Freshwater Tubenose Goby (*Proterorhinus semilunaris*)

Ecological Risk Screening Summary

U.S. Fish & Wildlife Service, February 2020
Revised, March 2020
Web Version, 1/25/2021

Organism Type: Fish
Overall Risk Assessment Category: High

Photo: Piet Spaans. Licensed under Wikimedia Commons. Available: https://commons.wikimedia.org/wiki/File:Proterorhinus_semilunaris,_the_Netherlands_-_20051030.jpg (February 2020).

1 Native Range and Status in the United States

Native Range

From Froese and Pauly (2020a):

"Euorpe [*sic*]: Black Sea basin; Maritza and Struma drainages in eastern Aegean basin."

Froese and Pauly (2020a) report this species is native in the following countries: Turkey, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Moldova, Romania, and Ukraine.

Status in the United States

According to Fuller et al. (2020) nonindigenous occurrences of *Proterorhinus semilunaris* have been reported in the following States, with range of years of reported observations and hydrologic units in parentheses:

- Michigan (1990–2020; Cheboygan, Clinton, Detroit, Lake Erie, Lake Huron, Lake St. Clair, Lone Lake-Ocqueoc, Ottawa-Stony, Raisin, St. Clair)
- Minnesota (2001–2015; St. Louis River)
- New York (2016–2020; Headwaters of the St. Lawrence River; Raisin River-St. Lawrence River)
- Ohio (2001–2019; Cedar-Portage; Lake Erie)
- Pennsylvania (2011–2015; Lake Erie)
- Wisconsin (2003–2016; Beartrap-Nemadji, St. Louis).

From Fuller et al. (2020):

"This species is not spreading rapidly (Vanderploeg et al. 2002), but has undergone some recent expansion in both the western and eastern basins of Lake Erie (Kocovsky et al. 2011; Grant et al. 2012)."

From Kocovsky et al. (2011):

"Tubenose gobies spread throughout Lake St. Clair, its tributaries, and the Detroit River system, and also are present in the Duluth-Superior harbor of Lake Superior."

Proterorhinus semilunaris falls within Group I of New Mexico's Department of Game and Fish Director's Species Importation List (New Mexico Department of Game and Fish 2010). Group I species "are designated semi-domesticated animals and do not require an importation permit." It also has the additional restriction of "Not to be used as bait fish."

P. semilunaris is listed as a Prohibited species in New York (New York State Senate 2019). "Prohibited invasive species cannot be knowingly possessed with the intent to sell, import, purchase, transport or introduce. In addition, no person shall sell, import, purchase, transport, introduce or propagate prohibited invasive species."

From Virginia DWR (2020):

"A special permit is required, and may be issued by the Department, if consistent with the Department's fish and wildlife management program, to import, possess, or sell the following non-native (exotic) amphibians, fish, mollusks, aquatic invertebrates, and reptiles: […] tubenose goby"

Means of Introductions in the United States

From Fuller et al. (2020):

"Introduced via ballast water."

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

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing
According to Fricke et al. (2020), *Proterorhinus semilunaris* (Heckel 1839) is the current valid name for this species. It was originally described as *Gobius semilunaris* (Heckel 1839).

From Froese and Pauly (2020b):

"Animalia (Kingdom) > Chordata (Phylum) > Vertebrata (Subphylum) > Gnathostomata (Superclass) > […] Actinopterygii (Class) > Perciformes (Order) > Gobioidei (Suborder) > Gobiidae (Family) > Gobiinae (Subfamily) > *Proterorhinus* (Genus) > *Proterorhinus semilunaris* (Species)"

Size, Weight, and Age Range
From Froese and Pauly (2020a):

"Max length : 9.0 cm SL male/unsexed; [Kottelat and Freyhof 2007]"

From Eakins (2020):

"Adult Length (cm): 4.5-7.7 TL
Adult Weight (kg): 0.001-0.006
Age at Maturity (yrs): 1-2
Maximum Length (cm): 9.0 SL
Maximum Weight (kg): no data
Lifespan (yrs): 3-4"

From Fuller et al. (2020):

"12.7 cm total length"

Environment
From Froese and Pauly (2020a):

"Freshwater; brackish; benthopelagic."

Climate
From Froese and Pauly (2020a):

"Temperate"

Distribution Outside the United States

Native

From Froese and Pauly (2020a):

"Euorpe [*sic*]: Black Sea basin; Maritza and Struma drainages in eastern Aegean basin."

Froese and Pauly (2020a) report this species is native in the following countries: Turkey, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Moldova, Romania, and Ukraine.

Introduced

From Froese and Pauly (2020a):

"In Danube, present up to about Vienna, invasive since 1970s, now reaching upstream to southern Germany. In South Bug and Dniepr native far upriver. Introduced to North America in 1991 […]."

