Banded Darter (*Etheostoma zonale*)

Ecological Risk Screening Summary

U.S. Fish and Wildlife Service, December 2022
Revised, March 2023
Web Version, 3/18/2024

Organism Type: Fish
Overall Risk Assessment Category: High

Photo: Fish Folk Aquatics. Licensed under CC-BY-3.0. Available: https://www.fishbase.us/photos/ThumbnailsSummary.php?ID=3483# (March 2023).

1 Native Range and Status in the United States

Native Range

From Fuller and Neilson (2022):

"**Native Range:** Lake Michigan and Mississippi River basins from southwestern New York to Minnesota, and south to northern Georgia, northern Alabama, and southern Arkansas. Absent from Former Mississippi Embayment; Wabash River drainage of Ohio, Indiana, and Illinois; and streams of southern Illinois, southern Iowa, and northern Missouri (Page and Burr 1991)."

From Carlson (2008):

"Historically, the range of the Banded Darter, *Etheostoma zonale* […], extended from Minnesota and western New York in the north to Louisiana and Mississippi in the south and included tributaries of both the Allegheny and Mississippi rivers […]."

From Haslouer et al. (2005):

"This species occurs in the Spring River basin in extreme southeastern Kansas and a small area of the Fall River in the lower Verdigris River basin (Cross 1967). It ranges in abundance from rare to common in the Spring River basin and is not abundant in the Fall River (Cross and Collins 1995)."

Status in the United States

From Fuller and Neilson (2022):

"**Native Range:** Lake Michigan and Mississippi River basins from southwestern New York to Minnesota, and south to northern Georgia, northern Alabama, and southern Arkansas. Absent from Former Mississippi Embayment; Wabash River drainage of Ohio, Indiana, and Illinois; and streams of southern Illinois, southern Iowa, and northern Missouri (Page and Burr 1991)."

Fuller and Neilson (2022) also list the following nonindigenous occurrences for *E. zonale*, with the range of years, watersheds, and population status (one or more watersheds) where reported in parentheses.

- Maryland (1978–2008; Lower Susquehannah, Upper Chesapeake; established)
- New York (1981–2012; Chemung, Chenango, Owego-Wappasening, Seneca, Tioga, Upper Genesee [failed], Upper Susquehanna; established)
- Pennsylvania (1971–2011; Lower Juniata, Lower Susquehanna, Lower Susquehanna-Penns, Lower Susquehanna-Swatara, Lower West Branch Susquehanna, Middle West Branch Susquehanna, Owego-Wappasening, Pine, Raystown, Sinnemahoning, Susquehanna, Tioga, Upper Juniata, Upper Susquehanna-Lackawanna, Upper Susquehanna-Tunkhannock; established)
- South Carolina (1961–2009; Saluda, Seneca [failed], Upper Savannah; established)

From Fuller and Nielson (2022):

"Menhinick (1991) did not list this species as occurring in North Carolina, and Dahlberg and Scott (1971a) report it was not collected in the Savannah drainage in Georgia."

From Haslouer et al. (2005):

"Most recorded localities for this taxon are in close proximity, raising the possibility that a single abiotic or biotic event could affect the viability of the Banded Darter in Kansas. This species was described by Frank Cross (unpub. observ.) as 'significantly reduced in range or abundance' in Kansas. The KNHI [Kansas Natural Heritage Inventory] lists this darter as 'vulnerable' in Kansas (NatureServe 2004)."

From Carlson (2008):

"In 1971, *E. zonale* was collected for the first time in the Susquehanna River drainage at Little Pine Creek, Lycoming Co., PA, following what was likely a human-mediated introduction in the late 1950s or 1960s (Kneib, 1972). By 1975, *E. zonale* was collected approximately 400 km downstream from the site of its first capture (Denoncourt et al., 1975[…]), and by October 1980, it had reached central New York; two individuals of both sexes were collected at Catatonk Creek, Candor, Tioga Co., NY (Greenberg, 1982[…])."

There is evidence of *E. zonale* being sold through private fish farms with the intention of supplying fish species for private aquariums and ponds (e.g., Jonah's Aquarium 2022).

Regulations

Kansas Administrative Regulations (2019) designates this species as a nongame species in need of conservation and prohibits the possession of this species unless special conditions are met.

Etheostoma zonale is listed as an 'approved aquaculture species' in Iowa (Iowa Administrative Code 2022).

New Mexico Department of Game and Fish (2010) lists all members in the genus *Etheostoma* as Group IV; federally threatened.

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

Means of Introductions within the United States

From Fuller and Nielson (2022):

"The species was introduced into the Susquehanna River in the late 1960s, possibly during a high-water event (Cooper 1983) or through bait bucket transfer (Kneib 1972; Denoncourt et al. 1975), and is now the most abundant darter in many parts of the drainage (Raesly et al. 1990). […] Tsai and Raney (1974) stated that *E. zonale* may have entered the Savannah River drainage of the Atlantic Slope via stream capture."

