Climate Matching

Summary of Climate Matching Analysis

The climate match for *Enneacanthus gloriosus* in the contiguous United States was generally high from the Atlantic Coast, where the species is native, to the eastern Great Plains. Medium matches were found in the Rocky Mountains region and parts of the Southwest. Areas of low match were found in the coastal Pacific Northwest and Pacific Southwest. The overall Climate 6 score (Sanders et al. 2023; 16 climate variables; Euclidean distance) for the contiguous United States was 0.487, 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 $\geq$ 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 *Enneacanthus gloriosus* (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.
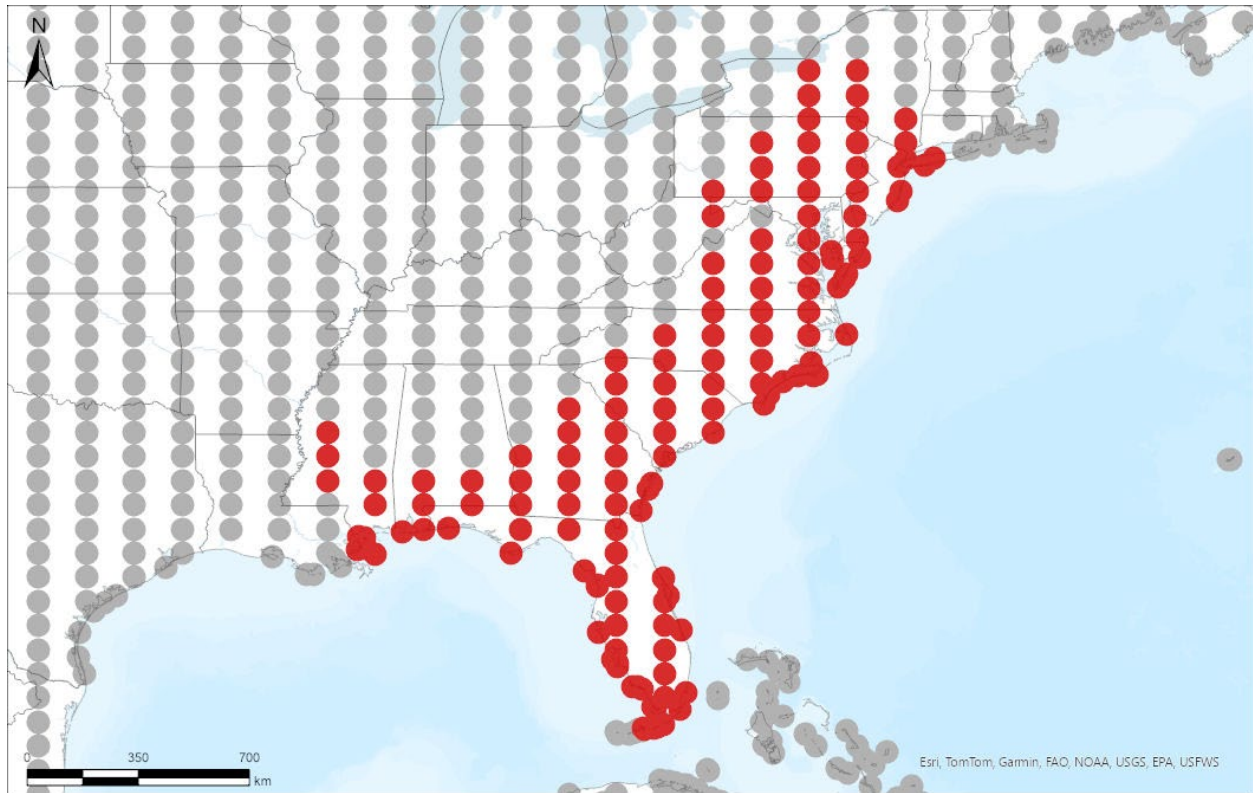