Froese and Pauly (2020a) report this species is introduced in the following countries: Austria, Belarus, Germany, Hungary, and Netherlands.

From Manné and Poulet (2008):

"Western tubenose gobies were captured for the first time in France in the Rhine River in September 2007."

"It spread out its native range as far as the Netherlands in Europe in 2002 […]."

"In August 1997, *P. semilunaris* was observed in the Roth drainage (Germany), which receives water from the Rhine-Main-Danube canal (Von Landwust, 2006). It reached the River Main in 1999 (Reinartz et al., 2000; Schadt, 2000) and then it was reported in the Rhine River in 2000 between the Main confluence and Coblence before being captured in the Netherlands in 2002 (Kottelat and Freyhof, 2007). In 2005, it was found in the downstream part of the Moselle drainage, one of the main Rhine tributaries (Von Landwust, 2006)"

From Mombaerts et al. (2014):

"In 2010, the tubenose goby (*Proterorhinus semilunaris*) and round goby (*Neogobius melanostomus*) were observed in Belgium for the first time."

From Adámek et al. (2010):

"In the Danube River watershed, tubenose goby was registered for a long time as far west as Neusiedler Lake in Austria and in the Danube River tributaries – the Váh, Nitra and Morava rivers – on the Slovak territory."

"In the Morava River (the Danube tributary from the Czech territory), tubenose goby was first recorded by Koelbel (1874), near the mouth into the Danube. This site has been for a long time the only locality of tubenose goby occurrence in the Morava River. In the nineties, the tubenose goby slowly commenced to spread upstream up to 41 r. km of the Morava River near the village of Gajary (Slovakia) (Spindler et al., 1992; Prášek and Jurajda, 2005)."

Huyse et al. (2015):

"Here we report for the first time that this parasite species successfully reached Belgium, together with its type host, *P. semilunaris*. Given the fact that the most likely introduction is via the Rhine Main-Danube canal (Mombaerts et al. 2014 and references therein), this finding implies that *G. proterorhini* has probably also been introduced in the Netherlands and Germany."

Means of Introduction Outside the United States

From Froese and Pauly (2020a):

"[…] through ballast of ships."

"It is invasive in Danube and Rhine where reportedly, the spreading was due to canalization of main river and reservoirs or slow-flowing waters created by hydroelectric plants [Kottelat and Freyhof 2007]."

From Manné and Poulet (2008):

"Its expansion in Western Europe has been facilitated by the digging of the "Rhine-Main-Danube" canal in 1992 (Freyhof, 2003), but also by its use as live bait in the south-eastern Czech Republic (Prasek and Jurajda, 2005)."

From Kocovsky et al. 2011:

"Nighttime drift of larval and juvenile freshwater tubenose gobies has been demonstrated in the Danube River system in Austria (Zitek et al. 2004), which has facilitated their expansion beyond commercial shipping ports.

Short Description

From Fuller et al. (2020):

"This species (along with the round goby *Neogobius melanostomus*) can be distinguished from all other fishes in the Great Lakes by the presence of fused pelvic fins. Tubenose goby can be distinguished from the round goby by its long anterior nostrils and lack of black spot on posterior base of dorsal fin (Miller 1986; Jude 1993)."

Biology

From Froese and Pauly (2020a):

"Inhabits a variety of slow-flowing or still waters from estuarine to small, slow flowing premontane streams; usually in dense vegetation or coarse rocks, and often very abundant in backwaters and lakes, breeds in reservoirs and channels. Preys on benthic invertebrates. Spawns for the first time at 1-2 years, usually for 1-2 seasons only, in April to August. Females may spawn more than once during the season and males guard the eggs that are deposited in cavities. Larvae and juveniles are benthic."

From Fuller et al. (2020):

"The tubenose goby is a benthic omnivores [*sic*], consuming a wide variety of benthic invertebrates (chironomids, crustaceans, copepods, dipterans, ephemeropterans, ostracods, and trichopterans) and occasionaly larval fishes (French and Jude 2001; Adamek et al. 2007). Generally inhabits shallow (less than 5 m depth), slow-moving, nearshore environments. Prefers areas with abundant aquatic macrophytes, but can also be found in sandy areas (Jude and Deboe 1996)."

From Kocovsky et al. (2011):

"Tubenose gobies, like round gobies *Neogobius melanostomus*, have early life stages that drift owing to vertical migration, which probably allowed them to spread from areas of colonization."

Human Uses

From Manné and Poulet (2008):

"[…] use as live bait in the south-eastern Czech Republic (Prasek and Jurajda, 2005)."

