Inland Silverside (*Menidia beryllina*)

Ecological Risk Screening Summary

U.S. Fish & Wildlife Service, June 2016
Revised, January 2017, November 2017, December 2017
Web Version, 9/13/2018

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1 Native Range and Status in the United States

Native Range

From NatureServe (2013):

"Global Distribution: Western Atlantic: Maine to Florida, and the northern Gulf of Mexico from Laguna Madre, Tamaulipas, Mexico, east to Florida (Chernoff 2002, Richards 2006, Kells and Carpenter 2011)."

From Fuller et al. (2016):

"Eastern North America including Atlantic and Gulf slopes (mostly near the coast) from Massachusetts to the Rio Grande drainage, Texas, and southeastern New Mexico; north from the

Mississippi River and major tributaries (mainly Arkansas and Red Rivers) to southern Illinois and eastern Oklahoma."

Status in the United States

The species' native range includes parts of the United States. There are also introduced populations in the United States.

From NatureServe (2013):

"Some inland populations in California, Oklahoma, and Missouri likely were introduced (Lee et al. 1980). Introduced in Pecos River drainage, New Mexico (Sublette et al.1990)."

From Fuller et al. (2016):

"This species was introduced into, or recorded from, large reservoirs and other areas of Arkansas (Robison and Buchanan 1988; Cross et al. 1986), as well as several locations and drainages in California, including Blue Lakes and Clear Lake, Lake County; Putah and Cache creeks, Yolo County; Lake Elizabeth and Shadow Cliffs Lake, Alameda County; Vasona Reservior, Santa Clara County; the Yolo Bypass, Yolo and Solano Counties; Suisun Marsh; and reservoirs in the San Francisco Bay area (Cook and Moore 1970; Moyle et al. 1974a; Li et al. 1976; Moyle 1976a, 1976b; Meinz and Mecum 1977; Shapovalov et al. 1981; Swift et al. 1993; Sommer et al. 2001; Matern et al. 2002). In Illinois it was collected from Lake Baldwin, Lake of Egypt, Rend Lake, Cache River, Wabash River, and the Mississippi, Ohio, and Kankakee Rivers (Laird and Page 1996). It was collected in 1950 in Turtle Lake, Minnesota (UF 8705). It has also been introduced into Stockton Reservoir in the lower Missouri River drainage and to several other lakes and ponds in Missouri (Pflieger 1975, 1997; Lee et al. 1980 et seq.; Cross et al. 1986); the lower Pecos River drainage in New Mexico (Smith and Miller 1986; Sublette et al. 1990); Boomer Lake on the lower Cimarron (Miller and Robison 1973; Cross et al. 1986) and a tributary of the Canadian River, Pittsburgh County, and Lake Optima in Oklahoma (Li et al. 1976; Lee et al. 1980 et seq.; Cross et al. 1986; Smith and Miller 1986; Pigg 1987); and the Pecos and Cochos drainages, and White River and Greenbelt reservoirs (Kraai et al. 1983; Conner and Suttkus 1986; Smith and Miller 1986) and Red River, Grayson, and Cottle Counties in Texas (Red River Authority of Texas 2001) as well as the Braunig Reservoir (Hubbs 1978)."

"Established in Arkansas, California, Illinois, Kentucky, possibly Missouri, Oklahoma, New Mexico, and Texas. Two years after these fish were introduced into Clear Lake, California, this species became the most abundant fish in the littoral zone (Moyle 1976a). Pflieger (1997) indicated that none of the Missouri impoundments currently support populations; for instance, the Stockton Reservoir population in Missouri died out during the severe winter of 1976 to 1977."

Means of Introductions in the United States

From Fuller et al. (2016):

"Intentionally stocked as forage for sport fish in most locations, but unknown in the Canadian River system. Unauthorized introduction into Clear Lake, California, in 1967 to control the Clear

Lake gnat *Chaoborus astictopus* and chironomid midges, and to serve as a nutrient reservoir to control bluegreen algae blooms (Moyle et al. 1974a; Moyle 1976a). A few introductions in California were authorized; however, many additional stockings were unauthorized and help to spread this fish (Moyle et al. 1974a). Introduction to the upper Mississippi and Ohio Rivers may be the result of dispersal through the Tennessee-Tombigbee waterway (Etnier and Starnes 1993) or natural dispersal up the Mississippi made possible by a change in water quality (Burr et al. 1996). Brood stock for Missouri introductions came from Lake Texoma, Oklahoma (Pflieger 1997)."

