Round Goby (*Neogobius melanostomus*)
Ecological Risk Screening Summary

Web Version—08/08/2014

Photo: E. Engbretson, USFWS.

1 Native Range, and Status in the United States

Native Range

From Kottelat (1997):

"Europe and Asia: Sea of Azov, Black Sea and Caspian basins."

Status in the United States

From Fuller et al. (2011):

"Already spread to all five Great Lakes, with large populations in Lakes Erie and Ontario. Likely to find suitable habitat throughout Lake Erie and in all Great Lakes waters at depths less than 60 m (EPA 2008). Established outside of the Great Lakes basin in 1994 (Dennison, personal communication), and in 2010 spread into the lower Illinois River (Irons, personal communication)."

"Round goby was considered extremely abundant in the St. Clair River in 1994. Short trawls made in Lake Erie in October 1994 turned up 200 individuals. Frequent trawling in 1995 collected over 3,000 individuals near Fairport Harbor, Ohio (Knight, personal communication). Densities in Calumet Harbor exceed 20 per square meter (Marsden and Jude 1995). Gravid females and different size classes have been found in Lake Erie (Cavender, personal communication). In Lake Superior, primarily established in Duluth-Superior Harbor and lower St. Louis River, and absent from the remainder of the western portion of the lake (Bergstrom et al. 2008)."

"This species was introduced into the St. Clair River and vicinity on the Michigan-Ontario border where several collections were made in 1990 on both the U.S. and the Canadian side (Jude et al. 1992, D. J. Jude and D. Nelson, personal communication). By 1994 the species had spread to the north end of Lake St. Clair at Anchor Bay. Gobies have been taken inland in the Shiawasse and Flint rivers since August 1996 and June 1997, respectively, and the River Raisin in 1999 (D. Jude, personal communication). In 1998, the goby was reported from numerous places along the eastern shore of Michigan in Lake Huron such as Lexington, Tawas City, and Thunder Bay River (Hintz 2000, A. Hintz, personal communication). Gobies have also been collected in Michigan's Upper Peninsula at Port Inland and in Little Bay De Noc (G. Madison, personal communication). They have also been collected in the Upper Peninsula ports of Kipling and Escanaba, and the northeastern port of Charlevoix (Clapp et al. 2001) as well as Lake Michigan and the Saginaw River (Czypinski et al. 2000, Czypinski et al. 2002, Hintz 2000). Established in Muskegon Lake (Alexander 2004). In 1994, the round goby began appearing in southern Lake Michigan near the Calumet-Chicago area of Illinois (T. Cavender, P. Thiel, personal communication). *N. melanostomus* also has been documented to occur in lower Lake Michigan at the ports of Muskegon, Grand Haven, and Saugatuck (Clapp et al. 2001). In 1999, the goby was near the confluence of the Calumet-Sag Channel and the Chicago Sanitary and Shipping Canal (F. Veraldi, personal communication). Also collected at Illinois River (R.M. 249.3) [vicinity of Marseilles, IL] (Sublette et al. 1990) and in the La Grange reach of the river between Beardstown and Peoria in 2004 (K. Irons, personal communication). It was first collected in Indiana from the Grand Calumet River in 1993 (J. Francis, personal communication). The following year it was taken in Hammond Harbor (J. Francis and T. Lauer, personal communication); then in the Port of Indiana and East Chicago in 1996 (J. Francis, personal communication), in Wolf Lake (P. Charlebois, personal communication), and Indiana Dunes National Lakeshore (Tilmant 1999). Gobies have been reported from Alpena, Arenac, Bay, Charlevoix, Cheboygan, Huron, Iosco, Mackinac, Monroe, Ottawa, Saginaw, Schoolcraft, and Wayne Counties, Michigan (Bowen, unpublished data). In 1993, it was collected at Fairport