Diseases

No records of OIE-reportable diseases (OIE 2021) were found for *Proterorhinus semilunaris*.

From Zhokhov et al. (2017):

"The metazoan parasites of the invasive goby species *Proterorhinus semilunaris* were studied in August 2015. In total, 101 specimens sampled at four sites of Rybinsk Reservoir were analyzed. Six parasite species were found: Unionidae gen. sp., *Paracoenogonimus ovatus, Diplostomum* sp., *Ichthiocotylurus platycephalus, Posthodiplostomum cuticola*, and *Camallanus lacustris*. Trematode metacercariae were the dominant parasites in all the studied samples."

From Huyse et al. (2015):

"[*Gyrodactylus*] *proterorhini* was originally described from the tubenose goby *P. semilunaris* […]"

From Manné and Poulet (2008):

"Furthermore, *P. semilunaris* has been identified as a paratenic host [can be a host of immature stages of the parasite but is not necessary for parasite's life cycle] of *Anguillicola crassus*, an eel parasite with severe pathological effects with, nevertheless, a low prevalence (Koubková and Baruš, 2000)."

Threat to Humans

From Froese and Pauly (2020a):

"Harmless"

3 Impacts of Introductions

From Mikl et al. (2017):

"Gobies [*Proterorhinus semilunaris*] had a negative impact on invertebrates at both sites, with overall invertebrate density reduced by 15% (ca. 17.9 g m-2 per year) at Site 1 and 36% (ca. 23.6 g m-2 per year) at Site 2. Both species showed increased impact in summer and ingested larger invertebrates preferentially, resulting in an overall reduction in invertebrate body size. Tubenose gobies had a significant impact on Annelida, Gastropoda, Crustacea and Ephemeroptera nymphs, while tubenose and round goby together impacted Annelida, Bivalvia (Dreissena), Gastropoda, Crustacea, Ephemeroptera nymphs, Odonata nymphs and Chironomidae larvae. Our results confirm that round and tubenose gobies can have a significant negative impact on aquatic invertebrate density and community composition."

From Van Kessel et al. (2011):

"Various habitat choice experiments were conducted between two common native benthic fish species (*Cottus perifretum* and *Barbatula barbatula*) and four invasive non-native gobiid species (*Proterorhinus semilunaris, Neogobius melanostomus, N. kessleri* and *N. fluviatilis*). The first series of single specimen experiments determined the habitat choice of each individual fish species. In a second series of competition experiments, shifts in habitat choice in comparison with the previously observed habitat choice, were determined when a native benthic fish species co-occurred with non-native gobiid species. Native *C. perifretum* displayed a significant shift in habitat choice in co-occurrence with the gobiids *N. kessleri* or *P. semilunaris*. […] Our study therefore suggests that competition for shelter is likely to occur in rivers invaded by *N. kessleri* and *P. semilunaris* at sites where shelter is limiting"

The following sections refers to potential, not documented impacts.

From Kocovsky et al. (2011):

"The diet of tubenose gobies was almost exclusively invertebrates, suggesting dietary overlap with other benthic fishes, such as darters (*Etheostoma* spp. and *Percina* sp.), madtoms (*Noturus* spp.), and sculpins (*Cottus* spp.)."

From Fuller et al. (2020):

"The tubenose goby does not feed on zebra mussels, as do round gobies (Vanderploeg et al. 2002). However, it has been shown to have a significant overlap in diet preference with rainbow darters (*Etheostoma caeruleum*) and northern madtoms (*Noturus stigmosus*) and may compete with these native fish for food (French and Jude 2001)."

Proterorhinus semilunaris is a regulated species in at least three States.

4 History of Invasiveness

Proterorhinus semilunaris has been introduced to several countries including the United States, accidentally via ballast water and used as a live bait for fishing. Peer-reviewed studies demonstrate that *Proterorhinus semilunaris* has an impact on benthic invertebrate communities in the areas it is introduced to, resulting in a reduction of those communities densities. It has also been recorded as a potential competitor for food and habitat with several other benthic species including daters, scuplins, and madtoms. *Proterorhinus semilunaris* is a known vector for the parasite *G. proterorhini*. Therefore, the history of invasiveness is classified as "high."

5 Global Distribution

Figure 1. Known global distribution of *Proterorhinus semilunaris*. Observations are reported from United States, Canada, Netherlands, Belgium, France, Germany, Bulgaria, Greece, Serbia, Poland, Romania, Austria, Turkey, Slovakia, Moldova, Croatia and Hungary. Map from GBIF Secretariat (2020).

Exact coordinates for populations in Belarus and Bosnia and Herzegovina were not found and therefore not used to select source locations for climate source match.