Remarks

From Fuller et al. (2016):

"The Oklahoma records are from upstream of the native range of the inland silverside (Lee et al. 1980 et seq.). Moyle et al. (1974a) showed a map of the distribution of silversides in California. There is some disagreement concerning the records of *Menidia beryllina* in the Mississippi and Ohio rivers in the Illinois and Kentucky area. According to Burr et al. (1996), the species may have either "expanded its range after the low water levels of the late 1980s created water-quality conditions (high dissolved solids) favorable for this species to disperse" or "it may have entered the Ohio River via the Tennessee-Tombigbee waterway which now connects Gulf Coast drainages to the Ohio River, especially because of recent (1991) records from both Kentucky and Barkley reservoirs (Etnier and Starnes 1993)." Burr considered either one equally possible. However, Mettee et al. (1996) show no records of this species from the Tennessee-Tombigbee waterway. Therefore, we believe that the presence of the species in the Mississippi River in southern Illinois and in the lower Ohio River in Illinois and Kentucky are a result of natural dispersal. According to Pigg (1987), the species was stocked in Lake Optima in 1981 by the Oklahoma Dept. of Wildlife Conservation."

At one point the Mississippi Silverside (*Menidia audens*) was synonymized with *M. beryllina* (NatureServe 2016; Eschmeyer et al. 2017) but is again determined to be a separate, valid species (Eschmeyer et al. 2017). This assessment is for *M. beryllina* and does not consider any information regarding *M. audens*.

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

According to Eschmeyer et al. (2017), *Menidia beryllina* (Cope 1867) is the valid name for this species. It was originally described as *Chirostoma beryllinum*.

From ITIS (2016):

"Kingdom Animalia
Subkingdom Bilateria
Infrakingdom Deuterostomia
Phylum Chordata
Subphylum Vertebrata

Infraphylum Gnathostomata
Superclass Osteichthyes
Class Actinopterygii
Subclass Neopterygii
Infraclass Teleostei
Superorder Acanthopterygii
Order Atheriniformes
Family Atherinopsidae
Subfamily Menidiinae
Genus *Menidia*
Species *Menidia beryllina* (Cope, 1867)"

Size, Weight, and Age Range

From NatureServe (2013):

"The maximum total length (TL) of *Menidia beryllina* was recorded as 15 cm (Page and Burr 1991), however, Robins and Ray (1986), Chernoff (2002), and Kells and Carpenter (2011) noted *M. beryllina* maximum total length (TL) to be 10 cm."

From Froese and Pauly (2016):

"Max length : 15.0 cm TL male/unsexed; [Page and Burr 1991]; common length : 7.8 cm TL male/unsexed; [Hugg 1996]; max. reported age: 2 years [Mense 1967]"

From NatureServe (2016):

"Adult life span about 16 months (few survive 2nd winter)."

Environment

From NatureServe (2013):

"*Menidia beryllina* is pelagic and can tolerant varying salinities (Richards 2006, Kells and Carpenter 2011)."

From NatureServe (2016):

"Coastal and freshwater habitats. Moderate to highly alkaline and euryhaline waters."

Climate/Range

From Froese and Pauly (2016):

"Subtropical; 42°N - 25°N, 98°W - 70°W"

Distribution Outside the United States

Native

Part of the native range of *Menidia beryllina* is within the United States. See Section 1 for details.

From Fuller et al. (2016):

"Native Range: […] Also in Mexico [Page and Burr 1991]."

Introduced

No records of introductions of *Menidia beryllina* outside the United States were found.

Means of Introduction Outside the United States

No records of introductions of *Menidia beryllina* outside the United States were found.

Short Description

From Froese and Pauly (2016):

"Anal soft rays: 16 - 19; Vertebrae: 38 – 42"

Biology

From NatureServe (2013):

"*Menidia beryllina* form large schools and is omnivorous (Kells and Carpenter 2011). Survival and growth of larvae was greater at salinity of 15 ppt than at 5 or 30 ppt (Sublette et al. 1990)."