Figure 3. RAMP (Sanders et al. 2023) source map showing weather stations in the United States selected as source locations (red; Florida, Georgia, Mississippi, Alabama, Louisiana, North Carolina, South Carolina, Virginia, West Virginia, Pennsylvania, Maryland, Delaware, New Jersey, New York) and non-source locations (gray) for *Enneacanthus gloriosus* 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.
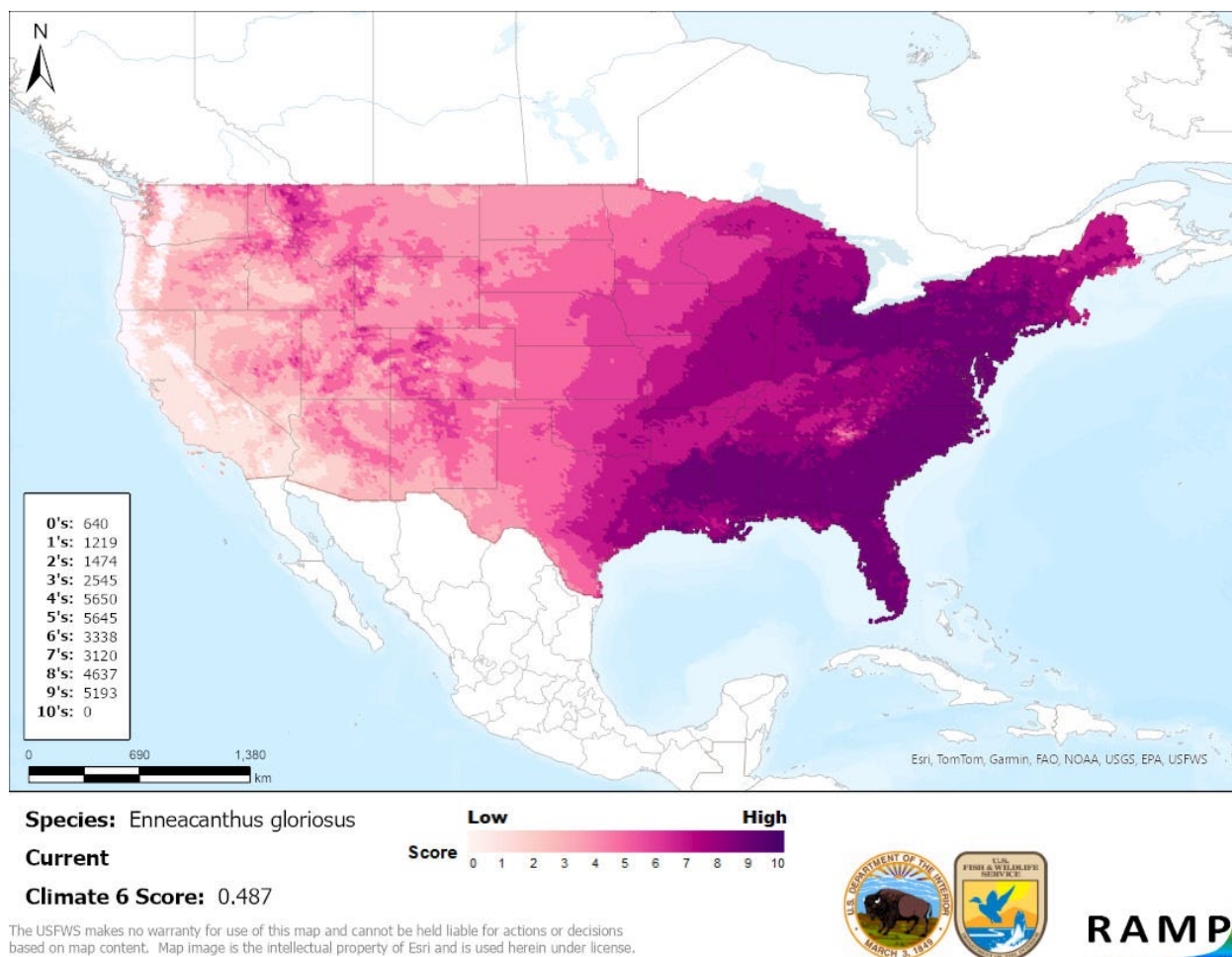
Figure 4. Map of RAMP (Sanders et al. 2023) climate matches for *Enneacanthus gloriosus* in the contiguous United States based on source locations reported by GBIF Secretariat (2023). Counts of climate match scores are tabulated on the left. 0/Pale Pink = Lowest match, 10/Dark Purple = Highest match.