Harbor in Lake Erie, and from the mouth of the Grand River in Lake County, Ohio (Knight 1994). Annual surveys are collecting gobies from Lake Erie at Conneaut, Ashtabula, Cleveland, and Sandusky, Ohio (Czypinski et al. 2002, S. Keppner, personal communication). In 1994, the species was taken from the lake offshore at depths of 70 feet, and reportedly from Lorain Harbor in Lorain County, Ohio, 60 miles west of Fairport, although there are no vouchers to confirm this location (T. Cavender, personal communication). It is established in Cedar Point National Wildlife Refuge (USFWS 2005). This species was also collected in the Maumee and Cuyahoga Rivers (Czypinski et al. 2002). The round goby was first reported from Pennsylvania in October 1996, in Lake Erie off Walnut Creek, just west of the city of Erie (C. Murray, personal communication) and later collected in Lake Erie in ruffe surveys (Czypinski et al.2000, Czypinski et al. 2002). In 2001 and 2002, a study found that several Pennsylvania tributaries of Lake Erie had established populations of round goby: Elk Creek, Twenty Mile Creek, Walnut Creek, and Sixteen Mile Creek (Phillips et al. 2003). In July 1995, a single individual was collected from Wisconsin waters of the St. Louis Bay, Lake Superior, on the Minnesota-Wisconsin state line in a trawl (T. Busiahn, personal communication); This species was also collected in the St. Louis River estuary from 1999-2001 (Czypinski et al.2000, Czypinski et al. 2002). In May 1996, the first single adult was taken in Duluth Harbor, Minnesota. By 1999, gobies were found in several other locations within the harbor (D. Jensen, personal communication). There was an unconfirmed report of a round goby in eastern Lake Ontario, New York, during the summer of 1995. Reports of gobies in eastern Lake Erie in Buffalo, New York were confirmed in 1998 (Czypinski 2002, S. Keppner, personal communication). They have been reported in the Erie Canal, Buffalo River, St. Lawrence River, Genesee River, Tonowanda Creek, and Lake Ontario in 2004 and 2005 (Goehle, unpublished data). Gobies have also been found in the Welland Canal near Welland, Ontario, Canada (Anonymous, personal communication). The first confirmed collection of a round goby in Lake Ontario occurred in July 1998. A single fish was collected at Port Dalhousie at the mouth of the Welland Canal in Ontario, Canada (C. Scobie, personal communication). Gobies were collected in Lake Huron in 1994 at Goderich, Ontario. They have since been collected near Bayfield, Grand Bend, and Port Franks, Ontario (A. Dextrase, personal communication). Along the north shore of Lake Erie, gobies have been reported from Colchester, Point Pelee, Port Glasgow, Port Bruce, and Port Burwell, Ontario. A single goby was taken in the St. Lawrence River near Quebec, Quebec in 1997 (L. Lapierre, personal communication). In July 1999, a goby was collected in northeastern Lake Ontario in the Bay of Quinte (R. Dermott, personal communication)."

Means of Introductions in the United States

From Fuller et al. (2011):

"Introduced into the Great Lakes from the Black Sea via freighter ballast. Spread to Lake Superior by freighters operating within the Great Lakes."

Remarks

From Fuller et al. (2011):

"The diet of round gobies collected in the United States consists of aquatic insects, zebra mussels, and some native snails. Studies have shown a single goby can eat as many as 78 zebra mussels per day. This goby is a very pugnacious fish that feeds voraciously, and, as such, it may prey on the young of other deepwater bottom dwellers such as sculpins, darters, and logperch. Its well-developed lateral line may help it out compete natives for food in the murky Great Lakes waters. Its pugnacious appetite is not reserved solely for other species; round goby males are known to eat other male's eggs when they take over a spawning ground (Janssen and Jude 2001, and references therein). Adult round goby also have been known to feed on smaller round goby."