"*Menidia beryllina* spawn between March and October primarily in tidal freshwater or brackish water (Richards 2006). Middaugh and Hemmer (1992) noted that spawning periods vary according to latitude and water temperature. In Rhode Island, spawning occurs in June and July (Bengtson 1984), in New Jersey from May to July (Coorey et al. 1985), in North Carolina from March to September (Hildebrand 1922), in Tampa, Florida all months except January and August (Springer and Woodburn 1960), and in coastal Texas from February to August (Gunter 1945). *Menidia beryllina* spawns over beds of aquatic vegetation or among emergent vegetation (Moyle 1976). *Menidia beryllina* is oviparous with demersal eggs and planktonic larvae (Richards 2006). Some landlocked populations (e.g., where introduced in reservoirs) reproduce in fresh water (Page and Burr 1991).

Growth in *M. beryllina* is density-dependent (increased growth when density is low) (Hubbs 1982). Females exhibit a faster growth rate than males. Mortality rates for males increase during spawning season (Hubbs 1982).

In Lake Texoma (Oklahoma), Hubbs (1982) found *M. beryllina* diet consisted of copepods, cladocerans and chironomids and feeding occurred largely during daylight hours (Saunders 1959, Elston and Bachen 1976).

Fecundity is size-dependent of females, with smaller females producing less eggs than larger females. Clutch sizes ranged from 384 to 1699 eggs, with an average of 984 eggs laid (Mense 1967). Females generally spawn daily during the spawning season (Hubbs 1982). Once Lake Texoma exceeded 30°C, spawning ceased. Thus, spawning by *M. beryllina* appears to be temperature dependent in Lake Texoma (Hubbs 1982)."

"*Menidia beryllina* inhabits shallower waters of freshwater inland waterways, estuaries, and coastal areas (Chernoff 2002)."

From NatureServe (2016):

"Spawning protracted; multiple peaks suggested. Most spawn and die their 2nd summer of life; eggs hatch in 4-30 days at 13-34 C. Female may produce eggs throughout breeding season. Adult life span about 16 months (few survive 2nd winter). In northwestern Florida, most reproduction occurred February-April; some young-of-year matured in July-September and spawned (Copeia 1992:53-61)."

"Moves far up streams and rivers, especially in southern part of range. In fresh water, usually swims at surface of clear quiet water over sand and gravel bottom."

Human Uses

From NatureServe (2013):

"There is no use/trade information for *Menidia beryllina*, but it is probably utilized as a bait fish for recreational fisherman."

From NatureServe (2016):

"Could serve as useful biological control agent for mosquitoes in water with salinities of 0-25 ppt (Middaugh et al. 1985) […]. Has been used in carcinogenesis testing (Metcalfe 1989)."

Diseases

Infection with *Gyrodactylus salaris* is an OIE reportable disease; Poelen et al. (2014) did not specify which species of *Gyrodactylus* can parasitize *Menidia beryllina*.

From Bailly (2015):

"Host of
Bomolochus concinnus Wilson C.B., 1911 (parasitic: ectoparasitic)
Ergasilus funduli Krøyer, 1863 (parasitic: ectoparasitic)
Ergasilus manicatus Wilson C.B., 1911 (parasitic: ectoparasitic)"

From Poelen et al. (2014):

Menidia beryllina can be parasitized by *Gyrodactylus* sp., *Arhythmorhynchus brevis*, and *Southwellina hispida* (Strona et al. 2013).

Threat to Humans

From Froese and Pauly (2016):

"Harmless"

3 Impacts of Introductions

From Fuller et al. (2016):

"In Oklahoma, the inland silverside has almost completely replaced the brook silverside *Labidesthes sicculus*, an ecologically similar species (Gomez and Lindsay 1972; Moyle 1976a). Cook and Moore (1970) gave details of the stocking in Clear Lake, California. In Clear Lake, inland silversides were reported as having displaced native fishes, including the hitch *Lavinia exilicauda*, the Sacramento blackfish *Orthodon microlepidotus*, and the now extinct Clear Lake splittail *Pogonichthys ciscoides*, apparently through competition for food. Inland silversides also may have replaced or diminished introduced bluegill (Moyle 1976a). Li et al. (1976) found the introduction of Mississippi silversides inhibited growth of black and white crappies *Pomoxis* spp. for the first two years of life and enhanced growth after that time. Moyle and Holzhauser (1978) discussed effects on feeding habits of introduced largemouth bass. Moyle et al. (1974) speculated that if this silverside reaches the delta area, it could negatively impact the Delta smelt *Hypomesus t. transpacificus* and perhaps juvenile striped bass. Baerwald et al. (2012) detected Delta smelt DNA in the gut contents in Mississippi silversides collected in the Sacramento Deepwater Ship Channel. Moyle (1976a) and Dill and Cordone (1997) provided detailed discussion of the history and reasons for this species' introduction into California and of its impacts."

