Bream (*Abramis brama*)
Ecological Risk Screening Summary

U.S. Fish & Wildlife Service, October 2012
Revised, May 2019
Web Version, 10/24/2019

Photo: T. Østergaard. Licensed under Creative Commons BY-NC 3.0 Unported. Available: https://www.fishbase.se/photos/PicturesSummary.php?StartRow=1&ID=268&what=species&TotRec=12. (October 2012).

1 Native Range and Status in the United States

Native Range

From Froese and Pauly (2019a):

"Europe and Asia: most European drainages from Adour (France) to Pechora (White Sea basin); Aegean Sea basin, in Lake Volvi and Struma and Maritza drainages. Naturally absent from Iberian Peninsula, Adriatic basin, Italy, Scotland, Scandinavia north of Bergen (Norway) and 67°N (Finland). […] In Asia, from Marmara basin (Turkey) and eastward to Aral basin."

"Reported from the Caspian Sea [Iranian Fisheries Company and Iranian Fisheries Research Organization 2000]."

"[In Turkey:] Known from the European Black Sea watersheds and Caspian Sea watersheds [Fricke et al. 2007]. Distributed in Thracian and Northwestern Anatolian lakes, in Sakaraya and Yesilirmak [Bogutskaya 1997]. Recorded from Marmara basin [Kottelat and Freyhof 2007]; Aegean, Black Sea watersheds and Kura-Aras River Basin [Çiçek et al. 2015]."

"Occurs in Odra and Morava river basins [Czech Republic] [Hanel 2003]."

"[In Estonia:] Common in the Gulf of Riga and rare in the Gulf of Finland [Ojaveer and Pihu 2003]. Commercially taken from Lake Peipus and the Võrtsjärv [Anonymous 1999]."

"Northest occurence [*sic*] in Sodankylä [Finland], common South from Oulujoki water course."

"Recorded from Danube and Rhine drainages [Germany] [Kottelat and Freyhof 2007]. Found in Elbe estuary [Thiel et al. 2003]."

"Present [in Russia] in waters belonging to the White Sea basin e.g. in the rivers falling into the White Sea in Karelia, in Topozero, in Keret'ozero, in Segozero, in Lake Charandskoe (Onega R. basin), in the Severnaya Dvina from Lake KUBENSKOE O Arkhangel'sk [*sic*], in the rivers Kuloi, Mezen and Pechora."

"Widespread in central and northern parts of Serbia. Also found in the southern parts of Serbia [Simonovic 2001]."

Froese and Pauly (2019a) list *Abramis brama* as native in Afghanistan, Armenia, Azerbaijan, Georgia, Iran, Kazakhstan, Turkey, Turkmenistan, Uzbekistan, Andorra, Austria, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Latvia, Liechtenstein, Lithuania, Luxembourg, Macedonia, Moldova, Montenegro, Netherlands, Norway, Poland, Romania, Russia, Serbia, Slovakia, Slovenia, Sweden, Switzerland, England, Wales, and Ukraine.

Status in the United States
No records of *Abramis brama* in the wild or in trade in the United States were found.

Means of Introductions in the United States
No records of *Abramis brama* in the wild in the United States were found.

Remarks
A previous version of this ERSS was published in 2012. Revisions were done to incorporate new information and to bring the document in line with current standards.

From Kottelat and Freyhof (2007:156):

"Frequently forms fertile hybrids with *Rutilus rutilus*."

Some introduced populations are referred to by the synonym *Abramis brama orientalis* (Zhang and Jiang 2016; Fricke et al. 2019). Information searches were conducted using both *Abramis brama* and *A. brama orientalis*.

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From Fricke et al. (2019):

"**Current status:** Valid as *Abramis brama* (Linnaeus 1758)."

From ITIS (2019):

"Kingdom Animalia
 Subkingdom Bilateria
  Infrakingdom Deuterostomia
   Phylum Chordata
    Subphylum Vertebrata
     Infraphylum Gnathostomata
      Superclass Actinopterygii
       Class Teleostei
        Superorder Ostariophysi
         Order Cypriniformes
          Superfamily Cyprinoidea
           Family Cyprinidae
            Genus *Abramis*
             Species *Abramis brama* (Linnaeus, 1758)"

Size, Weight, and Age Range

From Froese and Pauly (2019a):

"Max length : 82.0 cm TL male/unsexed; [Koli 1990]; common length : 25.0 cm TL male/unsexed; [Chugunova 1959]; max. published weight: 6.0 kg [International Game Fish Association 1991]; max. reported age: 23 years [Beverton and Holt 1959]"

Environment

From Froese and Pauly (2019a):

"Freshwater; brackish; benthopelagic; pH range: 7.0 - 7.5; dH range: 15 - ?; potamodromous [Riede 2004]; depth range 1 - ? m [Vostradovsky 1973]. […]; 10°C - 24°C [assumed to be recommended aquarium temperature] [Baensch and Riehl 1991]; […]"

Climate/Range
From Froese and Pauly (2019a):

"Temperate; […]; 75°N - 40°N, 11°W - 73°E"

Distribution Outside the United States
Native
From Froese and Pauly (2019a):

"Europe and Asia: most European drainages from Adour (France) to Pechora (White Sea basin); Aegean Sea basin, in Lake Volvi and Struma and Maritza drainages. Naturally absent from Iberian Peninsula, Adriatic basin, Italy, Scotland, Scandinavia north of Bergen (Norway) and 67°N (Finland). […] In Asia, from Marmara basin (Turkey) and eastward to Aral basin."