"The round goby's aggressive nature may allow individuals to dominate prime spawning sites, making these sites unavailable to natives. There is a long spawning period during which individuals can spawn every 20 days, while they aggressively defend their nests (Jude et al. 1992, Jude 1993). Although Jude (1993) expected introduced round gobies to be restricted to near-shore rocky or weedy habitats, the species has since been captured at depths as great as 21.5 m (Cavender, personal communication). Divers have found an unusual characteristic of *N. melanostomus*. When divers overturn rocks to expose round gobies in their daytime shelters, more round gobies come to the site to feed on exposed prey but also to observe the divers (Janssen and Jude 2001). Yet if a predator approaches, such as a small-mouthed bass (*Micropterus dolomieu*) or a rock bass (*Amploplites rupestris*), the gobies will seek shelter (Janssen and Jude 2001). "

"Although the species exhibits two pigmentation morphs and investigations were planned to determine whether more than one introduction of *Neogobius* occurred in the Great Lakes (Cavender, personal communication), only *N. melanostomus*has been observed."

"Introduced populations of round gobies in the Great Lakes show reduced diversity and numbers of parasites compared to populations from its native range as well as to native Great Lakes fishes, providing some support for the 'enemy release hypothesis' for invasion success (Kvach and Stepien 2008a, Gendron et al. 2012). However, Gendron et al. (2012) found that round gobies from Lake St. Clair (one of the earliest introduced populations) showed an increase in parasite diversity and density over time."

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From ITIS (2010):

"Kingdom Animalia
Phylum Chordata
Subphylum Vertebrata
Superclass Osteichthyes
Class Actinopterygii
Subclass Neopterygii
Infraclass Teleostei
Superorder Acanthopterygii
Order Perciformes
Suborder Gobioidei
Family Gobiidae
Genus Neogobius
Species Neogobius melanostomus (Pallas, 1814)

Taxonomic Status: Valid."

Size, Weight, and Age Range

From Kottelat (1997):

"Maturity: Lm ?, range 4 - ? cm; Max length : 24.6 cm TL male/unsexed; (Skora et al. 1999); max. reported age: 4 years (Skora et al. 1999)."

Environment

From Kottelat (1997):

"Marine; freshwater; brackish; demersal; amphidromous (McDowall 1997); depth range 0 - 30 m (Skora et al. 1999)."

Climate/Range

From Kottelat (1997):

"Temperate; 4°C - 20°C (Baensch and Riehl 1991); 60°N - 36°N, 18°E - 58°E."

Distribution Outside the United States

Native
From Kottelat (1997):

"Europe and Asia: Sea of Azov, Black Sea and Caspian basins."

Introduced
From Kottelat (1997):

The species is reported as introduced in south Sweden (FAO 1997), Kazakhstan (Reshetnikov et al. 1997), Denmark (Sapota 2012), Austria (Wiesner 2004), the Aral Sea (Kamilov and Urchinov 1995), the Moscow River (FAO 1997), the Gulf of Gdansk (Skora et al. 1999), Rügen island (Skora et al. 1999), Riga Bay (Sapota 2012), the Netherlands (Bartley 2006), the Czech Republic (Lusk et al. 2010), the Baltic Sea (Sapota 2012), and Belgium (Verreycken et al. 2011).

Means of Introduction Outside the United States
From Kottelat (1997):

Reasons given for these introductions include unknown (FAO 1997, Lusk et al. 2010, Reshetnikov et al. 1997), diffused from other countries (Bartley 2006, Sapota 2012, Skora et al. 1999, Wiesner 2004), accidental (Kamilov and Urchinov 1995), and accidental with ships (Sapota 2012, Skora et al. 1999, Verreycken et al. 2011). All introduced populations are reported as established and most are reported to be having negative ecological impacts on native species.

Short description
From Kottelat (1997):

"Dorsal spines (total): 7 - 8; Dorsal soft rays (total): 12-17; Anal spines: 1; Anal soft rays: 9 - 14; Vertebrae: 31 - 34. This species is distinguished from its congeners entering freshwater in Europe by the following characters: first branched ray of second dorsal about as long as penultimate ray; no scales on midline of nape, in front of preoperculum; pelvic-disc fraenum with small rounded lobes and the length is less than 1/6 of width at base; scales in midlateral series 45-54 + 2-3; a large black spot on the posterior part of first dorsal (Kottelat and Freyhof 2007)."