4 Global Distribution

Figure 1. Known global distribution of *Menidia beryllina*. Locations are in the United States, Mexico, Myanmar, and India. Map from GBIF Secretariat (2016).

The locations in Myanmar and India were not used as source locations for the climate match. The records details indicate that the specimen listed in Myanmar was actually caught in the Rio Grande, an error in the coordinates resulted in the incorrect country (GBIF Secretariat 2016). The details for the specimen listed in India indicate that it was caught in Carancahua Bay, Texas; the incorrect country is again the result of an error in the coordinates (GBIF Secretariat 2016).

5 Distribution Within the United States

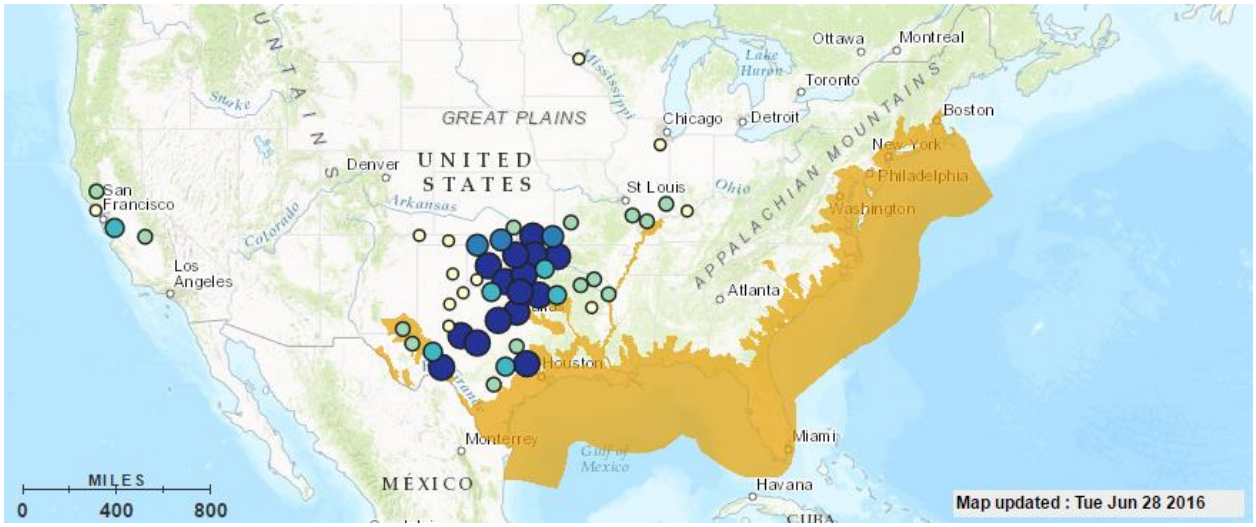

Figure 2. Known distribution of *Menidia beryllina* in the United States. Size and shading of the dots indicate concentration of observations. Yellow shaded area indicates the native range of *M. beryllina.* Map from Fuller et al. (2016).

