Big-scale Sand Smelt (*Atherina boyeri*)

Ecological Risk Screening Summary

U.S. Fish and Wildlife Service, Web Version – 9/13/2017

Photo: Roberto Pillon. Licensed under CC BY 3.0 Unported. Available: https://commons.wikimedia.org/wiki/File:Atherina_boyeri_Sardinia.jpg.

1 Native Range and Status in the United States

Native Range

From Freyhof and Kottelat (2008):

"Along coast of Mediterranean, Black, Azov and Caspian Sea basins. Atlantic coast northward to Loire estuary (France). Isolated populations along costs of southern England and the Netherlands (some might actually be the marine *A. mochon*). Permanent freshwater resident populations in Guadalquivir and Tagus (now extirpated) drainages, Santo André lagoon (Portugal) and Lake Trichonis (Greece)."

From Froese and Pauly (2016):

"Eastern Atlantic: Portugal and Spain to Nouadhibou in Mauritania and Madeira, and throughout the Mediterranean and Black Sea. Isolated populations on coasts of England and the Netherlands [Quignard and Pras 1986]. Previously, two subspecies were recognized in Russian waters: *Atherina boyeri pontica* [Eichwald, 1838] from the Black Sea and the Sea of Azov and *Atherina boyeri caspia* [Eichwald, 1838] from the Caspian Sea [Reshetnikov et al. 1997]."

From Baker et al. (2015):

"Spain (Elvira 1995). Ponto-Caspian basin. Eastern Mediterranean Sea (Kalogirou et al. 2012)."

From Clavero et al. (2014):

"Sandsmelt (*Atherina boyeri*) is a native species in Morocco, inhabiting wetlands and the lower reaches of rivers (Azeroual, 2003; Francisco et al., 2008), […]"

Figure 1. Native range of *Atherina boyeri*. Map from Kottelat and Freyhof (2007).

Status in the United States

Atherina boyeri was introduced to Baltimore, Maryland from Belgium (Zeebrugge) (Froese and Pauly 2016).

From FAO (2016):

"*Atherina boyeri* introduced to USA from Belgium"

From Baker et al. (2015):

"*Atherina boyeri* does not currently occur near waters connected to the Great Lakes. There is no indication that this species is sold or stocked in North America. However, it occurs in ports that have direct connections with the Great Lakes (NBIC)."

Means of Introductions in the United States

From FAO (2016):

"Reasons of Introduction: 1) accidental"

From Baker et al. (2015):

"It can survive in hypersaline conditions up to 110% salinity and temperatures between 6-25°C (Henderson and Bamber 1987). It is likely that *Atherina boyer*i has the potential to survive ballast tank environments."

Remarks

Some authors consider *Atherina mochon* to be a junior synonym for *Atherina boyeri* (Froese and Pauly 2016; ITIS 2016), others consider it to be a separate, fully marine species (Kottelat and Freyhof 2007). For this assessment, those fully marine populations, usually indicated with the name *Atherina mochon* were not considered.

From Baker et al. (2015):

"The native and introduced ranges of *Atherina boyeri* have similar climatic and abiotic conditions to that of the Great Lakes (EPA 2008; Reid and Orlova 2002; Grigorovich et al. 2003). If introduced, *Atherina boyeri* is likely to find a suitable habitat in the Great Lakes. Although it is commonly found in estuaries, it has no problem establishing in freshwater due to its ability to tolerate a broad range of salinities and adapt quickly (Henderson and Bamber, 1987; Leonardos and Sinis 2000). It is thermophilous, its ability to survive the winters of the Great Lakes is limited (Den Hartog and Van der Velde 1987; Henderson and Bamber 1987). *Atherina boyeri* exhibits a rapid growth rate, early maturity, and frequent spawning over a long breeding season (Fernández-Delgado et al. 1988). Its reproductive strategy may contribute to its establishment if introduced to the Great Lakes."

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From Eschmeyer et al. (2016):

"***boyeri, Atherina*** Risso [A.] 1810:338, Pl. 10 (fig. 38) [Ichthyologie de Nice] Dept. du Var, France, northwestern Mediterranean Sea. Lectotype: MNHN A-4342 (70.6 mm SL). Paralectotypes: MNHN A-4342 (now 1, poor condition), MNHN B-860 (1, dry). Type catalog: Bertin 1945:376, Blanc & Hureau 1971:703. Spelled *boieri* in Cuvier & Valenciennes 1835:xxiij, 432, Pl. 303. Recognition of subspecies still in doubt; see Miller 2003:53-55. Lectotype selected by Kottelat & Freyhof 2009:83. •Valid as *Atherina boyeri* Risso 1810 -- (Kiener & Spillmann 1973:576, Quignard & Pras in Whitehead et al. 1986:1208, Maugé 1986:277, Maugé 1990:604, Trabelsi et al. 1994:457, Vasil'eva 1994: 618, Coad 1995:26, Bianco et al. 1996:56, Vasil'eva 1996: 203, Kottelat 1997:158, Reshetnikov et al. 1997:746,

Sokolov 1998:108, Coad 1998:103, Azeroual et al. 2000:20, Trabelsi et al. 2000:77, Bilecenoglu et al. 2002:57, Miller 2003:47 in subgenus *Hepsetia*, Bogutskaya & Naseka 2004:175, Fricke et al. 2007:68, Kottelat & Freyhof 2007:470, Vasil'eva 2007:65, Parin et al. 2014:192, Barbieri et al. 2015:89, de Morais et al. 2016:2115). **Current status:** Valid as *Atherina boyeri* Risso 1810. Atherinidae: Atherininae."

From ITIS (2016):

"Taxonomic Status: Current Standing: valid"

"Kingdom Animalia
Subkingdom Bilateria
Infrakingdom Deuterostomia
Phylum Chordata
Subphylum Vertebrata
Infraphylum Gnathostomata
Superclass Osteichthyes
Class Actinopterygii
Subclass Neopterygii
Infraclass Teleostei
Superorder Atheriniformes
Order Atheriniformes
Suborder Atherinidae
Family Atherinidae
Subfamily Atherininae
Genus *Atherina*
Species *Atherina boyeri* Risso, 1810"

Size, Weight, and Age Range

From Freyhof and Kottelat (2008):

"Usually lives 1-2 years, rarely up to four."