6 Distribution Within the United States

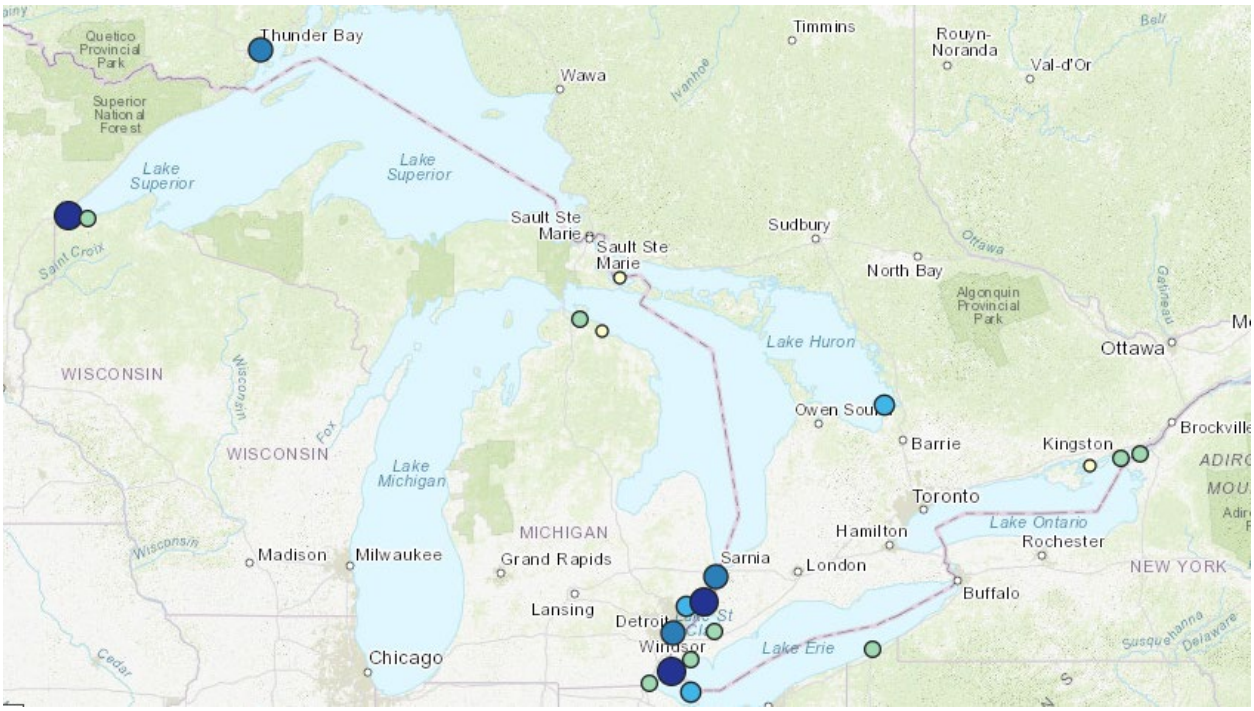

Figure 2. Known distribution of *Proterorhinus semilunaris* in the contiguous United States and Canada. Map from Fuller et al. (2020).

7 Climate Matching

Summary of Climate Matching Analysis

The climate match for *Proterorhinus semilunaris* was generally high throughout the contiguous United States with of areas of medium match in the west and areas of low match in the southeast and along the west coast. Areas of high climate match were generally found around the Great Lakes, the Northeast, and throughout the Midwest, while areas of low match were concentrated around Florida to Louisiana, and the west coast. The overall Climate 6 score was 0.428, high (scores 0.103 and greater are classified as high). All States had high individual climate 6 scores except for Kentucky, North Carolina, Rhode Island, and Tennessee, which had a medium score, and Alabama, Florida, Georgia, Louisiana, Mississippi, South Carolina, and Texas, which had low scores.