Remarks

From NatureServe (2022):

"*E. lynceum*, formerly included in *E. zonale*, was regarded as specifically distinct by Etnier and Starnes (1986); the 1991 AFS checklist also regarded *lynceum* as a separate species (Robins et al. 1991). Apparently hybridizes with *E. olmstedi* in Susquehanna River, Pennsylvania (Raesly et al. 1990)."

From Gray et al. (2005):

"*E. zonale* is currently the most abundant darter throughout the Susquehanna River drainage and has hybridized with *E. olmstedi*."

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From ITIS (2022):

Kingdom Animalia
Subkingdom Bilateria
Infrakingdom Deuterostomia
Phylum Chordata
Subphylum Vertebrata
Infraphylum Gnathostomata
Superclass Actinopterygii
Class Teleostei
Superorder Acanthopterygii
Order Perciformes
Suborder Percoidei
Family Percidae
Genus *Etheostoma* Rafinesque, 1819
Species *Etheostoma zonale* (Cope, 1868)

According to Fricke et al. (2022), *Etheostoma zonale* is the current valid name for this species.

Size, Weight, and Age Range

From Fuller and Neilson (2022):

"**Size:** 7.8 cm."

From Illinois Department of Natural Resources (2020):

"The average length of the banded darter is one and one-half to three inches. The life span is about four years."

From NatureServe (2022):

"Sexually mature usually in 2 years in north (Page 1983). Known age range of breeding females is 2-3 years (Bart and Page 1992)."

Environment
From NatureServe (2022):

“In Arkansas, water temperatures during spawning were 11-21 C (Walters 1994).”

“Habitat includes rocky riffles of creeks and small to medium rivers (Page and Burr 2011); streams of moderate gradient with bottoms of coarse gravel to rubble, often at depths over 25 cm at or near midchannel.”

Fuller and Nielson (2022) lists *E. zonale* as benthopelagic.

Climate
From Froese and Pauly (2022):

“Temperate; 46°N - 33°N”

Distribution Outside the United States
No records were found for *Etheostoma zonale* in the wild outside the United States.

Means of Introduction Outside the United States
No records were found of introduction of *Etheostoma zonale* in the wild outside the United States.

Short Description
From Illinois Department of Natural Resources (2020):

“The banded darter's upper lip is connected to its snout by a narrow ridge of skin. The back and upper sides are green-brown with six or seven dark crossbars. There are dark green bars on the sides. The lower sides and belly are yellow-white with dark markings. A dark spot is present under and in front of each eye. The first dorsal fin is rust-colored at the base. All fins have narrow dark lines, and there are three or four dark spots at the base of the tail fin. The breeding male has about 10 green bars around the body, its lower head and breast are blue-green and the dorsal fin has a red band at the base.”

Biology
From Froese and Pauly (2022):

“Adults feed on midge larvae, mayfly nymphs, and blackfly larvae [Etnier and Starnes 1993]. Eggs are found attached to the substrate unguarded [Page 1983].”

From NatureServe (2022):

"Spawns April-May in Oklahoma and Kansas, mid-April to late May in Missouri, May-June in Illinois and Pennsylvania, as late as late July in western Kentucky, late March to mid-June in Arkansas (Hubbs 1985, Walters 1994)."

"In Arkansas, spawning occurred in runs about 0.6-1.6 meters deep with moderate current velocities (Walters 1994). Trautman (1981) reported spawning at depths of less than 0.6 meters. Eggs are laid on algae and moss growing on stones and boulders in riffles or runs (Becker 1983, Walters 1994)."

Human Uses

According to Fuller and Neilson (2022), *E. zonale* was likely used as bait.

Diseases

No information was found associating *Etheostoma zonale* with any diseases listed by the World Organisation of Animal Health (2022).

According to Fain and Whitaker (1978), a specimen of *E. zonale* was observed with the presence of *L. cyrpinacea*, a parasitic copepod, as well as *Piscicolaria reducta*, a Piscicolid leech, in southern Minnesota.

Threat to Humans

No information was found on threats to humans from *Etheostoma zonale*.

3 Impacts of Introductions

From Carlson (2008):

"When *E. olmstedi* and *E. zonale* occur in sympatry, as they do in the Pennsylvania portion of the Susquehanna, the species interact relatively frequently. Despite its smaller adult body size, *E. zonale* is nearly always the aggressor in these interactions (Gray and Stauffer, 2001). *Etheostoma olmstedi* responds to this aggression by shifting its habitat; it occurs almost exclusively in shallow areas of very low flow and small (i.e., sand or mud) substrate when it co-occurs with *E. zonale* (Gray, 1998; Gray and Stauffer, 2001; Gray et al., 2005). Thus, *E. zonale* out-competes *E. olmstedi* for habitat when the species occur in the same community (Gray, 1998; Gray and Stauffer, 2001; Gray et al., 2005)."