From Froese and Pauly (2016):

"Maturity: Lm 5.8, range 5 - ? cm
Max length: 20.0 cm TL male/unsexed; [Billard 1997]; max. reported age: 4 years [Kottelat and Freyhof 2007]"

Environment

From Froese and Pauly (2016):

"Marine; freshwater; brackish; demersal; amphidromous [Kottelat and Freyhof 2007]; depth range 1 - ? m."

"A very euryhaline species, where adults are frequently found in brackish waters and more sporadically in freshwater [Wildekamp et al. 1986], […]"

Climate/Range

From Froese and Pauly (2016):

"Subtropical; 53°N - 20°N, 18°W - 42°E"

Distribution Outside the United States

Native

From Freyhof and Kottelat (2008):

"Along coast of Mediterranean, Black, Azov and Caspian Sea basins. Atlantic coast northward to Loire estuary (France). Isolated populations along costs of southern England and the Netherlands (some might actually be the marine *A. mochon*). Permanent freshwater resident populations in Guadalquivir and Tagus (now extirpated) drainages, Santo André lagoon (Portugal) and Lake Trichonis (Greece)."

From Froese and Pauly (2016):

"Eastern Atlantic: Portugal and Spain to Nouadhibou in Mauritania and Madeira, and throughout the Mediterranean and Black Sea. Isolated populations on coasts of England and the Netherlands [Quignard and Pras 1986]. Previously, two subspecies were recognized in Russian waters: *Atherina boyeri pontica* [Eichwald, 1838] from the Black Sea and the Sea of Azov and *Atherina boyeri caspia* [Eichwald, 1838] from the Caspian Sea [Reshetnikov et al. 1997]."

From Baker et al. (2015):

"Spain (Elvira 1995). Ponto-Caspian basin. Eastern Mediterranean Sea (Kalogirou et al. 2012)."

From Clavero et al. (2014):

"Sandsmelt (*Atherina boyeri*) is a native species in Morocco, inhabiting wetlands and the lower reaches of rivers (Azeroual, 2003; Francisco et al., 2008), […]"

Introduced

From Freyhof and Kottelat (2008):

"Introduced in Aral Sea, Lake Trasimeno (Italy) and perhaps other lakes in Italy."

From Froese and Pauly (2016):

Year / Period	From	To	Established	Ecol. effects
Unknown	North East Atlantic	Netherlands	established	
1956	Caspian Sea	Aral Sea	Established	some

From Baker et al. (2015):

"*Atherina boyeri* occurs in isolated populations on the coasts of England (Fishbase). This species is found in Lake Trasimeno, Italy (Freyhof and Kottelat 2008), the coasts of the Netherlands (Den Hartog and Van der Velde 1987), Portugal (Fishbase), and Spain. Its occurrence has been recorded in Sapanca Lake (Geldiay and Balik 1996), Güzelhisar Stream, Köycegiz Lake (Balik 1979), Küçükçekmece Lake (Altun 1999), Lake Iznik (Özeren 2004), Homa Lagoon (Sezen 2005), Hirfanli Dam Lake, Beysehir Lake, and Mogan Lake (Innal and Erk'akan 2006), Turkey. It has been reported to occur in the Aral Sea (Freyhof and Kottelat 2008)."

From Clavero et al. (2014):

"[…] but is non-native to the study area [inland rivers of Morocco] (Table 1 [in source material]), Sandsmelt is unlikely to have naturally colonized the study area, since it was mainly recorded in relatively high altitude reaches (>1100 m asl) and about 850 km of mostly dry river bed far from the sea sources."

Means of Introduction Outside the United States

From Baker et al. (2015):

"This species is introduced into freshwater lakes and reservoirs in Europe to enhance stock (Economidis et al. 2000). In Turkey, it has been introduced to several lakes by local fishermen (Inaal and Erk'akan 2006)."

From Özulu et al. (2005):

"Having arrived through the riverlines and channels of the Riva Stream from the Black Sea before building of the reservoir dam wall in 1972, *A. boyeri* is now found in the Ömerli reservoir where it acclimatized and expanded, occupying the ecological niche of pelagic planctophagous fish."

Short Description

From Froese and Pauly (2016):

"Dorsal spines (total): 7 - 10; Dorsal soft rays (total): 8-16; Anal spines: 2; Anal soft rays: 10 - 18. Eye diameter wider than snout length [Muus and Nielsen 1999]."

From Baker et al. (2015):

"*Atherina boyeri* is a small fish that is brown and silver in color. Its head length is about 4 times less than its total length. This species possesses 21-39 gillrakers. Its back is brown to brownish gray. It has 40-47 vertebrae, 7-10 dorsal spines, and 8-10 dorsal soft rays (Muus and Nielsen 1999). The scales are in a longitudinal series (44-48) and silvery in color. The eye diameter is greater than the snout length. It exhibits a wide range in morphometric and meristic characteristics."

From Kottelat and Freyhof (2007):

"Distinguished from other species of Atherinidae in Europe by: 39-49 total scales in midlateral series / 23-31 gill rakers / 13-15½ anal rays. Size up to about 85mm SL, 120mm in Lake Trichonis and 145mm in Caspian Sea."

Biology

From Freyhof and Kottelat (2008):

"Gregarious…. Spawns for the first time at 1-2 years. Freshwater populations spawn in April-June in Guadalquivir, in March-October in Lake Trichonis. Short spawning migrations into estuaries in some populations. Fractional spawner, larger individuals spawn for a longer period. Eggs with long hairy appendages attaching them to filamentous algae, deposited at 2-6 m depth. Larvae are pelagic but often form schools close to the shores. In lakes and estuaries, feeds mainly on small planktonic invertebrates, often on benthos in rivers."

"Lower parts of rivers, estuaries, coastal lakes and sea. Freshwater populations prefer still or slow-flowing waters. Pelagic in lakes."

From Froese and Pauly (2016):

"Adults occur in great schools. They are carnivorous, feeding on small crustaceans, worms, mollusks [Quignard and Pras 1986] and fish larvae [Muus and Nielsen 1999] in lakes and estuaries, and on benthos in rivers [Kottelat and Freyhof 2007]. […] Some populations undergo spawning migrations into estuaries."