Biology
From Kottelat (1997):

"Prefer shallow, brackish waters but also occur in fresh waters (Skora et al. 1999); in lagoons and lakes, large rivers, harbors, on sand or rock bottom; mostly found on well vegetated or rock bottom (Kottelat and Freyhof 2007). Can tolerate a temperature range of 0 to 30°C, but mainly thrive in warm temperate waters; able to tolerate low oxygen content waters for several days (Skora et al. 1999). Oviparous, with demersal eggs (Skora et al. 1999). Longevity up to 4 years. Males reproduce for the first time at 3-4 years, females at 2-3 years. Spawning season in April to September; females may repeat spawning during a season, every 18-20 days; body of males entirely black during this season. Adhesive eggs deposited on stones, shells and aquatic plants; males guard eggs until hatching and usually die after spawning season. Egg clutches are supposed to be occasionally transported attached to the hull of ships, facilitating introduction to other areas. Feeds on a wide variety of invertebrates and small fish, mostly on molluscs (Kottelat and Freyhof 2007)."

Human uses

From Kottelat (1997):

"Fisheries: commercial; aquarium: commercial; bait: occasionally."

"Due to its large size, it has a major commercial value in some areas, especially in Azov Sea. It is usually salted, dried and consumed with beer (Patzner et al. 2011)."

Diseases

From Kornis et al. (2012):

"At least 94 species of parasites are known for *N. melanostomus* (Kvach and Stepien 2008b)."

"*Neogobius melanostomus* is also a known host of viral haemorrhagic septicaemia virus (VHSV) in the Great Lakes (Al-Hussinee et al. 2011)."

VHS is an OIE-reportable disease.

Threat to humans

Potential pest.

3 Impacts of Introductions

From Fuller et al. (2011):

"The distribution of the round goby around the inshore areas of the Black and Caspian seas indicates their potential for widespread occupation of inshore habitats with cover, especially plants or rocky rubble, in the lower [Great Lakes], yet they can migrate to deeper water 50-60m in winter (Jude et al. 1992).

"The numbers of native fish species have declined in areas where the round goby has become abundant (Crossman et al. 1992). This species has been found to prey on darters, other small fish, and lake trout eggs and fry in laboratory experiments. They also may feed on eggs and fry of sculpins, darters, and logperch (Marsden and Jude 1995) and have also been found to have a significant overlap in diet preference with many native fish species. They compete with rainbow darters (*Etheostoma caeruleum*), logperch (*Percina caprodes*), and northern madtoms (*Noturus stigmosus*) for small macroinvertebrates (French and Jude 2001)."

"Mottled sculpins (*Cottus bairdi*) have been particularly affected since the establishment of *N. melanostomus* (Marsden and Jude 1995). This is almost certainly due to competition with sculpins for spawning sites in large round goby (greater than 100mm), for space in medium round goby (60-100mm) and for food in small round goby (less than 60mm) (Janssen and Jude 2001). Janssen and Jude (2001) argued that the main cause of the dramatic decline in the native mottled sculpin population is due to nesting interference with round goby; the other competition factors having a less severe impact, although they acknowledge the need for further research on

food competition. Adults aggressively defend spawning sites and occupy prime spawning areas, keeping natives out (Marsden and Jude 1995, Dubs and Corkum 1996). Laboratory experiments have shown that the more aggressive *N. melanostomus* will evict *C. bairdi* from rock shelters that are being used for spawning or daytime predator evasion (Dubs and Corkum 1996). In trials where round gobies were introduced into tanks with mottled sculpin residents, the gobies approached and chased the resident sculpin (Dubs and Corkum 1996). When sculpin were released into resident round goby tanks, the sculpin were chased and bitten (Dubs and Corkum 1996). Sculpin did not exhibit any aggressive behavior towards the round gobies in any scenario (Dubs and Corkum 1996). In Calumet Harbor, there has been an absence of mottled sculpin nests and fish aged 0 since 1994, coinciding with *N. melanostomus* establishment (Janssen and Jude 2001). *Neogobius melanostomus* and *C. bairdi* both take daytime refuge from predators under rocks, emerging to feed nocturnally (Dubs and Corkum 1996). This space competition could displace *C. bairdi* into deeper and unprotected spaces where they can easily be predated. Competition for food between *N. melanostomus* and *C. bairdi* occurs most heavily when they are young (less than 60mm). This is due to the overlap of an arthropod diet at this age (Janessen and Jude 2001)."