"The trophic morphology of *E. olmstedi* in Catatonk Creek changed following a natural range expansion by an introduced congener *E. zonale*. The buccal cavity of post-invasion *E. olmstedi* was significantly longer relative to body size than that of pre-invasion *E. olmstedi*. The increase in BCL [buccal cavity length] likely has important functional consequences that in turn have ramifications for habitat use and prey capture. The functional relevance of the observed morphological change suggests that the change may be linked to a previously documented habitat shift by *E. olmstedi* when it occurs with *E. zonale*."

From Fuller and Nielson (2022):

"Introduced Banded Darters are hybridizing with native tessellated darters *E. olmstedi* in the Susquehanna River, Pennsylvania (Raesly et al. 1990). […] Habitat shifts and compression of niche breadth of *E. olmstedi* in areas of sympatry with *E. zonale* was observed by Van Snik Gray et al. (2005)."

Kansas, Iowa, and New Mexico have restrictions on this species for possession or importation. See Section 1 for further details for each state.

4 History of Invasiveness

Etheostoma zonale has been introduced and established outside of its native range in Maryland, New York, Pennsylvania, and South Carolina. Reliable evidence shows that established introductions in Pennsylvania and New York have led to the competition and hybridization with the native Tessellated Darter, *E. olmstedi*. There have also been morphological changes to the native darter population linked to the introduction of *E. zonale.* The History of Invasiveness for *Etheostoma zonale* is therefore classified as High.

5 Global Distribution

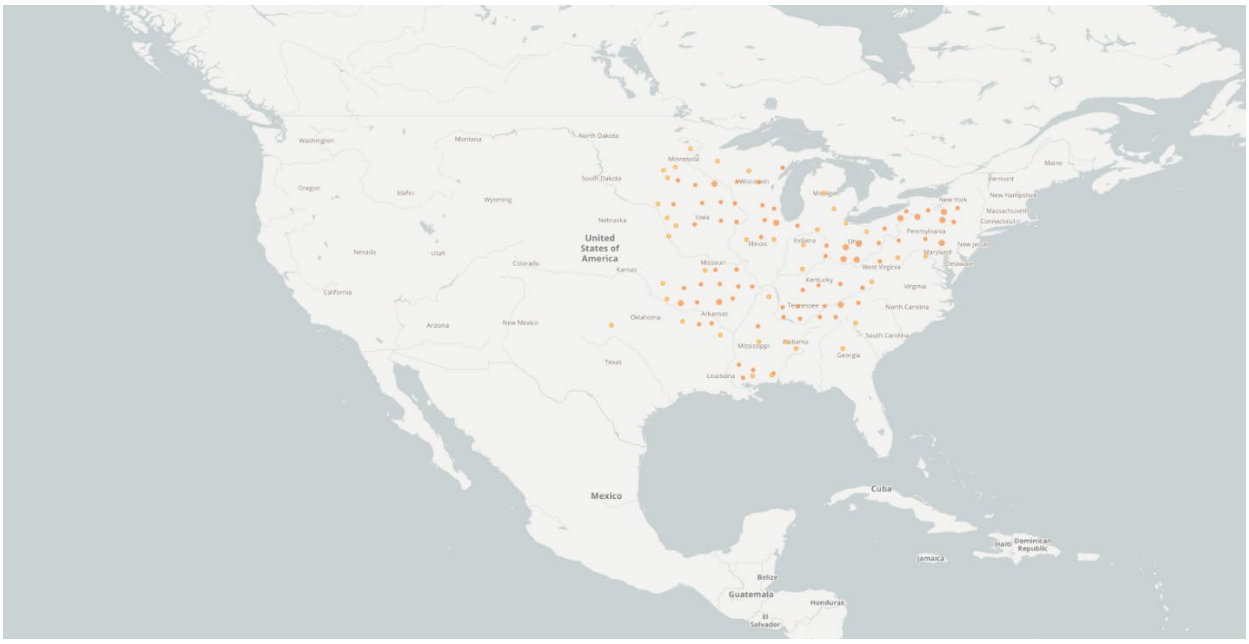

Figure 1. Reported global distribution of *Etheostoma zonale*. Map from GBIF Secretariat (2022). Observations are reported from much of the eastern half of the contiguous United States. Reported observations from southern Georgia, southern Alabama, Texas, and Michigan were excluded from the climate match as they were not found to represent established populations of *E. zonale*.