From Baker et al. (2015):

"*Atherina boyeri* is a small, short lived fish native to the Ponto-Caspian basin, eastern Mediterranean Sea, and Spain (Quignard and Pras 1986; Elivra 1995; Kalogirou et al. 2012). It inhabits coastal and estuarine waters, as well as inland waters. It can tolerate a broad range of salinities, and inhabits fresh to hypersaline waters (Henderson and Bamber, 1987; Leonardos and Sinis 2000). It is capable of adapting rapidly, perhaps due to the great variety in longevity, reproductive years, size at maturity, and maximum size attributed to this species (Küçük et al. 2012; Henderson and Bamber 1987). Juveniles have no abiotic preferences (Pombo 2005). It has a temperature range of 6-25°C and the northern range of this species is limited by the amount of fat the young can lay down (Henderson and Bamber 1987). It is thermophilous and may not be able to tolerate low temperatures, especially as juvenile fish (den Hartog and Van der Velde 1987; Henderson and Bamber 1987)."

"*Atherina boyeria* is carnivorous but its prey is primarily zooplankton and other small invertebrates due to its limited gape (Henderson and Bamber 1987). *Atherina boyeri* that inhabit coastal waters feed on zooplankton, while those that inhabit estuaries feed on benthic organisms (Kiener and Spillman 1969; Bartuloviç et al. 2004). This species is an opportunistic feeder and its diet changes with the seasons and prey availability (Bartuloviç et al. 2004). During the autumn, it feeds on fish larvae (Doulka et al. 2013). It has been suggested that this species plays

an important role in estuarine food webs (Bartuloviç et al. 2004). *Atherina boyeri* is preyed on by carnivorous fish such as Sphyraena (Kalogirou et al. 2012)."

"*Atherina boyeri* exhibits a rapid growth rate, early maturity, and frequent spawning over a long breeding season (Fernández-Delgado et al. 1988). This species develops to its full external adult morphology within 2 months of hatching, and reach sexual maturity within their first year of life (Henderson and Bamber 1987). This species reproduces in the summer with an average fecundity is 110.4 per individual (Küçük et al. 2012). Adults remain in or near their spawning areas (Henderson and Bamber 1987)."

Human Uses

From Froese and Pauly (2016):

"Fisheries: commercial"

From Baker et al. (2015):

"*Atherina boyeri* has commercial value as a prey of highly-priced carnivorous fish such as sea bass, *Dicentrarchus labrax*."

Diseases

No records of OIE reportable diseases were found.

From Baker et al. (2015):

"*Atherina boyeri* is a carrier of the metacercariae of *Labratrema minimus*, a parasitic trematode that also infects gobies (Combes 2001)."

From Scholz et al. (2011):

"Giovinazzo, Antegiovanni, Do¨rr & Elia (2006) reported *Bothriocephalus acheilognathi* from *Atherina boyeri* Risso from Lake Trasimeno, but species identification of these tapeworms requires confirmation."

From Bailly (2013):

"Host of *Bothriocephalus atherinae* Chernyshenko, 1949 (parasite)
Caligopsis ponticus Markevich, 1940 [via synonym] (parasitic: endoparasitic)
Sphaeromyxa sevastopoli Naidenova, 1970 (parasitic: endoparasitic)
Thersitina gasterostei (Pagenstecher, 1861) [via synonym] (parasitic: endoparasitic)
Tylodelphys clavata (von Nordmann, 1832) (parasitic: endoparasitic)"

Threat to Humans

From Froese and Pauly (2016):

"Harmless"

3 Impacts of Introductions

From Baker et al. (2015):

"*Atherina boyeri* can adapt to new environments rapidly. It established as a nonnative fish in Lake Egirdir within 2 years of its introduction (Küçük et al. 2007). *Atherina boyeri* is capable of reaching high densities; it became a dominant fish in the community, comprising of nearly 50% of the ichthyofauna composition in the Mala Neretva estuary (Sršen 1995)."

"It is considered as a potential threat to lentic ecoystems (Küçük et al. 2007)."

"Increased population size of *Atherina boyeri* in the Neretva River estuary enhanced the production of the local fishery and the stock of sea bass *Dicentrarchu labrax* (Küçük et al. 2007). In Greece, it is sold for about US $3 per kg and is edible (El-Sahn et al. 1990; Leonardos and Sinis 2000).

Introduction of *Atherina boyeri* may positively impact the populations of Great Lakes predatory fish and enhance recreational fishing. If *Atherina boyeri* were introduced, the parasitic trematode that it carries may infect invasive gobies of the Great Lakes and help decrease their populations."

From Küçük et al. (2012):

"There is no dominant pelagic fish other than zooplanktivorous *A. boyeri* in Lake Eğirdir. The hunting pressure on the lake zooplankton results in disappearance of zooplankton from food web and accordingly abnormal development of the phytoplankton, which leads to loss of water quality and transparency in the lake. Furthermore, feeding habits of the *A. boyeri* from a broad spectrum may have further negative impacts on larvae and juveniles of other fish species in the lake. Potential of leading to various changes in the lake ecosystem due to its invasiveness resulting from extremely fast adaptation and rapid breeding capability of the species can be inferred from our results."