8 Certainty of Assessment

The Certainty of Assessment for *Enneacanthus gloriosus* is classified as Low. Information is available on the biology, ecology, and distribution of *E. gloriosus*. However, no information is available on impacts of introduction, and minimal information is available on the use of *E. gloriosus* in trade.

9 Risk Assessment

Summary of Risk to the Contiguous United States

Enneacanthus gloriosus, the Bluespotted Sunfish, is a freshwater fish that is native to the eastern and southeastern coastal regions of the contiguous United States. *E. gloriosus* is relatively small compared to other species of sunfish and commonly found in slow-moving creeks and rivers with sandy-muddy bottoms as well as vegetated lakes and ponds. They are not often targeted by anglers but are of interest to aquarium hobbyists. *E. gloriosus* has been introduced outside of its

native range in parts of the Finger Lakes in New York and the lower Mississippi River basin. Arizona, Hawaii, New Hampshire, New Jersey, and New Mexico regulate this species at the species, genus, or family level. The History of Invasiveness for *E. gloriosus* is classified as Data Deficient due to a lack of information regarding impacts of introduction. The climate matching analysis for the contiguous United States indicates establishment concern for this species outside its native range. Areas of high match were found from the Atlantic Coast to the Great Plains. The Certainty of Assessment for this ERSS is classified as Low due to lack of information regarding impacts of introduction and trade. The Overall Risk Assessment Category for *Enneacanthus gloriosus* 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.

Arizona Game and Fish Commission. 2022. Restricted live wildlife. Arizona Administrative Code R12-4-406.

Cudmore-Vokey B, Crossman EJ. 2000. Checklists of the fish fauna of the Laurentian Great Lakes and their connecting channels. Burlington, Ontario: Fisheries and Oceans Canada. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2550.

Fricke R, Eschmeyer WN, van der Laan R, editors. 2023. Eschmeyer's catalog of fishes: genera, species, references. California Academy of Science. Available: https://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp (January 2023).

Froese R, Pauly D, editors. 2022. *Enneacanthus gloriosus* (Holbrook, 1855). FishBase. Available: https://www.fishbase.us/summary/SpeciesSummary.php?ID=3368&AT=bluespotted+sun fish (January 2023).

Fuller P, Jacobs G, Cannister M, Larson J, Makled TH, Fusaro A. 2023a. *Enneacanthus gloriosus* (Holbrook, 1855). Gainesville, Florida: U.S. Geological Survey, Nonindigenous Aquatic Species Database. Available: https://nas.er.usgs.gov/queries/FactSheet.aspx?SpeciesID=377 (January 2023).

Fuller P, Jacobs G, Cannister M, Larson J, Makled TH, Fusaro A. 2023b. Enneacanthus gloriosus Holbrook, 1855). 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=377&Potential=N &Type=0 (January 2023).

GBIF Secretariat. 2023. GBIF backbone taxonomy: *Enneacanthus gloriosus* (Holbrook, 1855). Copenhagen: Global Biodiversity Information Facility. Available: https://www.gbif.org/species/2394551 (January 2023).

[HDOA] Hawaii Department of Agriculture. 2019. Non-domestic animal import rules. Hawaii Administrative Rules Chapter 4-71.

[ITIS] Integrated Taxonomic Information System. 2023. *Enneacanthus gloriosus* (Holbrook, 1855). Reston, Virginia: Integrated Taxonomic Information System. Available: https://www.itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=168113#null (January 2023).

Jonah's Aquarium. 2023. *Enneacanthus gloriosus*. Jonah's Aquarium. Available: http://www.jonahsaquarium.com/jonahsite/picegloriosus02.htm (January 2023).

Live Aquaponics. 2023. Bluespotted sunfish. Live Aquaponics. Available: https://liveaquaponics.com/products/bluespotted-sunfish (January 2023).