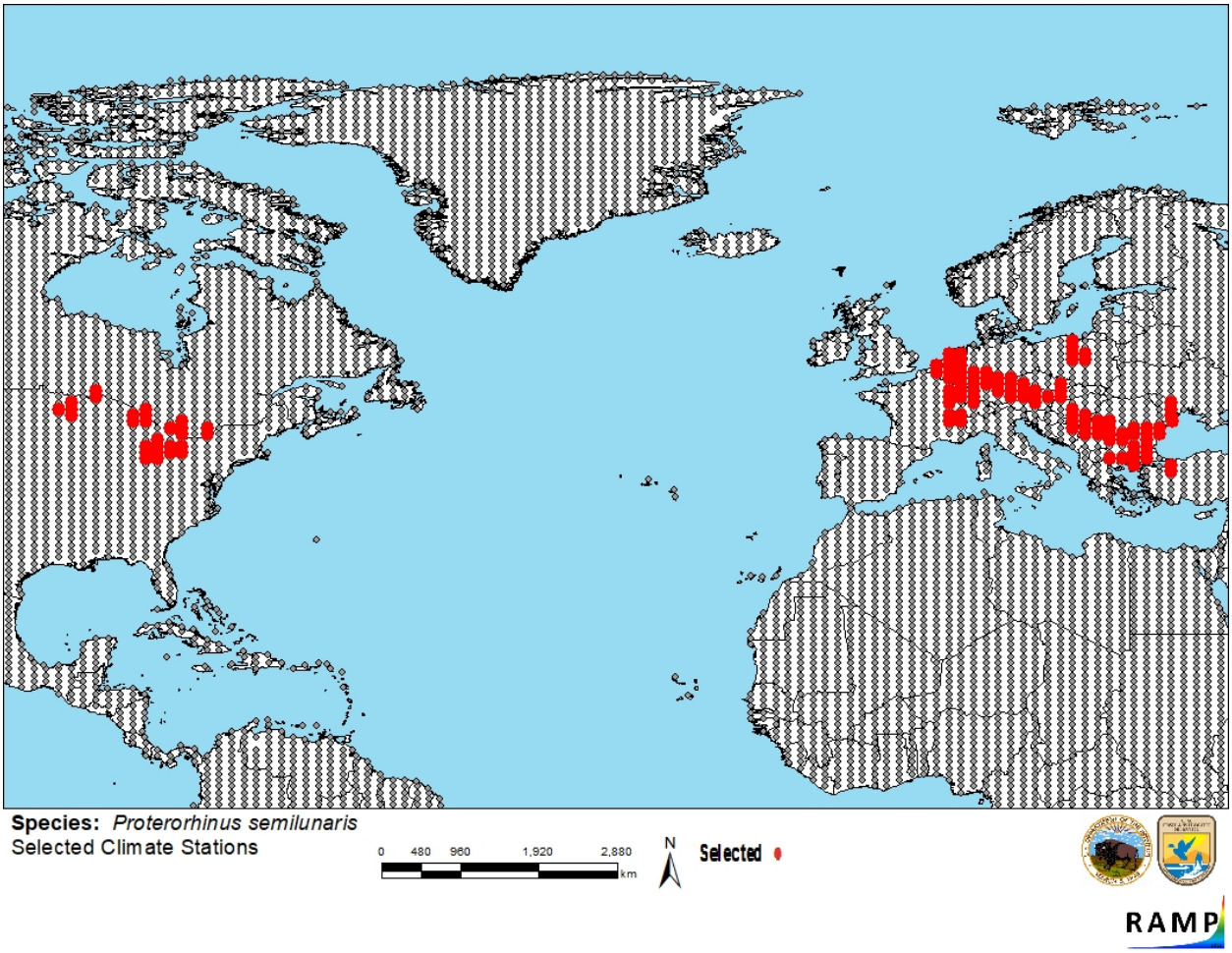

Figure 2. RAMP (Sanders et al. 2018) source map showing weather stations in North America and Europe selected as source locations (red; Canada, United States, Austria, Belgium, Bosnia-Herzegovina, Bulgaria, Czech Republic, Croatia, France, Germany, Greece, Hungary, Moldova, Netherlands, Poland, Romania, Serbia, Slovakia, Switzerland, Turkey, Ukraine) and non-source locations (gray) for *Proterorhinus semilunaris* climate matching. Source locations from GBIF Secretariat (2020). Selected source locations are within 100 km of one or more species occurrences, and do not necessarily represent the locations of occurrences themselves.