"The diet of larger round gobies consists mainly of zebra mussels, which no other fish species of the Great Lakes consumes so heavily, allowing round gobies to uniquely exploit a resource that could fuel a population explosion (Vanderploeg et al. 2002). Walleye anglers in Detroit report that at times, all they can catch are gobies, which eagerly attack bait (Marsden and Jude 1995)."

"The invasion of round gobies into Lake Erie has had very real environmental and economic impacts. The State of Ohio has shut down the smallmouth bass fishery in Lake Erie during the months of May and June. The reason is that high predation rates on nests are affecting smallmouth recruitment. Under normal circumstances male smallmouth bass guard nests and are effective in keeping round gobies away. When males are removed, round gobies immediately invade and have been shown to eat up to 4,000 eggs within 15 minutes. The months of May and June normally account for 50 percent of the total smallmouth catch in Lake Erie so there will be a considerable loss in funds generated by recreational fishers (National Invasive Species Council 2004)."

"Not all impacts of the introduced round goby are negative. Round gobies comprise the majority of the diet for Lake Erie water snakes (*Nerodia sipedon insularum*), and the abundance of gobies has been credited for the increase in population size, increased growth rates, and larger body size of the snakes (King et al. 2006). Due to their increase in abundance, the Lake Erie water snake was removed from the federal Endangered Species List in 2011. In addition, round gobies provide an abundant food source for several sportfishes including walleye (Taraborelli et al. 2010), yellow perch (Truemper and Lauer 2005), and largemouth/smallmouth bass (Steinhart et al. 2004, Taraborelli et al. 2010)."

"Increased abundance of round goby in the diet of double-crested cormorant (*Phalacrocorax auritus*) may reduce chick growth and reproductive success, due to a lower energy density compared to other native fishes (Ruetz et al. 2009), and thus could provide some control over cormorant populations (Van Guilder and Seefelt 2013)."

Neogobius melanostomus introductions may also be a vector for the spread of avian botulism. The change in behavior of infected gobies make them preferred prey items to piscivorous birds (Yule et al. 2006). At Lake Erie, botulism infected birds had been feeding more on round goby compared to uninfected birds (Corkum et al. 2004)."

From Lederer et al. (2006):

"There was a statistically significant negative relationship with round goby abundance for most invertebrates, including zebra mussels, quagga mussels, isopods, and snails, with the result for amphipods being suggestive…Thus, the results of the survey and rock-transfer experiment suggest that round gobies are influencing the benthic macroinvertebrate abundance through predation. The negative impact on mussels is probably due to direct predation while the negative impact on the other invertebrates may be a combination of direct predation and indirect effects due to the loss of the microhabitat or food that zebra mussels produce."

4 Global Distribution

Figure 1. Global distribution of *Neogobius melanostomus*. Map from GBIF (2010). Locations in Sweden; Columbus, Ohio; and off the coast of the Netherlands were not included because they were incorrectly located.

5 Distribution within the United States

Figure 2. Distribution of *Neogobius melanostomus* in the U.S. Map from Fuller (2010).

6 CLIMATCH

Summary of Climate Matching Analysis

The climate match (Australian Bureau of Rural Sciences 2008, 16 climate variables; Euclidean Distance) for the contiguous U.S. was high in the Midwest and the Northeast. The remaining inland areas have a medium match and coastal areas are low match. Climate 6 proportion indicated that the contiguous U.S. has a high climate match. The range for a high climate match is 0.103 and greater; climate match of *Neogobius melanostomus* is 0.461.