NatureServe. 2023. NatureServe Explorer: an online encyclopedia of life. Arlington, Virginia: NatureServe. Available: https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.102329/Enneacanthus_gloriosus (January 2023).

[NHFG] New Hampshire Fish and Game Department. 2022. The importation, possession and use of all wildlife. New Hampshire Code of Administrative Rules Fis 800.

[NJFW] New Jersey Division of Fish and Wildlife. 2022. Fish code. New Jersey Administrative Code 7:25-6.

[NMDGF] New Mexico Department of Game and Fish. 2010. Director's species importation list. Santa Fe: New Mexico Department of Game and Fish. Available: https://www.wildlife.state.nm.us/download/enforcement/importation/information/Directors-Species-Importation-List-08_03_2010.pdf (January 2023).

Poelen JH, Simons JD, Mungall CJ. 2014. Global Biotic Interactions: an open infrastructure to share and analyze species-interaction datasets. Ecological Informatics 24:148–159.

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

[USFWS] U.S. Fish and Wildlife Service. 2024. Standard operating procedure: how to prepare an "Ecological Risk Screening Summary." Version 3.

Warren ML. 2009. Centrarchid identification and natural history. Page 566 in Cooke SJ, Philipp DP, editors. Centrarchid fishes: diversity, biology, and conservation. West Sussex, England: Wiley-Blackwell.

Wild Fish Tanks. 2023.Bluespotted sunfish *Enneacanthus gloriosus*. Wild Fish Tanks. Available: https://www.wildfishtanks.com/product/BluespottedSunfish/84 (January 2023).

World Organisation for Animal Health. 2023. Animal diseases. Paris: World Organisation for Animal Health. Available: https://www.woah.org/en/what-we-do/animal-health-and-welfare/animal-diseases/ (January 2023).

Zimmerman's Fish. 2023. Bluespotted sunfish *Enneacanthus gloriosus*. Zimmerman's Fish. Available: http://www.zimmermansfish.com/Price.html (January 2023).

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.

Breder CM Jr, Redmond AC. 1929. The bluespotted sunfish. A contribution to the life history and habits of *Enneacanthus* with notes on other Lepominae. Zoologica 9(10):379–401.

Casterlin ME, Reynolds WW. 1980. Diel activity of the bluespotted sunfish, *Enneacanthus gloriosus*. Copeia 1980(2):344–345.

Cooper EL. 1983. Fishes of Pennsylvania and the northeastern United States. State College: Pennsylvania State University Press.

Denoncourt RF, Hocutt CH, Stauffer JR Jr. 1975. Additions to the Pennsylvania ichthyofauna of the Susquehanna River drainage. Proceedings of the Academy of Natural Sciences of Philadelphia 127(9):67–69.

Fox RS III. 1969. A study of the life history of the centrarchid *Enneacanthus gloriosus* (Holbrook) near southern limit of its range. Master's Thesis. Gainesville: University of Florida.

Hugg DO, Hugg S. 1996. MAPFISH georeferenced mapping database. Freshwater and estuarine fishes of North America. Edgewater, Maryland: Life Science Software.

Jenkins RE, Burkhead NM. 1994. Freshwater fishes of Virginia. Bethesda, Maryland: American Fisheries Society.

Lee DS, Gilbert CR, Hocutt CH, Jenkens RE, McAllister DE, Stauffer JR Jr. 1980. Atlas of North American freshwater fishes. Raleigh: North Carolina State Museum of Natural History.

Page LM, Burr BM. 1991. A field guide of freshwater fishes of North America north of Mexico. Boston: Houghton Mifflin Company.

Peterson MS, Ross ST. 1987. Nonmorphometric and meristic characteristics of a peripheral population of *Enneacanthus*. Southeastern Fishes Council Proceedings 17:1–4.

Riehl R, Baensch HA. 1991. Aquarien Atlas. Band 1. Melle, Germany: Mergus, Verlag für Natur-und Heimtierkunde.

Ross ST. 2001. The inland fishes of Mississippi. Jackson. University Press of Mississippi.