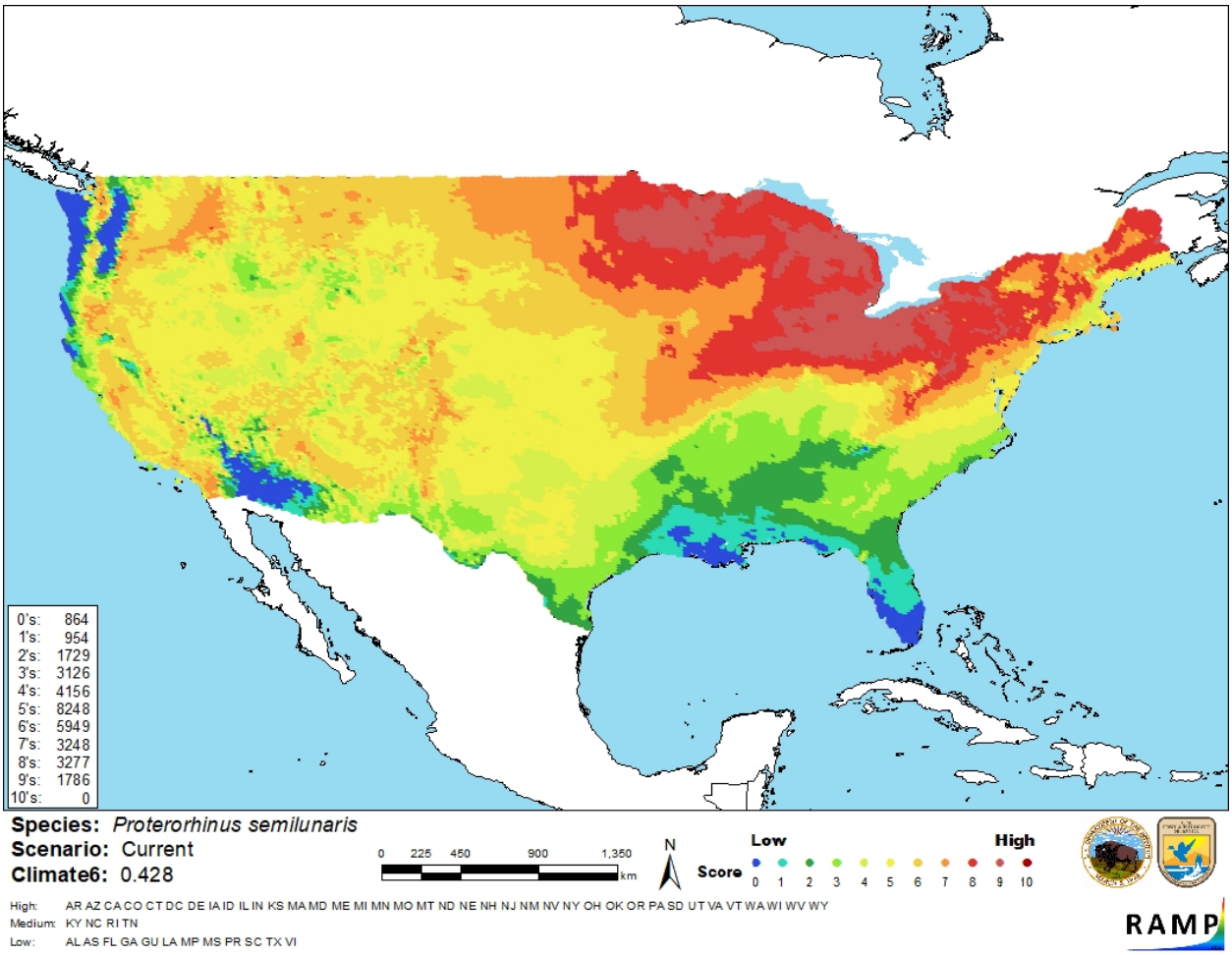

Figure 3. Map of RAMP (Sanders et al. 2018) climate matches for *Proterorhinus semilunaris* in the contiguous United States based on source locations reported by GBIF Secretariat (2020). Counts of climate match scores are tabulated on the left. 0/Blue = Lowest match, 10/Red = Highest match.

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

Climate 6: (Count of target points with climate scores 6-10)/ (Count of all target points)	Overall Climate Match Category
0.000≤X≤0.005	Low
0.005<X<0.103	Medium
≥0.103	High

8 Certainty of Assessment

The certainty for this assessment is high. There is quality information available about the biology and ecology of *Proterorhinus semilunaris*. Records of introduction, vectors and establishment were found in several countries outside of the native range for *Proterorhinus semilunaris*.

Several peer-reviewed sources documented the impacts *Proterorhinus semilunaris* has already had in the areas it has been introduced to, while also outlining several potential impacts that it may have as well.

9 Risk Assessment

Summary of Risk to the Contiguous United States

Proterorhinus semilunaris, the Freshwater Tubenose Goby, is a freshwater fish native to Europe in the Black Sea basin and the Maritza and Struma drainages in the eastern Aegean basin. The transportation, sale and use as a bait, and the drifting larval stage of *Proterorhinus semilunaris* has led to its introduction throughout parts of Europe as well as several of the Great Lakes in North America. The history of invasiveness is classified as "high." There are several peer reviewed articles that detail the negative impacts this species has had in its introduced range, while also documenting further potential impacts as well. *Proterorhinus semilunaris* is a regulated species in at least three States. The overall climate match for the contiguous United States was high. Most of the areas of high match were in the Northeast and Great Lakes area. Areas of low match were found around the Gulf Coast, Southwest, and Pacific Coast. The certainty of this assessment is high because of the abundant peer reviewed information that is available on this species and the impacts it has had in its introduced range. The overall risk assessment category is high.

Assessment Elements

- **History of Invasiveness (Sec. 4): High**
- **Overall Climate Match Category (Sec. 7): High**
- **Certainty of Assessment (Sec. 8): High**
- **Remarks/Important additional information: No additional remarks**
- **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.