4 Global Distribution

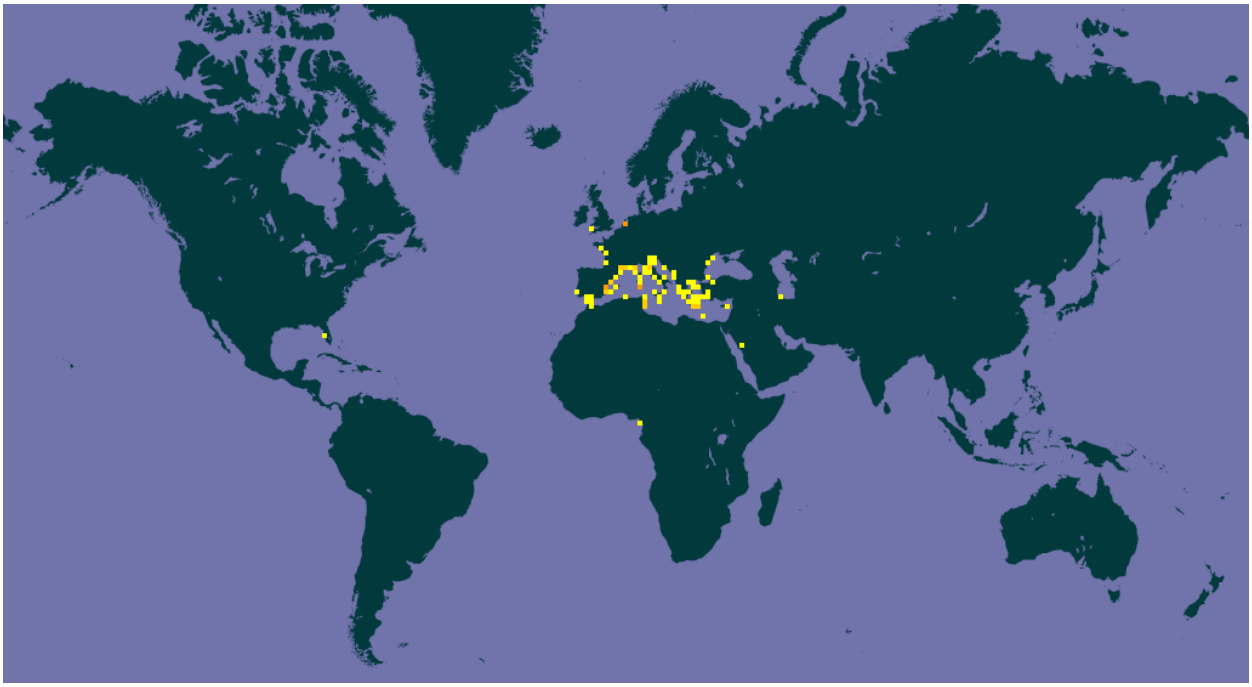

Figure 2. Known global distribution of *Atherina boyeri*. Map from GBIF (2013).

The observation in Florida is from *Atherina mochon* a fully marine congener of *Atherina boyeri* and was not used as a source point in the climate match. It could also not be corroborated by any other sources.

The observation off the east coast of Africa in Equatorial Guinea was a single specimen collected in 1965. It was collected in a marine environment and was not used as a source point for the climate match.

The observations shown in Saudi Arabia were actually collected from Skyros Island, which is part of Greece in the Aegean Sea. These observations were not used as source locations due the incorrect coordinates attached to the observations.

The observations in the Netherlands were not included in the climate match due to the need for thermal discharge to sustain those populations:

From Baker et al. (2015):

"*Atherina boyeri* is established in the Netherlands after intentional introduction, but its distribution is bound to waters that receive thermal discharge from the cooling systems of power plants (Den Hartog and Van der Velde 1987)."

5 Distribution Within the United States

No map of the distribution of *Atherina boyeri* in the United States was available. Froese and Pauly (2016) recorded an introduction into Maryland and GBIF (2013) contains a record for *Atherina mochon* in Florida. It is unknown if either observation indicates an established population.

6 Climate Matching

Summary of Climate Matching Analysis

The climate match for *Atherina boyeri* was high along the west coast, the southern Great Lakes Basin, and Appalachia. The match was low in the Pacific Northwest, upper Great Plains, northern New England, and Florida and along the Gulf Coast; it was medium everywhere else. The Climate 6 score (Sanders et al. 2014; 16 climate variables; Euclidean distance) for the Continental U.S. was 0.275, high, and high in Arkansas, Arizona, California, Connecticut, Delaware, Idaho, Illinois, Indiana, Kentucky, Maryland, Massachusetts, Michigan, Missouri, Nevada, New Jersey, New York, North Carolina, Ohio, Oregon, Pennsylvania, Rhode Island, Tennessee, Utah, Virginia, Washington, and West Virginia.