6 Distribution Within the United States

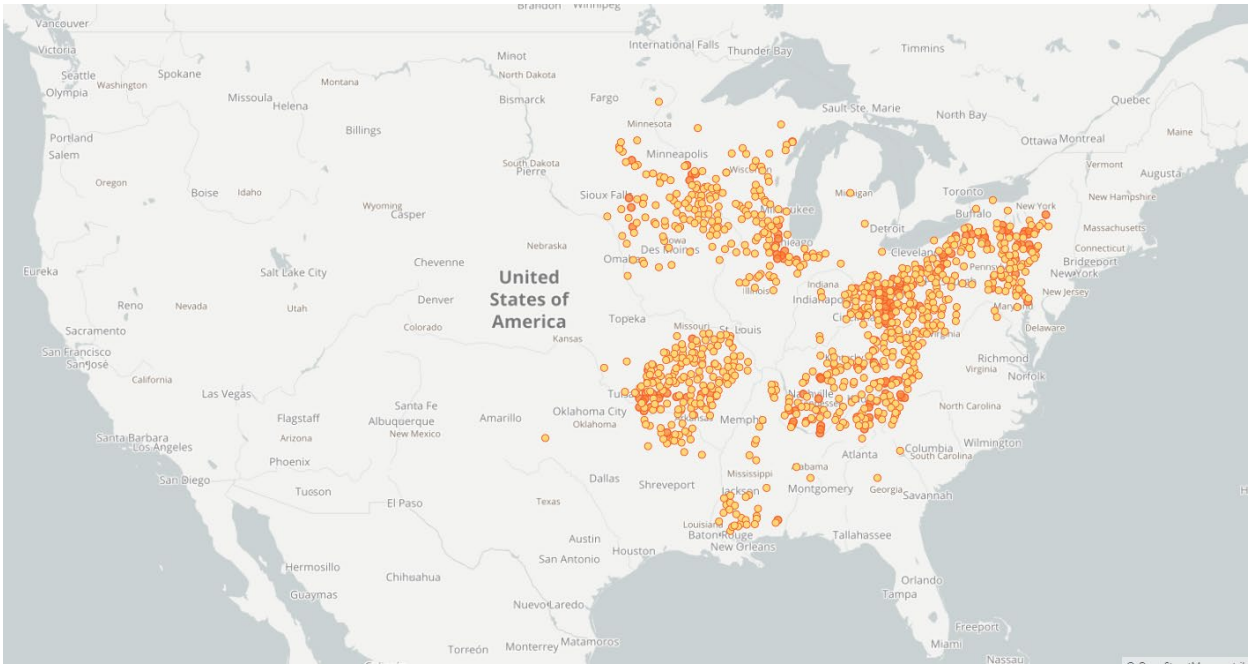

Figure 2. Reported distribution of *Etheostoma zonale* in the United States. Map from GBIF-US (2022). Observations are reported over much of the eastern half of the contiguous United States. Reported observations from northern Missouri, southern Georgia, southern Alabama, Texas, northern Ohio, southeastern West Virginia, southern Indiana, and Michigan were excluded from the climate match as they were not found to represent established populations of *E. zonale*. Observations reported in Mississippi and Louisiana were also excluded from climate matching as these points represented the species *E. lynceum*.

7 Climate Matching

Summary of Climate Matching Analysis

The highest climate match for *Etheostoma zonale* occurred in the northeastern and mid-western states from the Canadian border and Great Lakes to the south following the Mississippi River basin and its respective tributaries. Much of these areas are within the native range of *E. zonale*. Areas of low match occurred in the western states from the Rocky Mountains to the Pacific Coast. The overall Climate 6 score (Sanders et al. 2023; 16 climate variables; Euclidean distance) for the contiguous United States was 0.741, 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 *Etheostoma zonale* (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.