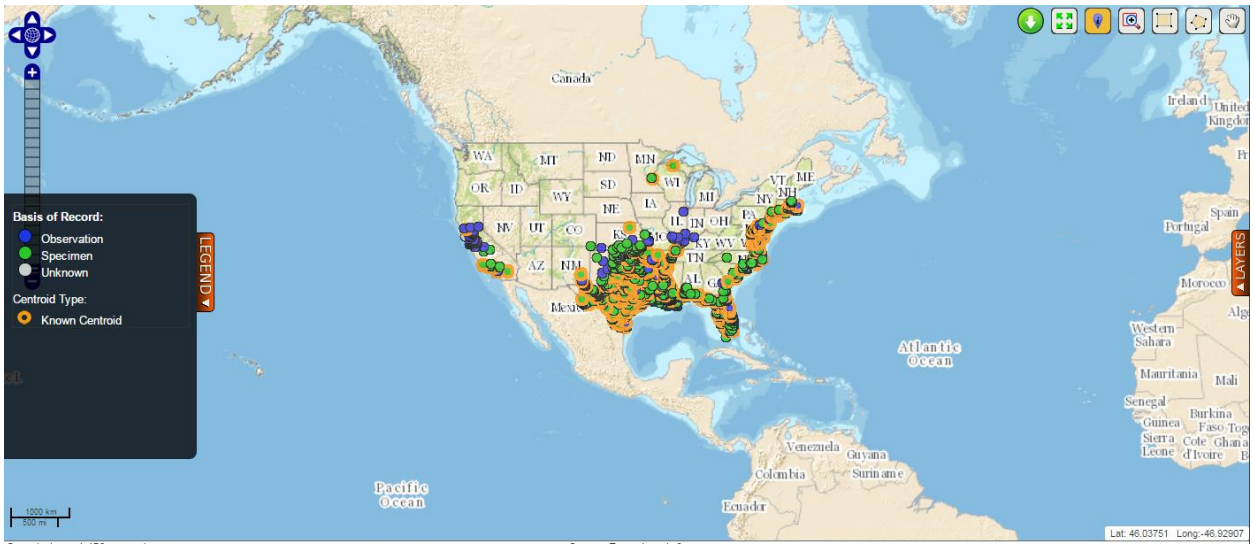

Figure 3. Known distribution of *Menidia beryllina* in the United States. Map from BISON (2017).

The location in Minnesota (Figures 2, 3) represents a failed introduction (Fuller et al. 2016) and was not used as a source point in the climate match.

The location in Michigan (Figure 3) was not used as a source point in the climate match. There is no mention of a population in Michigan in the literature.

6 Climate Matching

Summary of Climate Matching Analysis

The climate match for *Menidia beryllina* was low in western Washington, small pockets of the Great Plains and upper Midwest. It was medium in the Rocky Mountain States, upper Plains states, and much of the upper Midwest, and high everywhere else in the contiguous United States. A large portion of the areas of highest match comprise the native range of the species. The Climate 6 score (Sanders et al. 2018; 16 climate variables; Euclidean distance) for the contiguous United States was 0.767, high. All states had individually high climate scores except for North Dakota which had a low individual climate score. A score of 0.103 and above is high. This climate match only applies to the brackish and fresh water portions of the range of this species.