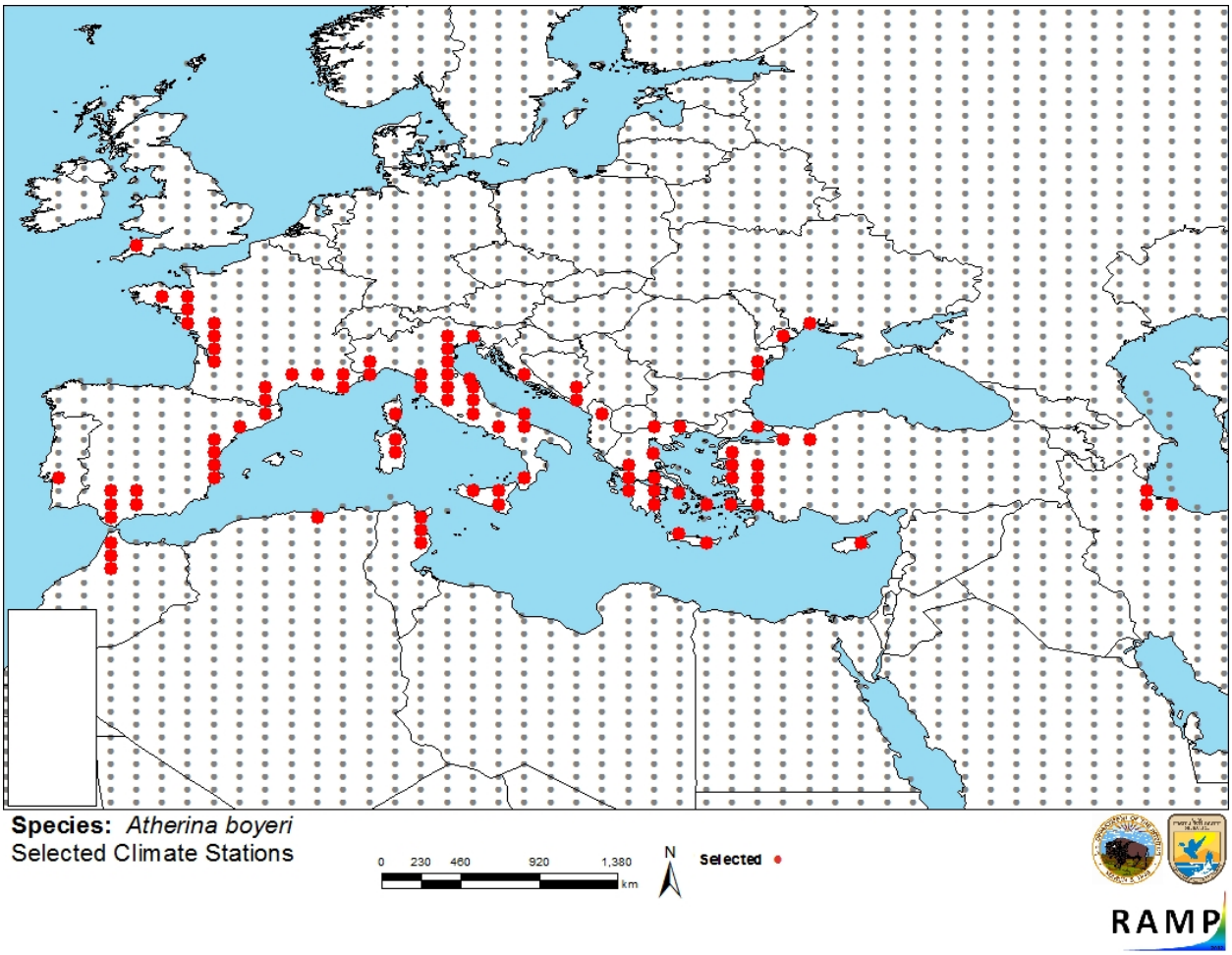

Figure 3. RAMP (Sanders et al. 2014) source map showing weather stations selected as source locations (red) and non-source locations (gray) for *Atherina boyeri* climate matching. Source locations from GBIF (2013) and Baker et al. (2015).

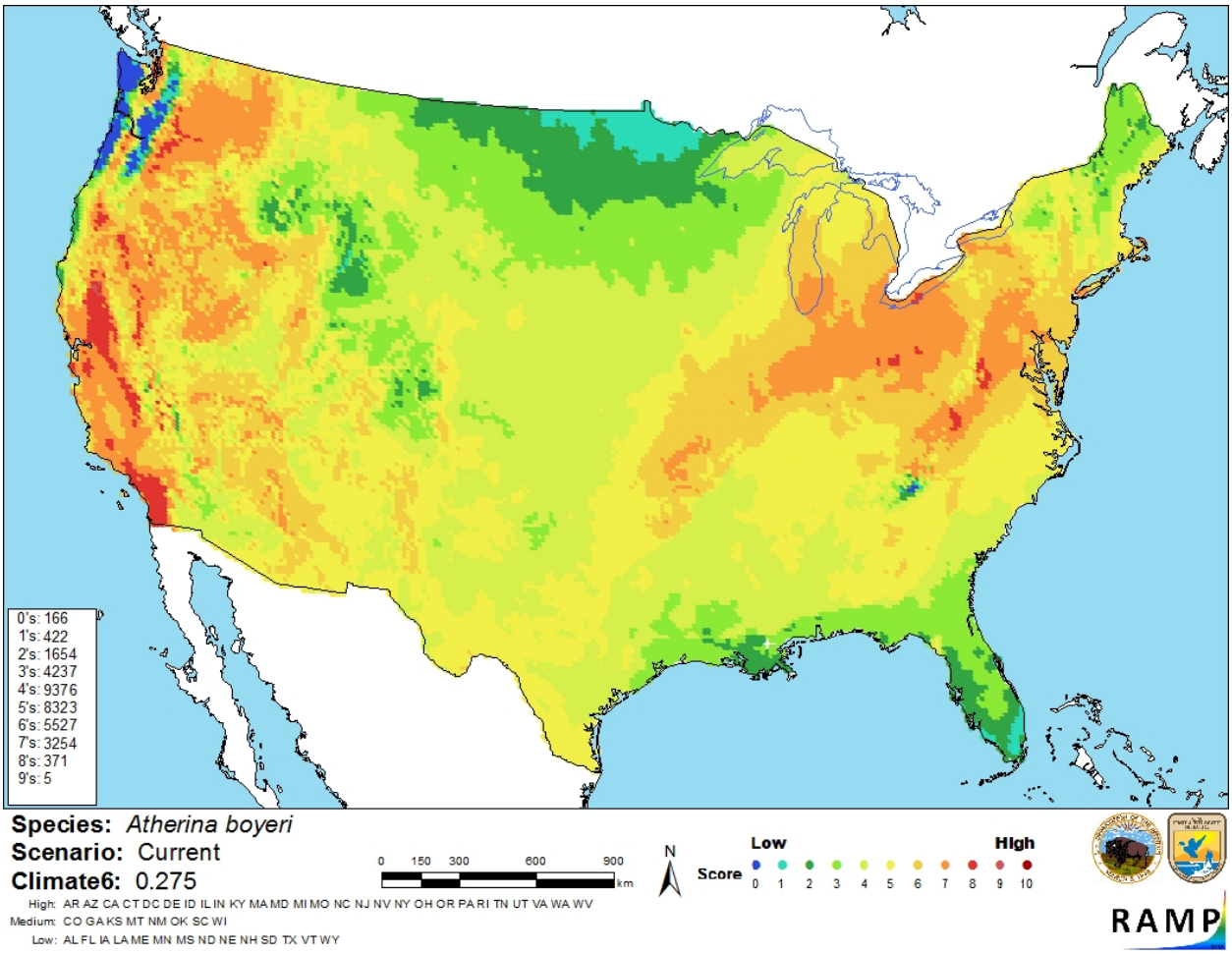

Figure 4. Map of RAMP (Sanders et al. 2014) climate matches for *Atherina boyeri* in the contiguous United States based on source locations reported by GBIF (2013) and Baker et al. (2015). 0= Lowest match, 10=Highest match.

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 assessment for *Atherina boyeri* is medium. There is an adequate amount of quality information on the ecology and biology of the species. There is some question if the fully marine populations are the same species or a separate species. In this assessment they were treated as a separate species, with *Atherina mochon* as the marine species. Records of introductions were found for *A. boyeri* but for some locations there was some conflict between

different sources on the exact native range of the species. Records of demonstrated and potential impacts from the introductions were found.

8 Risk Assessment

Summary of Risk to the Contiguous United States

The history of invasiveness of *Atherina boyeri* is high. Many records of introduction were found. Even allowing for the larger native range, there were still many instances of non-native introductions. The records of demonstrated impacts were significant, such as becoming nearly 50% of the total fish population in an invaded estuary. There are significant impacts predicted if this species reached the Great Lakes. The climate match was high, particularly along the Pacific Coast and the lower Great Lakes. This species has been identified in other efforts as a species of concern for the Great Lakes (Baker et al. 2015). The certainty of assessment is medium. 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): Medium**
- **Remarks/Important additional information No additional remarks.**
- **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.