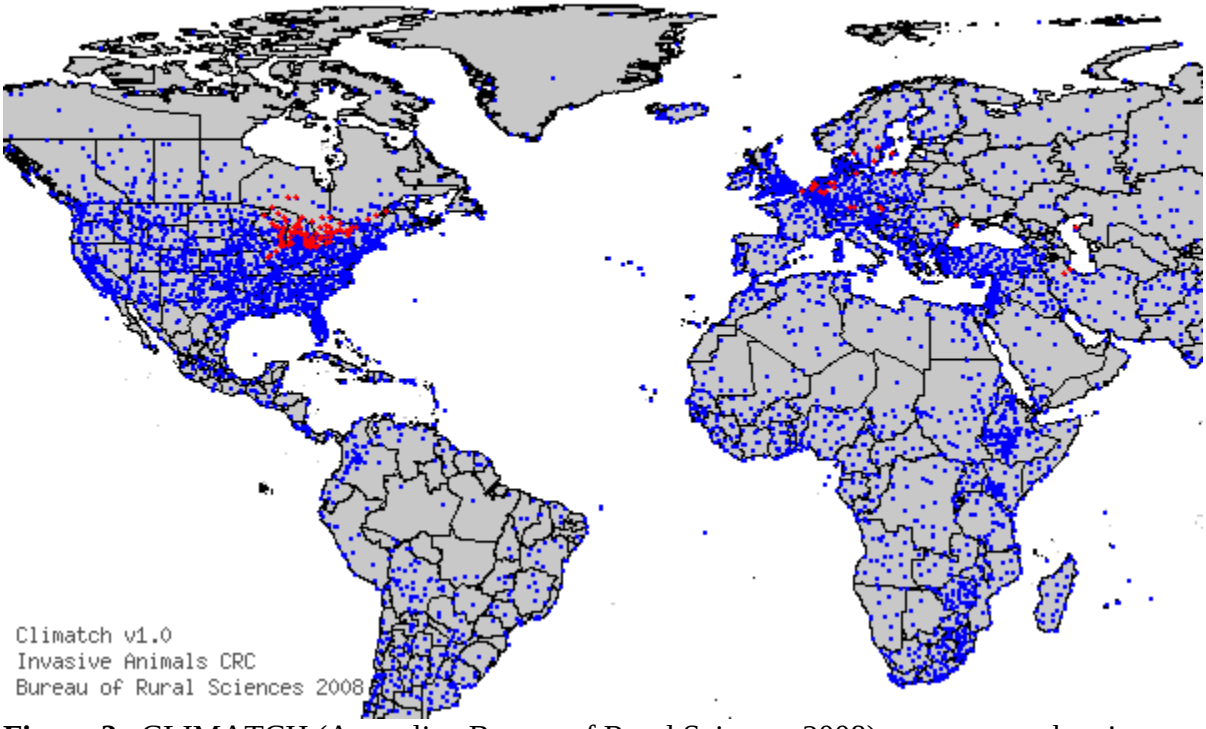

Figure 3. CLIMATCH (Australian Bureau of Rural Sciences 2008) source map showing weather stations selected as source locations (red) and non-source locations (blue) for *Neogobius melanostomus* climate matching. Source locations from GBIF (2010).