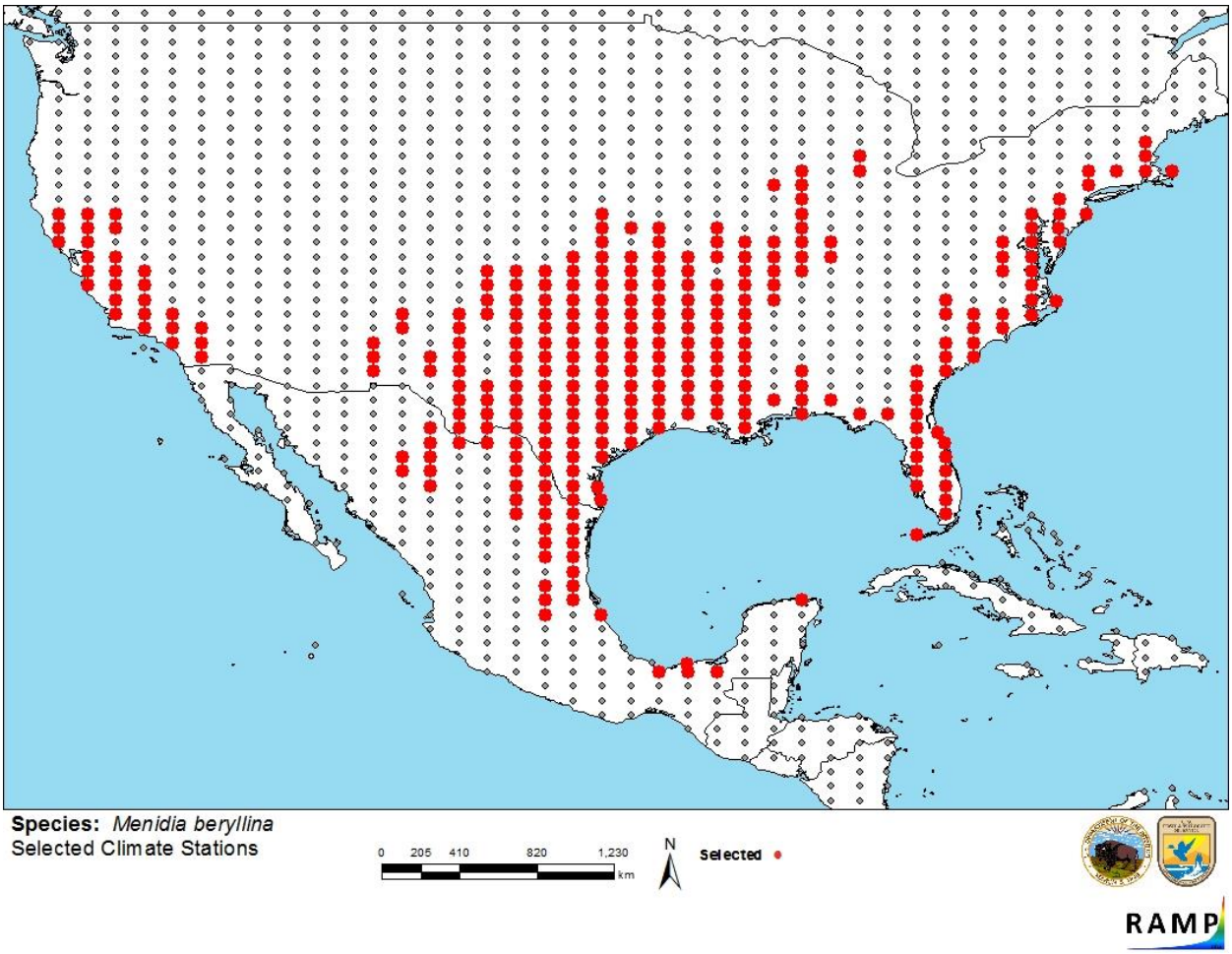

Figure 4. RAMP (Sanders et al. 2018) source map of North America showing weather stations selected as source locations (red) and non-source locations (gray) for *Menidia beryllina* climate matching. Source locations from Fuller et al. (2016), GBIF Secretariat (2016), and BISON (2017).