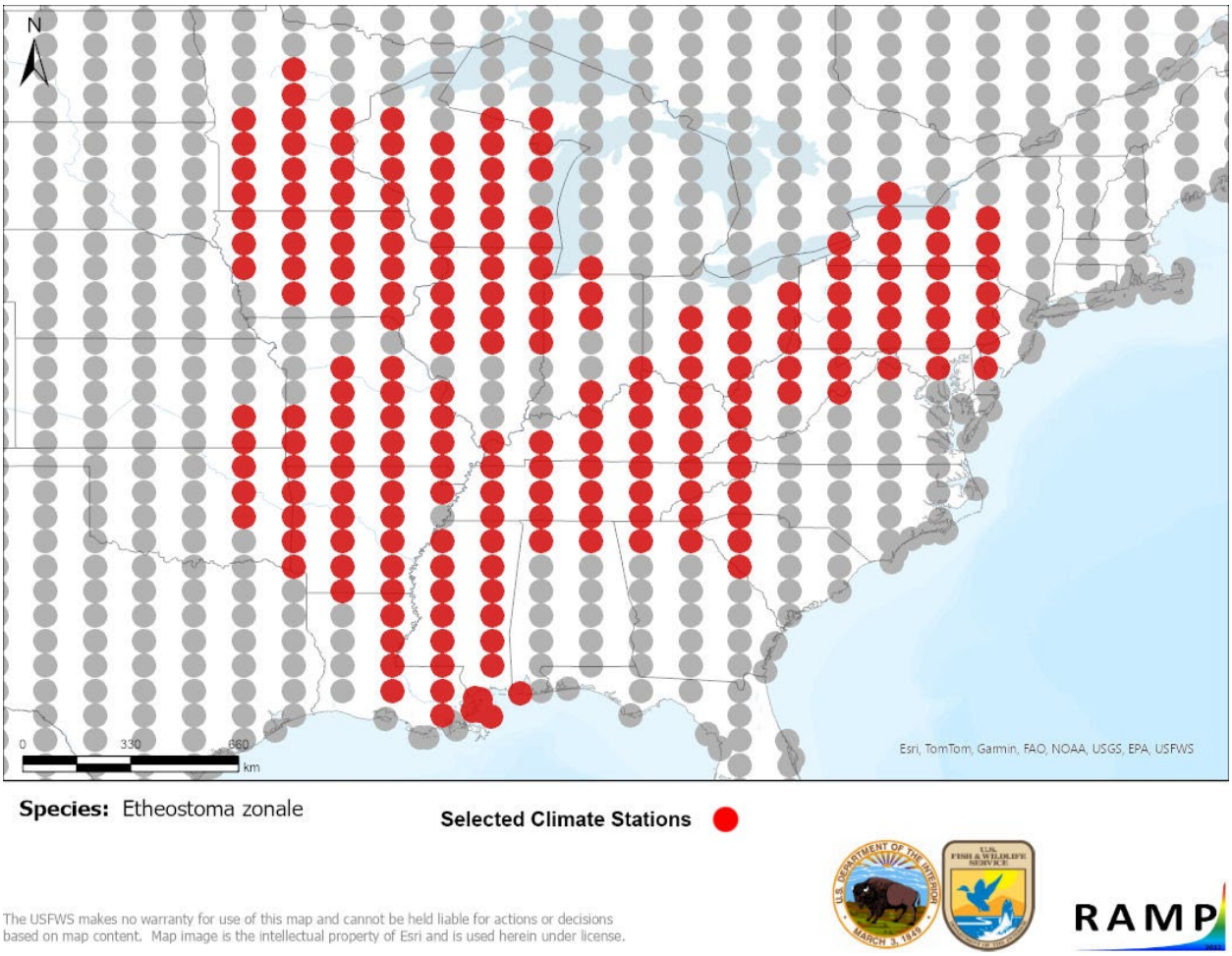

Figure 3. RAMP (Sanders et al. 2023) source map showing weather stations in the eastern United States selected as source locations (red; Minnesota, Michigan, Wisconsin, Iowa, Indiana, Illinois, Ohio, Pennsylvania, New York, West Virginia, Virginia, Kentucky, Tennessee, North Carolina, Virginia, Georgia, Alabama, Missouri, Kansas, Arkansas, Oklahoma, and Maryland) and non-source locations (gray) for *Etheostoma zonale* climate matching. Source locations from 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.