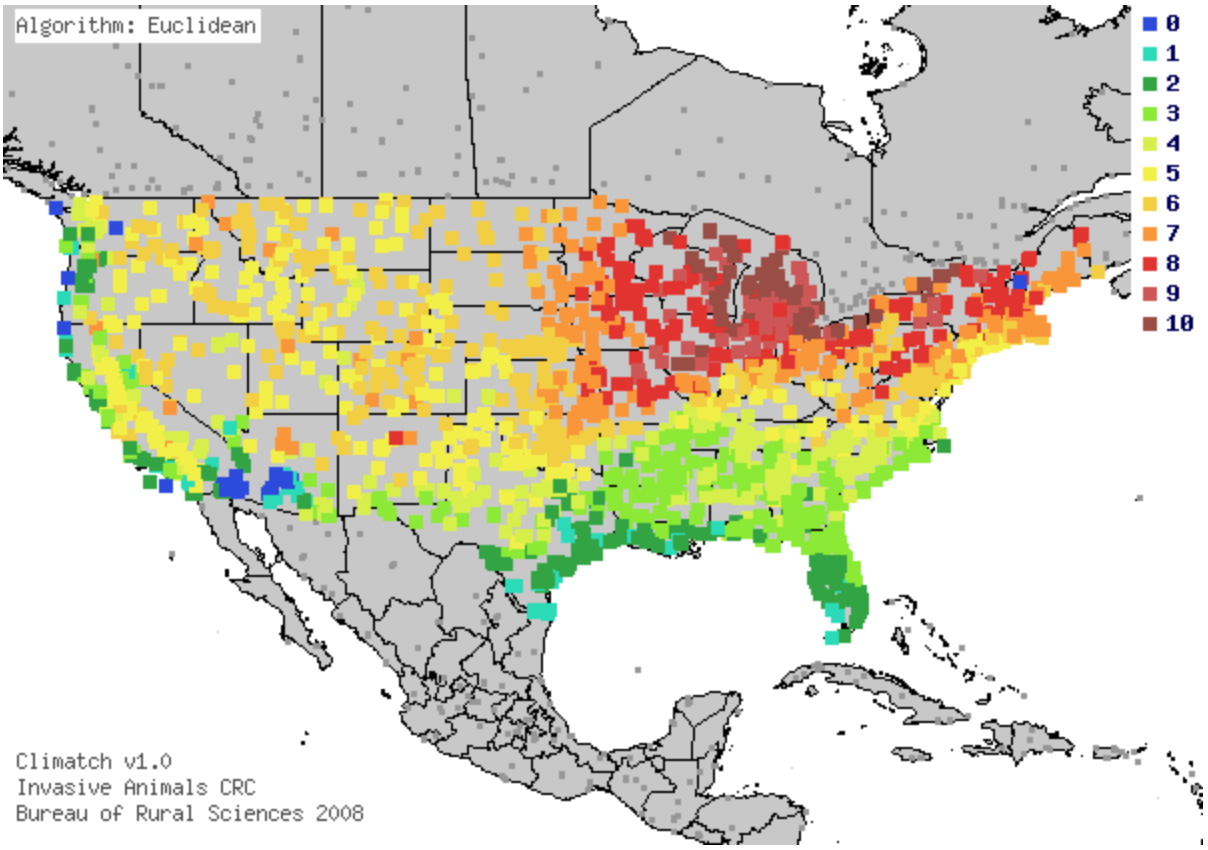

Figure 4. Map of CLIMATCH (Australian Bureau of Rural Sciences 2008) climate matches for *Neogobius melanostomus* in the continental United States based on source locations reported by GBIF (2010). 0= Lowest match, 10=Highest match.

Table 1. CLIMATCH (Australian Bureau of Rural Sciences 2008) climate match scores.

CLIMATCH Score	0	1	2	3	4	5	6	7	8	9	10
Count	28	56	192	270	226	291	359	216	182	72	82
Climate 6 Proportion =		0.461									

7 Certainty of Assessment

Information on the biology, impacts, and distribution of *Neogobius melanostomus* is readily available. Negative impacts from introductions of this species are adequately documented in the scientific literature. No further information is needed to evaluate the negative impacts the species is having where introduced. Certainty of this assessment is high.

8 Risk Assessment

Summary of Risk to the Contiguous United States

Neogobius melanostomus is a euryhaline fish native to the Sea of Azov, Black Sea, and Caspian basins. This species has been introduced to multiple countries, including the United States. This species has established in the Midwest and Northeast, and there is evidence of negative impacts. *Neogobius melanostomus* has become an important part of the food web in the Great Lakes to the advantage of some native species, but also at the expense of others. Several documents indicate that *Neogobius melanostomus* has a significant diet overlap with native fishes, which could indicate competition for food. This species feeds on fry and eggs of important sport fishes such as Smallmouth Bass. This species is also known to disrupt the spawning of native sculpins. Native fish abundance has decreased following invasion by *Neogobius melanostomus*. Climate match with the contiguous U.S. is high. The overall risk for this species 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** Potential pest, carries 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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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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