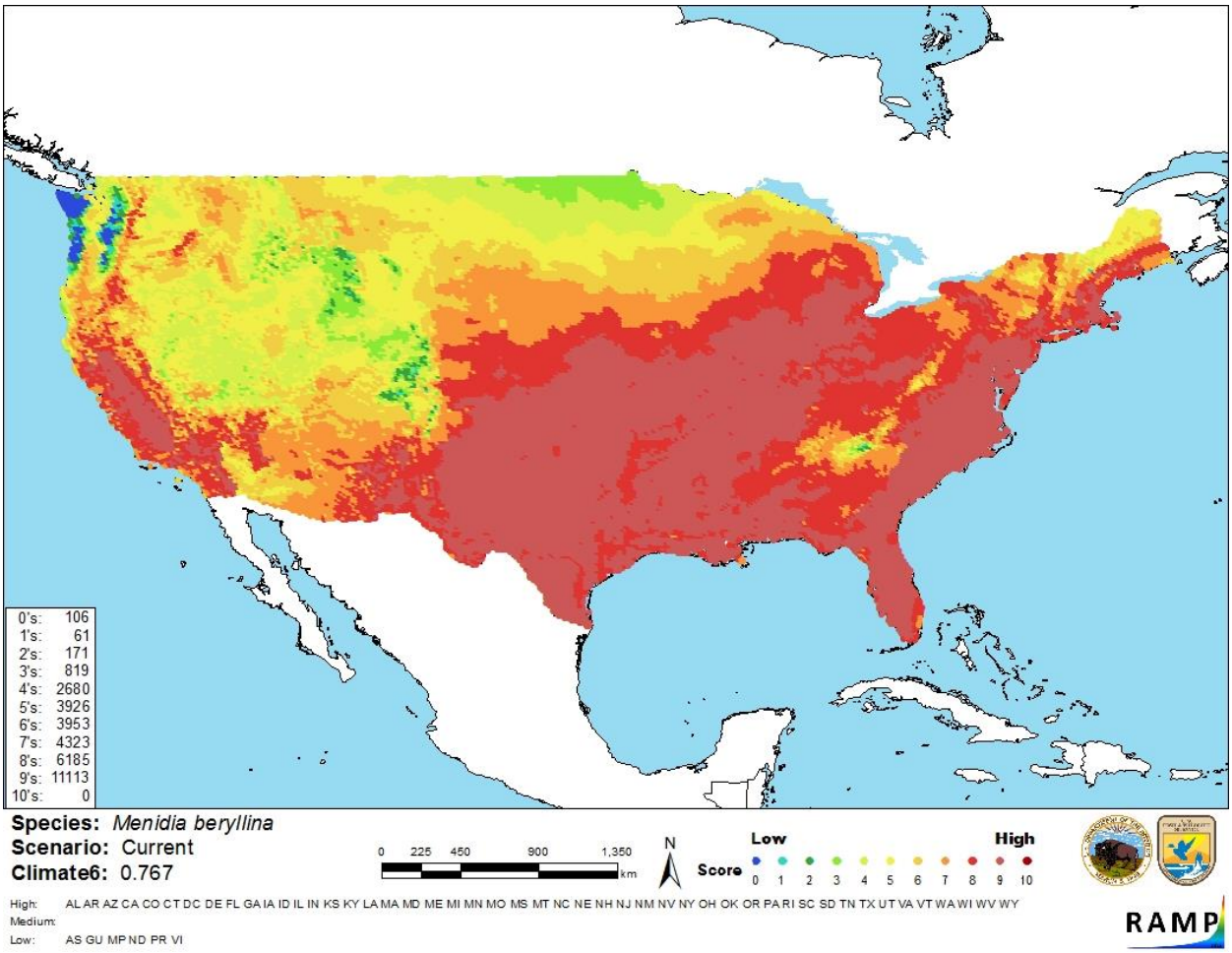

Figure 5. Map of RAMP (Sanders et al. 2018) climate matches for *Menidia beryllina* in the contiguous United States based on source locations reported by Fuller et al. (2016), GBIF Secretariat (2016), and BISON (2017). 0 = Lowest match, 10 = Highest match.

The High, Medium, and Low Climate match Categories are based on the following table:

Climate 6: Proportion of (Sum of Climate Scores 6-10) / (Sum of total Climate Scores)	Climate Match Category
0.000≤X≤0.005	Low
0.005<X<0.103	Medium
≥0.103	High

7 Certainty of Assessment

The certainty of this assessment is high. There is more than enough ecological and biological information available for *Menidia beryllina*. Many records of introduction were found that resulted in established populations and there were several studies in the peer-reviewed literature demonstrating significant impacts on the ecosystem where introduced.

8 Risk Assessment

Summary of Risk to the Contiguous United States

Inland Silverside (*Menidia beryllina*) is a fish native to the North American Atlantic and Gulf Coasts and the Mississippi River and their drainages. *M. beryllinia* has been stocked in the United States as food for sportfish and to control aquatic insects and algae. It likely is used as a baitfish, and is used in cancer research. An unidentified species of *Gyrodactylus* reportedly parasitized *M. beryllina; Gyrodactylus salaris* is an OIE reportable disease. The history of invasiveness for *Menidia beryllina* is high. There are many records of introduction, both intentional and accidental. Those introductions have resulted in significant impacts on native species, in some cases displacing them or contributing to extinction. The climate match is high for the contiguous United States; only western Washington, small pockets of the Great Plains, and the upper Midwest had a low match. Areas of high match extended beyond *M. beyllinia's* native range in the Atlantic and Gulf coastal areas and the Mississippi River drainage. Part of the range of this species is marine. The climate match only used fresh and brackish water locations as source points and only matched to non-marine areas. The certainty of assessment is high because information on distribution and impacts is clear and well-documented. The overall risk assessment category is high.

Assessment Elements

- **History of Invasiveness (Sec. 3): High**
- **Climate Match (Sec. 6): High**
- **Certainty of Assessment (Sec. 7): High**
- **Remarks/Important additional information:** An unidentified species of *Gyrodactylus* reportedly parasitized *M. beryllina; Gyrodactylus salaris* is an OIE reportable disease.
- **Overall Risk Assessment Category: High**

9 References

Note: The following references were accessed for this ERSS. References cited within quoted text but not accessed are included below in Section 10.

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