Bailly, N. 2013. *Atherina boyeri* Risso, 1810. *In* R. Froese, and D. Pauly, editors. FishBase. Accessed through World Register of Marine Species. Available: http://www.marinespecies.org/aphia.php?p=taxdetails&id=272027. (April 2016).

Baker, E., M. Asgari, and J. Li. 2015. *Atherina boyeri*. USGS Nonindigenous Aquatic Species Database, Gainesville, Florida, and NOAA Great Lakes Aquatic Nonindigenous Species Information System, Ann Arbor, Michigan. Available: http://nas.er.usgs.gov/queries/greatlakes/FactSheet.aspx?SpeciesID=39&Potential=Y&Type=2&HUCNumber=. (April 2016).

Clavero, M., J. Esquivias, A. Qninba, M. Riesco, J. Calzada, F. Ribeiro, N. Fernández, and M. Delibes. 2014. Fish invading deserts: non-native species in arid Moroccan rivers. Aquatic Conservation: Marine and Freshwater Ecosystems 25(1):49-60.

Eschmeyer, W. N. and R. Fricke, and R. van der Laan, editors. 2016. Catalog of fishes: genera, species, references. Available: http://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp. (April 2016).

FAO (Fisheries and Aquaculture Department). 2016. *Atherina boyeri*. Database on introductions of aquatic species. Available: http://www.fao.org/fishery/introsp/8607/en. (April 2016).

Freyhof, J., and M. Kottelat. 2008. *Atherina boyeri*. The IUCN Red List of Threatened Species 2008. Available: http://www.iucnredlist.org/details/full/2352/0. (April 2016).

Froese, R., and D. Pauly, editors. 2016. *Atherina boyeri* Risso, 1810 big-scale sand smelt. FishBase. Available: http://www.fishbase.org/summary/Atherina-boyeri.html. (April 2016).

GBIF (The Global Biodiversity Information Facility). 2013. *Atherina boyeri* Risso, 1810. GBIF backbone taxonomy. Available: http://www.gbif.org/species/2411944. (April 2016).

ITIS (Integrated Taxonomic Information System). 2016. *Atherina boyeri* Risso, 1810. Available: http://www.itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=166024. (April 2016).

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

Kücük, F., S. S. Güçlü, I. Gülle, Z. Güçl, N. L. Çiçek, and D. Gürkan. 2012. Reproductive features of Big Scale-Sand Smelt, *Atherina boyeri* (Risso 1810), an exotic fish in Lake Eğirdir (Isparta, Turkey). Turkish Journal of Fisheries and Aquatic Sciences 12:729–733.

Özulu, M., H. Acpnar, Ö. Gaygusuz, Ç. Gürsoy, and A. S. Tarkan. 2005. Effects of human factor on the fish fauna in a drinking-water resource (Ömerli Dam Lake-Istanbul, Turkey). Research Journal of Agriculture and Biological Sciences 1(1):50-55.

Sanders, S., C. Castiglione, and M. Hoff. 2014. Risk assessment mapping program: RAMP. U.S. Fish and Wildlife Service.

Scholz, T., T. T. Binh, and B. S. Dezfuli. 2011. *Khawia japonensis* (Cestoda: Caryophyllidea): another invasive parasite of carp, *Cyprinus carpio* L., imported to Europe. Journal of Fish Disease 34:943-949.

10 References Quoted But Not Accessed

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.

Altun, Ö. 1999. Morphological variations observed on the Sand Smelt (*Atherina boyeri* Risso, 1810) populations. Turkish Journal of Zoology 23(3):911–918.

Azeroual, A. 2003. Monographie des poissons des eaux continentales du Maroc: systématique, distribution et écologie. Doctoral disseratation. Université Mohammed V-Agdal, Rabat, Morocco. [In French]

Azeroual, A., A. J. Crivelli, A. Yahyaoui, and M. Dakki. 2000. L'ichtyofaune des eaux continentales du Maroc. Cybium 24(3)Supplement:17-22.

Balik, S. 1979. Bati Anadolu tatlisu baliklari üzerine arastirmalar. Ege Üniversitesi Fen Fakültesi Ilmi Raporlar Serisi 1979(236). Ege Üniversitesi Matbaasi, Izmir, Turkey. [In Turkish]

Barbieri, R., S. Zogaris, E. Kalogianni, M. Th. Stoumboudi, Y. Chatzinikolaou, S. Giakoumi, Y. Kapakos, D. Kommatas, N. Koutsikos, V. Tachos, L. Vardakas, and A. N. Economou. 2015. Freshwater fishes and lampreys of Greece. An annotated checklist. Monographs on Marine Sciences No. 8. Hellenic Centre for Marine Research, Athens, Greece.

Bartuloviç, V., D. Lucic, A. Conides, B. Glamuzina, J. Ducic, D. Hafner, and M. Batistic. 2004. Food of sand smelt, *Atherina boyeri* Risso, 1810 (Pisces: Atherinidae) in the estuary of the Mala Neretva River (middle-eastern, Adriatic, Croatia). Scientia Marina 64(4):597-603.

Bertin, L. 1945. Les ouvrages d'ichthyologie et les types de poissons de Risso au Muséum de Paris. Bulletin du Muséum National d'Histoire Naturelle (Série 2) 17(5):373-378.

Bianco, P. G., H. Ahnelt, and P. S. Economidis. 1996. The freshwater fishes from eastern, and large Mediterranean islands with comments on their safety status. Acta Universitatis Carolinae. Biologica 40:45-60.

Bilecenoglu, M., E. Taskavak, S. Mater, and M. Kaya. 2002. Checklist of the marine fishes of Turkey. Zootaxa 113:1-194.

Billard, R. 1997. Les poissons d'eau douce des rivières de France. Identification, inventaire et répartition des 83 espèces. Lausanne, Delachaux and Niestlé. [In French]

Blanc, M., and J.-C. Hureau. 1972. Catalogue critique des types de poissons du Muséum national d'Histoire naturelle. (Suite) (Mugiliformes et Polynémiformes). Bulletin du Muséum National d'Histoire Naturelle (Série 3: Zoologie) 15(1971):673-735.