Ross ST, Brenneman WM. 1991. Distribution of freshwater fishes in Mississippi. United States Fish and Wildlife Service. Manuscript.

Smith CL. 1985. The inland fishes of New York State. Albany: New York State Department of Environmental Conservation.

Snyder DJ. 1999. Foraging and prey selection by bluespotted sunfish *Enneacanthus* (Holbrook) in backwater, vegetated ponds in Mississippi. Journal of Freshwater Ecology 14(2):187–196.

Snyder DJ, Peterson MS. 1999. Life history of a peripheral population of bluespotted sunfish *Enneacanthus gloriosus* (Holbrook), with comments on geographic variation. American Midland Naturalist 141:345–357.

Werner RG. 1972. Bluespotted sunfish, *Enneacanthus gloriosus*, in the Lake Ontario drainage, New York. Copeia 1972:878–879.

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 *Enneacanthus gloriosus* was projected to occur in the Appalachian Range, Great Lakes, Mid-Atlantic, Northeast, Southeast, Southern Atlantic Coast, and Southern Florida regions of the contiguous United States. Areas of low climate match were projected to occur in California, the Great Basin, Northern Pacific Coast, and Southwest regions. The Climate 6 scores for the individual future scenario models (figure A2) ranged from a low of 0.373 (model: UKESM1-0-LL, SSP5, 2085) to a high of 0.491 (model: IPSL-CM6A-LR, 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 (0.487, figure 4) falls within 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 Colorado Plateau, Northeast, and Western Mountains 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, Colorado Plateau, Great Lakes, Gulf Coast, Mid-Atlantic, Northeast, Northern Plains, Southeast, Southern Atlantic Coast, Southern Florida, Southern Plains, and Southwest saw a moderate decrease in the climate match relative to current conditions. No large decreases were observed regardless of time step and climate scenarios. Additional, very small areas of large or moderate change may be visible on the maps (figure A3).
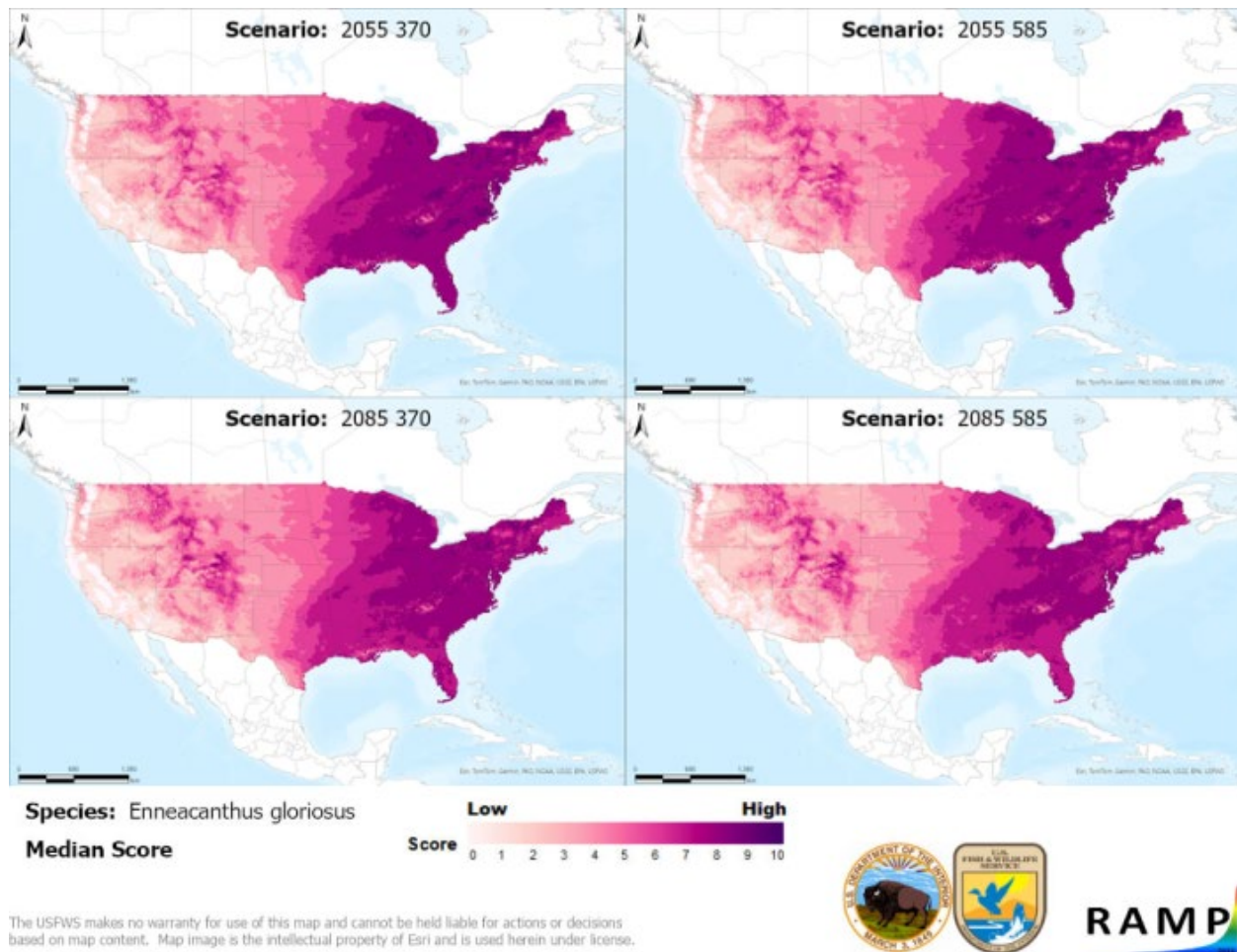
Figure A1. Maps of median RAMP (Sanders et al. 2023) climate matches projected under potential future climate conditions using five global climate models for *Enneacanthus gloriosus* in the contiguous United States. Climate matching is based on source locations reported by GBIF Secretariat (2023). Shared 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.