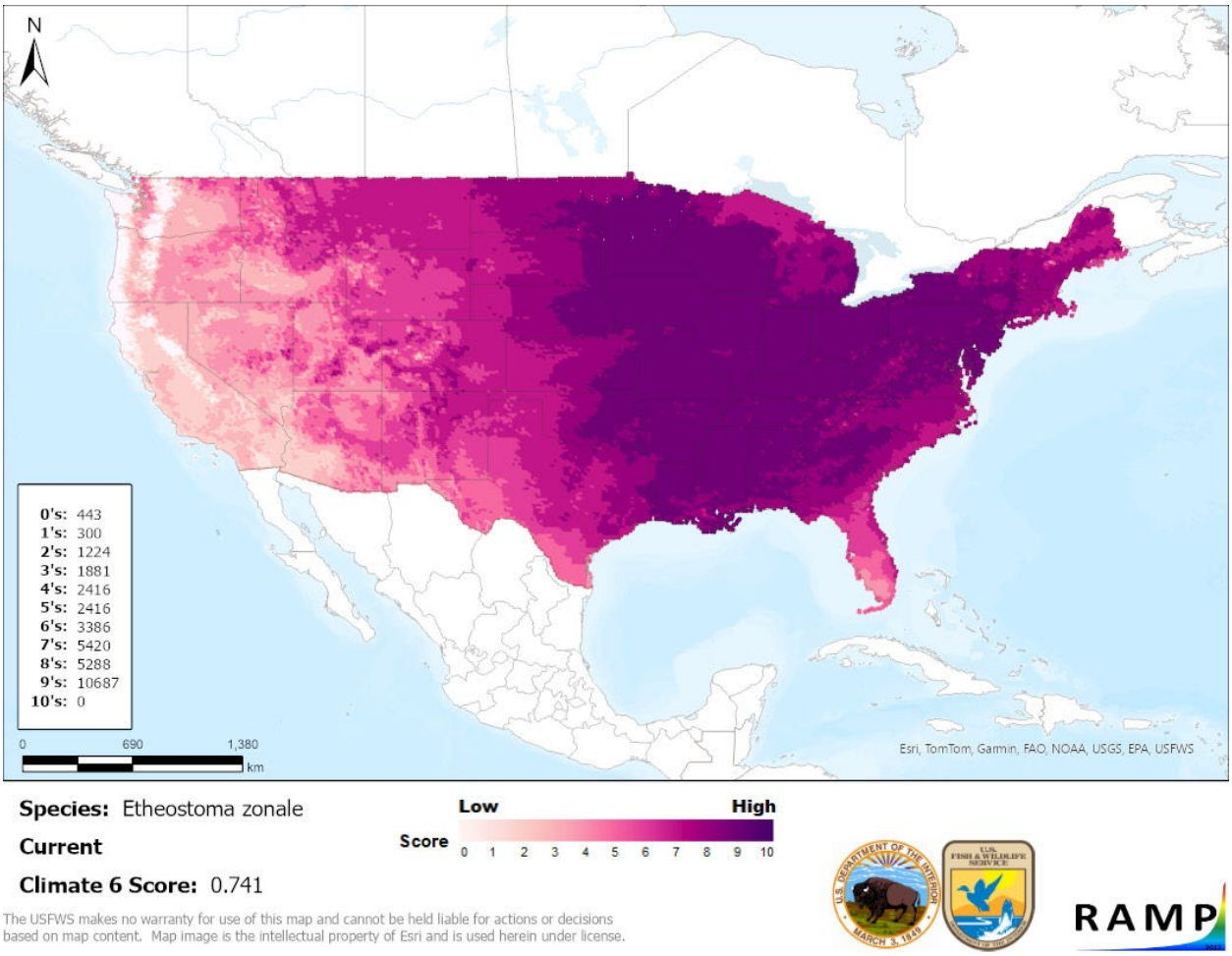

Figure 4. Map of RAMP (Sanders et al. 2023) climate matches for *Etheostoma zonale* in the contiguous United States based on source locations reported by GBIF Secretariat (2022). Counts of climate match scores are tabulated on the left. 0/Pale Pink = Lowest match, 10/Dark Purple = Highest match.

8 Certainty of Assessment

There is adequate, relevant biological, ecological, and distributional information available for *Etheostoma zonale. E. lynceum* was distinguished as a separate species from *E. zonale* in 1986 which may complicate interpretation of distribution information. There is a reasonable amount of information regarding the impacts from established nonnative populations from reliable sources. Therefore, the Certainty of Assessment for *Etheostoma zonale* is classified as Medium.

9 Risk Assessment

Summary of Risk to the Contiguous United States

Etheostoma zonale, Banded Darter, is a fish that is native to Lake Michigan and the Mississippi River basin, including the Ohio and Tennessee river basins. *E. zonale* inhabits rocky riffles of creeks and small to medium rivers where it forages for midge larvae, blackfly larvae, and mayfly nymphs. *E. zonale* spawns during late spring to mid-summer depending on geographic location.

Eggs are laid or attached to rocky substrate covered in algae or moss where they remain unguarded. These darters may be used as bait, which likely led to established populations in New York, Maryland, and Pennsylvania. Evidence shows established populations in Pennsylvania and New York have negatively impacted a native species of darter, *E. olmstedi*, through niche competition and hybridization. *E. zonale* is regulated in three States. The History of Invasiveness for *Etheostoma zonale* is classified as High due to evidence of established populations competing and hybridizing with a native darter species. The climate matching analysis for the contiguous United States indicates establishment concern for this species outside its native range. The highest climate matches occurred in the midwestern and eastern states surrounding the Mississippi River basin and Lower Great Lakes. The lowest matches occurred along the Pacific coast and in the Rocky Mountain region. The Certainty of Assessment for this ERSS is classified as Medium due to some difficultly in interpreting the range information due to taxonomic changes of some populations. The Overall Risk Assessment Category for *Etheostoma zonale* in the contiguous United States is High.

Assessment Elements

- **History of Invasiveness (see section 4): High**
- **Establishment Concern (see section 7): Yes**
- **Certainty of Assessment (see section 8): Medium**
- **Remarks, Important additional information: Evidence of hybridization with *E. olmstedi*.**
- **Overall Risk Assessment Category: High**

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

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.

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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 (2022).

Under the future climate scenarios (figure A1), on average, high climate match for *Etheostoma zonale* was projected to occur in the Appalachian Range, Great Lakes, Mid-Atlantic, Northeast, Northern Plains, and Southeast regions of the contiguous United States. Areas of low climate match were projected to occur west of the Rocky Mountains. Areas of high match decreased, contracting north and eastward, over time and from SSP3 to SSP5. The Climate 6 scores for the individual future scenario models (figure A2) ranged from a low of 0.535 (model: UKESM1-0-LL, SSP5, 2085) to a high of 0.736 (model: IPSL-CM6A-LR, SSP3, 2055). All future scenario Climate 6 scores were above the Establishment Concern threshold, indicating that Yes, there was an establishment concern for this species. The Climate 6 score for the current climate match (0.741, 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 SSP3, 2055 (figure A3). Under multiple 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. Very small areas of large increase were observed in those same regions. Under one or more time step and climate scenarios, areas within the Northern and Southern Plains saw a large decrease in the climate match relative to current conditions. Additionally, areas within the Appalachian Range, Colorado Plateau, Great Basin, Great Lakes, Gulf Coast, Mid-Atlantic, Northeast, Southeast, and Southwest saw a moderate decrease in the climate match relative to current conditions. The magnitude of change increased with further time steps and from SSP3 to SSP5.