Bogutskaya, N. G., and A. M. Naseka. 2004. Catalogue of agnathans and fishes of fresh and brackish waters of Russia with comments on nomenclature and taxonomy. Russian Academy of Sciences, Moscow. [In Russian.]

Coad, B. W. 1995. Freshwater fishes of Iran. Acta scientiarum naturalium Academiae scientiarum Bohemicae - Brno 29(1):1-64.

Coad, B. W. 1998. Systematic biodiversity in the freshwater fishes of Iran. Italian Journal of Zoology 65(Supplemental):101-108.

Combes, C. 2001. Parasitism: the ecology and evolution of intimate interactions. University of Chicago Press.

Cuvier, G., and A. Valenciennes. 1835. Histoire naturelle des poissons. Tome dixième. Suite du livre neuvième. Scombéroïdes. Livre dixième. De la famille des Teuthyes. Livre onzième. De la famille des Taenioïdes. Livre douzième. Des Athérines.

de Morais, L. T., M. Sylla, and W. Ivantsoff. 2016. Order Atheriniformes. Atherinidae. Pages 2111-2118 *in* K. E. Carpenter and N. De Angelis, editors. The living marine resources of the Eastern Central Atlantic. Volume 3. Bony fishes part 1 (Elopiformes to Scorpaeniformes). FAO Species Identification Guide for Fishery Purposes, Rome, FAO.

Den Hartog, C., and G. Van der Velde.1987. Invasions by plants and animals into coastal, brackish, and fresh water of the Netherlands. Ecology Proceedings C 90(1):31-37.

Doulka, E., G. Kehayias, E. Chalkia, and I. D. Leonardos. 2013. Feeding strategies of A*therina boyeri* (Risso 1810) in a freshwater ecosystem. Journal of Applied Ichthyology 29:200-207.

Economidis, P. S., E. Dimitriou, R. Pagoni, E. MIchaloudi, and L. Natsis. 2000. Fisheries Management and Ecology 7:239-250.

El-Sahn, M. A., A. M. Youssef, and Y. G. Moharram. 1990. Edible products from pelagic bissaria (*Atherina mochon*) fish. Food/Nahrung 34(1):47-52.

Elvira, B. 1995. Native and exotic freshwater fishes in Spanish river basins. Freshwater Biology 33:103-108.

Environmental Protection Agency (EPA). 2008. Predicting future introductions of nonindigenous species to the Great Lakes. National Center for Environmental Assessment, Washington, D.C. Available: http://www.epa.gov/ncea.

Fernández-Delgado, C., J. A. Hernando, M. Herrera, and M. Bellido. 1988. Life-history patterns of the sandsmelt *Atherina boyeri* Risso, 1810 in the estuary of the Guadalquivir River, Spain. Estuarine, Coastal, and Shelf Science 27:697-706.

Fishbase. *Atherina boyeri* Risso, 1810. Available: http://www.fishbase.org/summary/Atherina-boyeri.html. (June 2014).

Francisco, S. M., L. Congiu, S. Stefanni, L. Congiu, A. Brito, M. N. Vieira, and V. C. Almada. 2008. Phylogenetic relationships of the North-eastern Atlantic and Mediterranean forms of *Atherina* (Pisces, Atherinidae). Molecular Phylogenetics and Evolution 48:782–788.

Freyhof, J., and M. Kottelat. 2008. *Atherina boyeri*. IUCN Red List of Threatened Species. Version 2013.2. Available: http://www.iucnredlist.org/details/2352/0. (June 2014).

Fricke, R., M. Bilecenoglu, and H. M. Sari. 2007. Annotated checklist of fish and lamprey species (Gnathostomata and Petromyzontomorphi) of Turkey, including a Red List of threatened and declining species. Stuttgarter Beiträge zur Naturkunde. Serie A (Biologie) 706.

Geldiay, R., and S. Balik. 1996. Türkiye Tatlisu Baliklari. Ege Üniversitesi Fen Fakültesi Kitaplar Serisi Numer 97, Ege Üniversitesi Basimevi, Izmir, Turkey. [In Turkish]

Giovinazzo, G., P. Antegiovanni, A. J. M. Dörr, and A. C. Elia. 2006. Presenza di *Bothriocephalus acheilognathi* (Cestoda: Pseudophyllidea) in *Atherina boyeri* del Lago Trasimeno. Ittiopatologia 3:61–67.

Grigorovich et al. 2003. [Source material did not give fill citation for this reference.]

Henderson, P. A., and R. N. Bamber. 1987. On the reproductive biology of the sand smelt *Atherina boyeri* Risso (Pisces: Atherinidae) and its evolutionary potential. Biological Journal of the Linnean Society 32:395-415.

Inaal, D., and F. Erk'akan. Effects of exotic and translocated fish species in the inland waters of Turkey. Reviews in Fish Biology and Fisheries 16:39-50.

Kalogirou, S., F. Mittermayer, L. Pihl, and H. Wennhage. 2012. Feeding ecology of indigenous and non-indigenous fish species within the family Sphyaenidae. Journal of Fish Biology 80:2528-2548.

Kiener, A., and C. J. Spillman. 1969. Contributions a l'etude systematique et ecologique d'*Atherina boyeri* Risso (Poissons, Cyprinidae) dan sa zone de dispersion actuelle. Bulletin du Museum National d'Histoire Naturelle, 3rd Series, No. 55. Zoology 41:563-580. [In French]

Kiener, A., and J. Spillmann. 1973. Atherinidae. Pages 576-578 *in* J.-C. Hureau, and T. Monod. Check-list of the Fishes of the North-eastern Atlantic and of the Mediterranean. CLOFNAM. Unesco, Paris.

Kottelat, M. 1997. European freshwater fishes. Biologia (Bratislava) 52 (supplement 5):1-271.

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

Kottelat, M., and J. Freyhof. 2009. Notes on the taxonomy and nomenclature of some European freshwater fishes. Ichthyological Exploration of Freshwaters 20(1):75-90.