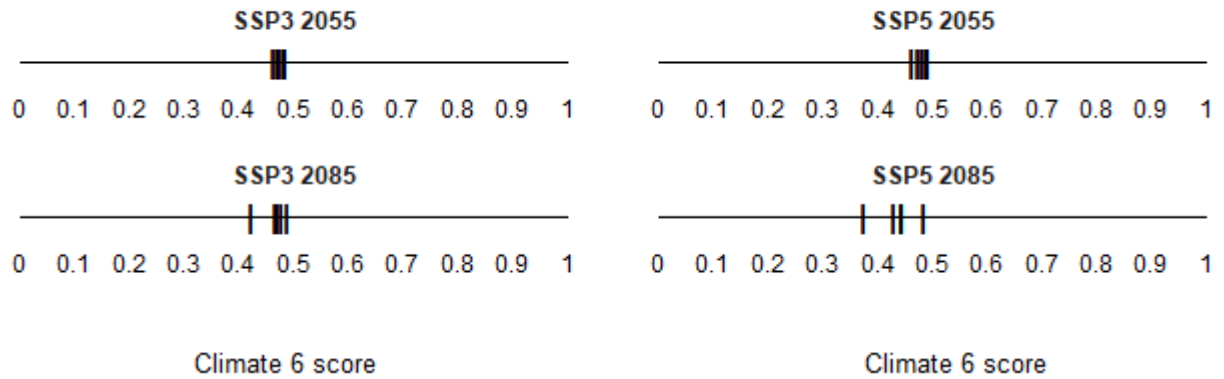
Figure A2. Comparison of projected future Climate 6 scores for *Enneacanthus gloriosus* in the contiguous United States for each of five global climate models under four combinations of Shared Socioeconomic Pathway (SSP) and time step. SSPs used (from left to right): SSP3, SSP5 (Karger et al. 2017, 2018; 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.
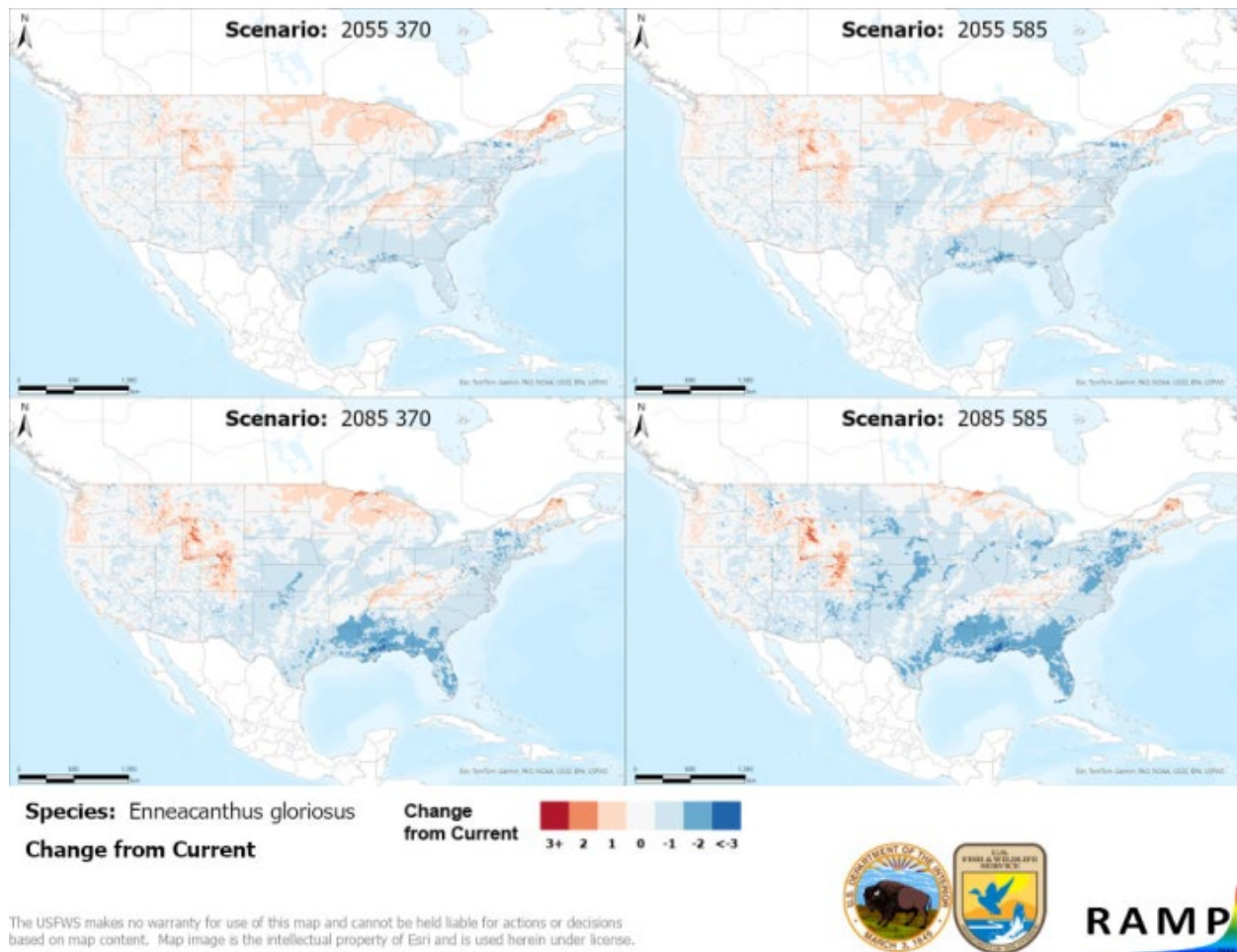
Figure A3. RAMP (Sanders et al. 2023) maps of the contiguous United States showing the difference between the current climate match target point score (figure 4) and the median target point score for future climate scenarios (figure A1) for *Enneacanthus gloriosus* based on source locations reported 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.

Literature Cited

GBIF Secretariat. 2023. GBIF backbone taxonomy: *Enneacanthus gloriosus* (Holbrook, 1855). Copenhagen: Global Biodiversity Information Facility. Available: https://www.gbif.org/species/2394551 (January 2023).

[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.

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