Adámek Z, Jurajda P, Prášek V, Sukop I. 2010. Seasonal diet patterns of non-native tubenose goby (*Proterorhinus semilunaris*) in a lowland reservoir (Mušov, Czech Republic). Knowledge and Management of Aquatic Ecosystems 397(2):1–12.

Eakins RJ. 2020. Freshwater tubenose goby. Ontario Freshwater Fishes Life History Database. Version 4.59. Available: http://www.ontariofishes.ca (February 2020).

Fricke R, Eschmeyer WN, van der Laan R, editors. 2020. Eschmeyer's catalog of fishes: genera, species, references. California Academy of Science. Available: http://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp (February 2020).

Froese R, Pauly D, editors. 2020a. *Proterorhinus semilunaris* (Heckel, 1837). FishBase. Available: http://www.fishbase.org/summary/Proterorhinus-semilunaris.html (February 2020).

Froese R, Pauly D, editors. 2020b. *Proterorhinus semilunaris*. World Register of Marine Species. Available: http://www.marinespecies.org/aphia.php?p=taxdetails&id=1022561 (February 2020).

Fuller P, Nico L, Maynard E, Neilson M, Larson J, Makled TH, Fusaro A. 2020. *Proterorhinus semilunaris* (Heckel, 1837). Gainesville, Florida: U.S. Geological Survey, Nonindigenous Aquatic Species Database. Available: https://nas.er.usgs.gov/queries/FactSheet.aspx?SpeciesID=714 (February 2020)

GBIF Secretariat. 2020. GBIF backbone taxonomy: *Proterorhinus semilunaris* (Heckel, 1837). Copenhagen: Global Biodiversity Information Facility. Available: https://www.gbif.org/species/2379245 (February 2020).

Huyse T, Vanhove MPM, Mombaerts M, Volckaert FAM, Verreycken H. 2015. Parasite introduction with an invasive goby in Belgium: double trouble? Parasitology Research 114:2789–2793.

Kocovsky PM, Tallman JA, Jude DJ, Murphy DM, Brown JE, Stepien CA. 2011. Expansion of tubenose gobies *Proterorhinus semilunaris* into western Lake Erie and potential effects on native species. Biological Invasions 13:2775–2784.

Manné S, Poulet N. 2008. First record of the western tubenose goby *Proterorhinus semilunaris* (Heckel, 1837) in France. Knowledge and Management of Aquatic Ecosystems 389(3):1–5.

Mikl L, Adámek Z, Všetičková L, Janáč M, Roche K, Šlapanskỳ L. 2017. Response of benthic macroinvertebrate assemblages to round (*Neogobius melanostomus*, Pallas 1814) and tubenose (*Proterorhinus semilunaris*, Heckel 1837) goby predation pressure. Hydrobiologia 785:219–232.

Mombaerts M, Verreycken H, Volckaert FAM, Huyse T. 2014. The invasive round goby *Neogobius melanostomus* and tubenose goby *Proterorhinus semilunaris*: two introduction routes into Belgium. Aquatic Invasions 9(3):305–314.

New Mexico Department of Game and Fish. 2010. Director's species importation list. Santa Fe, New Mexico: New Mexico Department of Game and Fish. Available: http://www.wildlife.state.nm.us/download/enforcement/importation/information/Directors-Species-Importation-List-08_03_2010.pdf (November 2020).

New York State Senate. 2019. Importation, possession and sale of fish without license or permit; prohibitions. Laws of New York, Article 11, Title 17, Section 11-1703.

[OIE] World Organisation for Animal Health. 2021. OIE-listed diseases, infections and infestations in force in 2021. Available: http://www.oie.int/animal-health-in-the-world/oie-listed-diseases-2021/ (January 2021).

Sanders S, Castiglione C, Hoff M. 2018. Risk Assessment Mapping Program: RAMP. Version 3.1. U.S. Fish and Wildlife Service.

Top N, Karakuş U, Tepeköy EG, Britton JR, Tarkan AS. 2018. Plasticity in life history traits of the native *Proterorhinus semilunaris* suggests high adaptive capacity in its invasive range. Knowledge and Management of Aquatic Ecosystems 419:48.

Van Kessel N, Dorenbosch M, De Boer MRM, Leuven RSEW, Van der Velde G. 2011. Competition for shelter between four invasive gobiids and two native benthic fish species. Current Zoology 57(6):844–851.

Virginia [DWR] Department of Wildlife Resources. 2020. Nongame fish, reptile, amphibian and aquatic invertebrate regulations. Henrico, Virginia: Virginia Department of Wildlife Resources. Available: https://dwr.virginia.gov/fishing/regulations/nongame/ (November 2020).