Küçük, F., I. Gülle, S. S. Güçlü, E. Gümüs, and O. Demir. 2007. Egirdir Gölü'ne sonradan giren gümüsbaligi (*Atherina boyeri* Risso, 1810)'nin göl ekosistemine ve balikçiliga etkisi. I. Ulusal Baliklandirma ve Rezervuar Yönetimi Sempozyumu Bildirileri, 7-9 Subat 2006 Antalya:119-128. [In Turkish]

Küçük, F., S. S. Güçlü, I. Gülle, Z. Güçlü, N. L. Çiçek, and G. Diken. 2012. Reproductive features of Big Scale-Sand Smelt, *Atherina boyeri* (Risso, 1810), and exotic fish in Lake Egirdir (Isparta, Turkey). Turkish Journal of Fisheries and Aquatic Sciences 12:729-733.

Leonardos, I., and A. Sinis. 2000. Age, growth, mortality of *Atherina boyeri* Risso, 1810 (Pisces: Atherinidae) in the Mesolongi and Etolikon lagoons (W. Greece). Fisheries Research 45:81-91.

Maugé, A. L. 1986. Atherinidae. Ambassidae. Kuhliidae. Gobiidae. Eleotridae. Periophthalmidae. Pages 277-279, 297-298, 306-307, 358-401 *in* J. Daget, J.-P. Gosse, and D. F. E. Thys van den Audenaerde, editors. Check-list of the freshwater fishes of Africa. CLOFFA. ISNB Bruxelles, MRAC Tervuren, ORSTOM Paris.

Maugé, A. L. 1990. Atherinidae. Anthiidae. Grammistidae. Apogonidae. Apogoninae. Chaetodontidae. Pomacanthidae. Pages 604-605, 707-710, 714-715, 837-841 *in* C. Quéro, J.-C. Hureau, C. Karrer, A. Post, and L. Saldanha. Check-list of the fishes of the eastern tropical Atlantic. CLOFETA. UNESCO, Paris, 3 vols.

Miller, P. J. 2003. Family Atherinidae Risso, 1827. Family Atherinopsidae Fowler, 1903. Suborder Gobioidei, and other gobiioid accounts. Pages 43-77, 79-90, 123 *in* P. J. Miller, editor. The freshwater fishes of Europe.

Muus, B. J., and J. G. Nielsen. 1999. Sea fish. Scandinavian Fishing Year Book, Hedehusene, Denmark.

National Ballast Information Clearinghouse (NBCI). 2009. NBIC Online Database. Electronic publication, Smithsonian Environmental Research Center and United States Coast Guard. Available: http://invasions.si.edu/nbic/search.html. (June 2014).

Özeren, C. S. 2004. Iznik Gölü baliklarinin taksonomisi ve *Cyprinus carpio* L., 1758 (Sazan), Rutilus frisii Nordmann, 1840 (Akbalik) ve *Atherina boyeri* Risso,1810 (Gümüs baligi)'nin biyo-ekolojik yönden incelenmesi. Doctoral dissertation. Hacettepe University, Ankara, Turkey. [In Turkish]

Parin, N. V., S. A. Evseenko, and E. D. Vasil'eva. 2014. Fishes of Russian seas: annotated catalogue. KMK Scientific Press 53, Moscow.

Pombo, L., M. Elliot, and J. E. Rebelo. 2005. Ecology, age and growth of *Atherina boyeri* and *Atherina presbyter* in the Ria de Aveiro, Portugal. Cybium 29(1):47-55.

Quignard, J.-P., and A. Pras. 1986. Atherinidae. Pages 1207-1210 *in* P. J. P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen, and E. Tortonese, editors. Fishes of the North-eastern Atlantic and the Mediterranean. Volume 3. UNESCO, Paris.

Reshetnikov, Y. S., N. G. Bogutskaya, E. D. Vasil'eva, E. A. Dorofeeva, A. M. Naseka, O. A. Popova, K. A. Savvaitova, V. G. Sideleva, and L. I. Sokolov. 1997. An annotated check-list of the freshwater fishes of Russia. Journal of Ichthyology 37(9):687-736.

Reid and Orlova. 2002. [Source material did not give full citation for this reference.]

Risso, A. 1810. Ichthyologie de Nice, ou histoire naturelle des poissons du Département des Alpes Maritimes. F. Schoell, Paris.

Sezen, B. 2005. Izmir Homa Lagünü gümüs baligi (*Atherina boyeri* Risso, 1810) populasyonunun biyolojik özelliklerinin incelenmesi. Master's thesis. Ege University, Imzir, Turkey.

Sokolov, L. I. 1998. Various family accounts. *In* Annotated check-list of Cyclotomata and fishes of the continual waters of Russia. Nauka Publishers, Moscow.

Sršen, V. 1995. Ichthyofauna of the Neretva River estuary. Bachelor's thesis. Faculty of Science, University of Zagreb, Zagreb, Croatia.

Trabelsi, M., J.-P. Quignard, and F. Kartas. 1994. *Atherina boyeri*: première mention en Méditerrané de deux populations marines sympatriques. Cybium 18(4):457-459.

Trabelsi, M., J.-P. Quignard, J.-A. Tomasini, M. Boussaid, B. Focant, and F. Maamouri. 2000. Discriminative value of the meristic characteristics of the punctuated sand smelts marine populations. Oebalia 26:77-88.

Vasil'eva, E. D. 1994. Cranial morphology data of the Black Sea, Sea of Azov and Caspian Sea populations and problems in the systematics of *Atherina* (Atherinidae). Voprosy Ikhtiologii 34(5):611-621. [In Russian]

Vasil'eva, E. D. 1996. Cranial data and some problems in the systematics of the genus *Atherina* (Atherinidae). Publicaciones Especiales, Instituto Español de Oceanografía, Madrid 21:199-204.

Vasil'eva, E. D. 2007. Fish of the Black Sea. Key to marine, brackish-water, euryhaline, and anadromous species with color illustrations, collected by S. V. Bogorodsky. [In Russian, with English abstract]. VNIRO Publishing, Moscow.

Whitehead, P. J. P., M.-L. Bauchot, J.-C. Hureau, J. G. Nielsen, and E. Tortonese. 1986. Fishes of the North-eastern Atlantic and the Mediterranean. UNESCO III:1015-1473.

Wildekamp, R. H., R. Romand, and J. J. Scheel. 1986. Cyprinodontidae. Pages 165-276 *in* J. Daget, J.-P. Gosse, and D. F. E. Thys van den Audenaerde, editors. Check-list of the freshwater fishes of Africa (CLOFFA). Volume 2. ISNB, Brussels; MRAC, Tervuren; and ORSTOM, Paris.