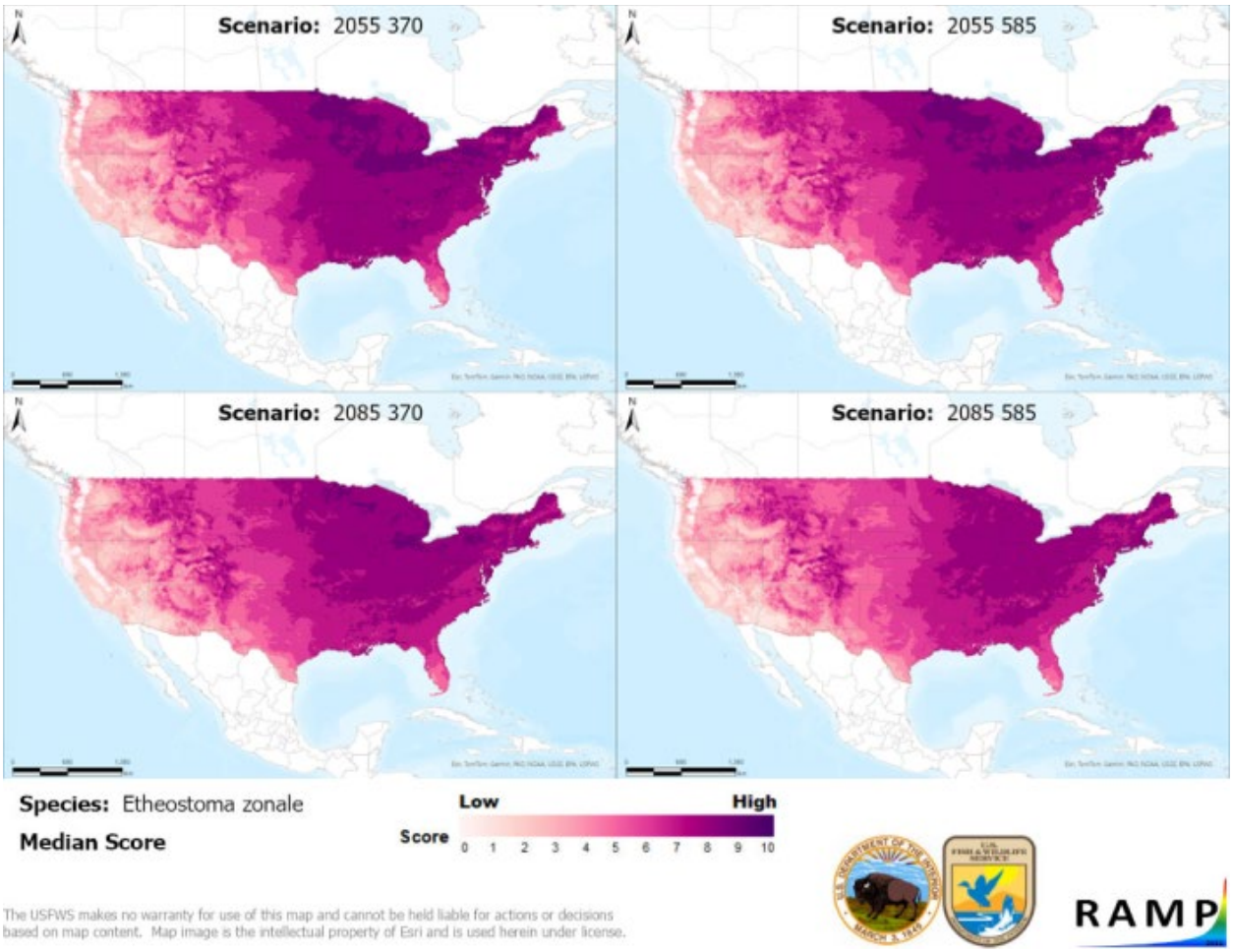

Figure A1. Maps of median RAMP (Sanders et al. 2023) climate matches projected under potential future climate conditions using five global climate models for *Etheostoma zonale* in the contiguous United States. Climate matching is based on source locations reported by GBIF Secretariat (2022). Shared 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.