Zhokhov AE, Pugacheva MN, Molodozhnikova NM. 2017. Parasites of the invasive goby *Proterorhinus semilunaris* (Pisces: Gobiidae) in Rybinsk Reservoir and checklist of the parasites of gobiids (genus *Proterorhinus*) in Eurasia. Russian Journal of Biological Invasions 8:18–33.

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.

Adamek Z, Andreji J, Gallardo JM. 2007. Food habits of four bottom-dwelling gobiid species at the confluence of the Danube and Hron rivers (South Slovakia). International Review of Hydrobiology 92:554–563.

French JRP III, Jude DJ. 2001. Diets and diet overlap of nonindigenous gobies and small benthic native fishes co-inhabiting the St. Clair River, Michigan. Journal of Great Lakes Research 27(3):300–311.

Freyhof J. 2003. Immigration and potential impacts of invasive freshwater fishes in Germany. Berichte des IGB 17:51–58.

Grant KA, Shadle MJ, Andraso G. 2012. First report of tubenose goby (*Proterorhinus semilunaris*) in the eastern basin of Lake Erie. Journal of Great Lakes Research 38:821–824.

Heckel JJ. 1839. Ichthyologische Beiträge zu den Familien der Cottoiden, Scorpaenoiden, Gobioiden und Cyprinoiden. Annalen des Wiener Museums der Naturgeschichte 2:143–164.

Jude DJ. 1993. The alien goby in the Great Lakes Basin. Great Lakes Information Network (Online). [Source material did not give full citation for this reference.]

Jude DJ, Deboe SF. 1996. Possible impact of gobies and other introduced species on habitat restoration efforts. Canadian Journal of Fisheries and Aquatic Sciences 53(S1):136–141.

Koelbel C. 1874. Über die Identität der *Gobius semilunaris* Heck und *G. rubromaculatus* Kriesch mit *G. marmoratus* Pallas. Verhandlungen der Kaiserlich-Königlichen Zoologisch-Botanischen Gesellschaft in Wien 269–574.

Kottelat M, Freyhof J. 2007. Handbook of European freshwater fishes. Berlin and Cornol, Switzerland: Publications Kottelat and Freyhof.

Kocovsky PM, Tallman JA, Jude DJ, Murphy DM, Brown JE, Stepien CA. 2011. Expansion of tubenose gobies *Proterorhinus semilunaris* into western Lake Erie and potential effects on native species. Biological Invasions 13:2775–2784.

Koubková B, Baruš V. 2000. The tubenose goby (*Proterorhinus marmoratus*: Perciformes) as paratenic host of the nematode *Anguillicola crassus* (Dracunculoidea). Helminthologia, 37:43–45.

Miller PJ. 1986. Gobiidae. Pages 1019-1085 in Whitehead PJP, Bauchot M-L, Hureau J-C, Nielsen J, Tortonese E, editors. Fishes of the north-eastern Atlantic and the Mediterranean, volume III. Paris: United Nations Educational, Scientific and Cultural Organization.

Prasek V, Jurajda P. 2005. Expansion of *Proterorhinus marmoratus* in the Morava River basin (Czech Republic, Danube R. watershed). Folia Zoologica 54:189–192.

Reinartz R, Hilbrich T, Born O. 2000. Nachweis der Marmorierten Grundel (*Proterorhinus marmoratus* Pallas, 1811) im unterfränkischen Main bei Eltmann (Rheineinzugsgebiet). Österreichs Fischerei 53:192–194.

Schadt J. 2000. Neue Fischart im Main entdeckt: Marmorierte Grundel (*Proterorhinus marmoratus*). Fischer Teichwirt 51:217–218.

Spindler T, Holcík J, Hensel K. 1992. Die Fischfauna der österreichisch – tschechoslowakischen Ğrenzstrecke der March samt ihrem Einzugsgebiet. Bericht 5/1992, Forschungsinstitut WWF Österreich.

Vanderploeg HA, Nalepa TF, Jude DJ, Mills EL, Holeck KT, Leibig JR, Grigorovich IA, Ojaveer H. 2002. Dispersal and emerging ecological impacts of Ponto-Caspian species in the Laurentian Great Lakes. Canadian Journal of Fisheries and Aquatic Sciences 59:1209–1228.

Von Landwust C. 2006. Expansion of *Proterorhinus marmoratus* (Teleostei, Gobiidae) into the River Moselle (Germany). Folia Zoologica 55:107–111.

Zitek A, Schmutz S, Ploner A. 2004. Fish drift in a Danube sidearm-system: II. Seasonal and diurnal patterns. Journal of Fish Biology 65:1339–1357