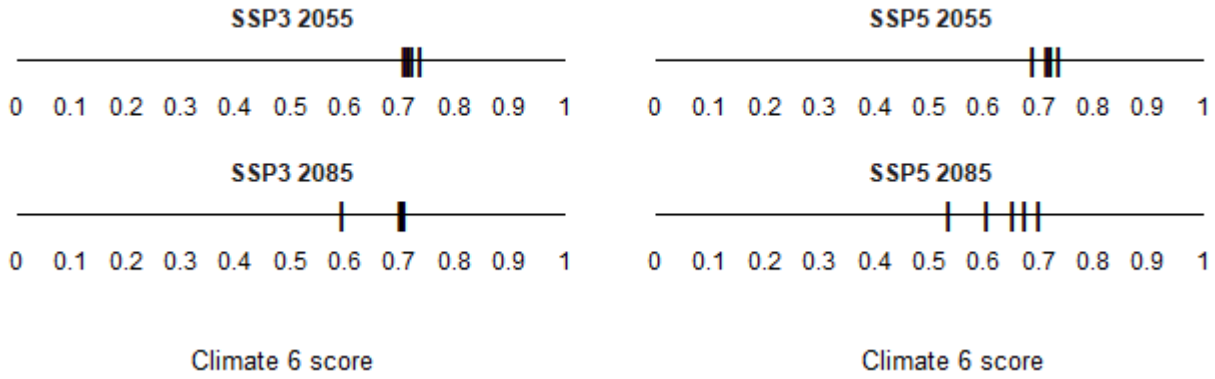

Figure A2. Comparison of projected future Climate 6 scores for *Etheostoma zonale* in the contiguous United States for each of five global climate models under four combinations of Shared Socioeconomic Pathway (SSP) and time step. SSPs used (from left to right): SSP3, SSP5 (Karger et al. 2017, 2018;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

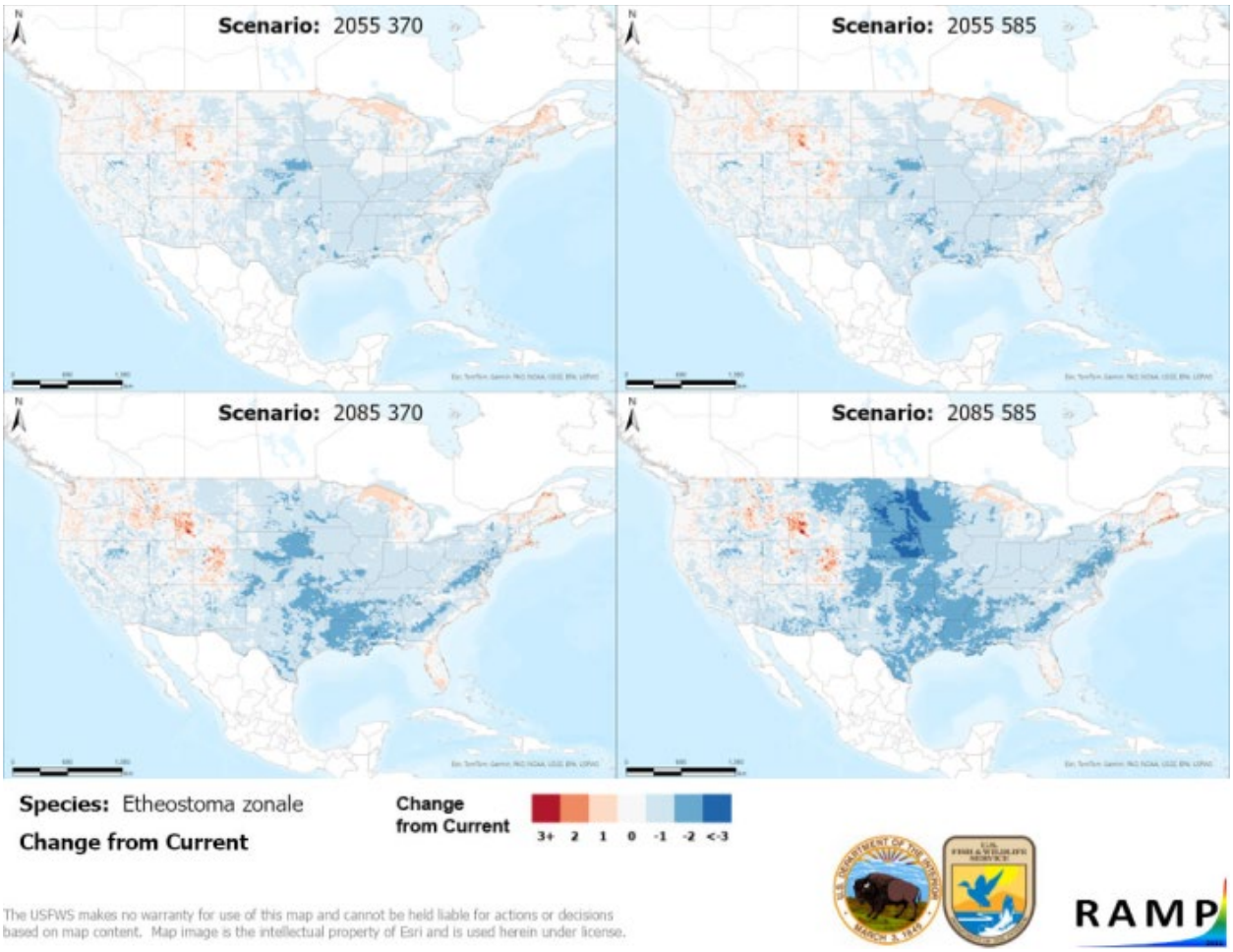

Figure A3. RAMP (Sanders et al. 2023) maps of the contiguous United States showing the difference between the current climate match target point score (figure 4) and the median target point score for future climate scenarios (figure A1) for *Etheostoma zonale* based on source locations reported by GBIF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

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