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Introduced

From Froese and Pauly (2019a):

"Locally introduced in Ireland, Spain and northeastern Italy. […] Introduced in Lake Baikal and upper Ob and Yenisei drainages [Russia]."

"Occurs in Erqishi, Ulungur, Bosten, Tarim and Yili [China] [Walker and Yang 1999]. Also found in Xinjiang [Institute of Hydrobiology, Academia Sinica, Shanghai Natural Museum and Ministry of Agriculture of China 1993]."

"Introduced in Lake Balkhash and Irtysh river [Kazakhstan] [Mitrofanov and Petr 1999]."

"Occurs in Lake Issyk-kul [Kyrgyzstan]."

"[In Uzbekistan] Translocated to [the] Zarafshan river [from] the Ural river. In 1963, 156 brooders have been accidentally introduced into the Degrez water reservoir with zander where they naturally reporoduced [*sic*] [Khurshut 2001]."

"[…] locally introduced to northeastern Italy [Freyhof and Kottelat 2008] which it has established [Bianco and Ketmaier 2001; Bianco 2014]. Rarely found in natural waters [Holcík 1991]."

"Artificialy [*sic*] transplanted [within Russia] on the Iset [Berg 1964]. This has been translocated to areas within the country for stocking in open waters. It has rapidly expanded its range and is now widely established in the country [Bogutskaya and Naseka 2002]."

"Recorded from the Ain Zada reservoir [Algeria; not established], probably part of the 2006 summer introduction of carps [Kara 2011]."

From Burdukovskaya and Pronin (2015):

"Long-term introduction works performed in the Soviet and Russian part of Lake Baikal since 1932 with repeated deliveries of several species of fish […] led to naturalization of only three invader species (bream [*Abramis brama*], Amur catfish, and Amur carp) […]. Bream, Amur catfish, and Amur carp spontaneously dispersed into the Mongolian part of the Selenga River basin (Dgebuadze et al., 2009)."

From Miranda et al. (2012):

"Common carp and common bream [*Abramis brama*] are cultivated in Lago Metztitlán [Mexico] as a source of food. […] Common bream is only in the lake, […]."

In addition to the locations mentioned above, Froese and Pauly (2019a) list *Abramis brama* as introduced and probably established in Portugal.

Means of Introduction Outside the United States

From Froese and Pauly (2019a):

"Introduced [to China] for food [Ma et al. 2003]."

From Volta et al. (2013):

"How bream was introduced to the lake is unknown, although accidental introduction as live bait is a probable explanation as has been concluded for the recent arrivals of this and similar species in lakes of isolated regions of Europe (e.g. Winfield et al. 2011)."

From Burdukovskaya and Pronin (2015):

"Long-term introduction works performed in the Soviet and Russian part of Lake Baikal since 1932 with repeated deliveries of several species of fish (starlet *Acipenser ruthenus*, chum salmon *Oncorhynchus keta*, sockeye salmon *O. nerka*, rainbow trout *O. mykiss*, cisco *Coregonus albula ladogensis*, peled *C. peled*, bream *Abramis brama*, […]"

Short Description

From Froese and Pauly (2019a):

"Dorsal spines (total): 3; Dorsal soft rays (total): 9-10; Anal spines: 3; Anal soft rays: 23 - 30; Vertebrae: 43 - 45. The only species of the genus which can be diagnosed from other species of *Ballerus*, *Blicca* and *Vimba* by the following characters: mouth sub-inferior, which can be extended as a tube; lateral line with 51-60 scales; anal fin with 30½ branched rays; eye diameter about 2/3 of snout length in individuals larger than 10 cm SL; pharyngeal teeth 5-5; and base of paired fins hyaline or grey [Kottelat and Freyhof 2007]. Caudal fin with 19 rays [Spillman 1961]. Tall, laterally compressed body. Fins darker in adults. Anal fin base twice as long as the dorsal fin [Muus and Nielsen 1999]."

From Kottelat and Freyhof (2007):

"Males with nuptial tubercles on head and body."

Biology

From Froese and Pauly (2019a):

"Adults inhabit a wide variety of lakes and large to medium sized rivers. […] Larger specimens may feed on small fish. […] Usually spawn in backwaters, floodplains or lakes shores with dense vegetation [Kottelat and Freyhof 2007]. Can survive out of the water for extended periods [Frimodt 1995]."

From Kottelat and Freyhof (2007:155):

"Gregarious. During winter, forms large aggregations, often together with other fish. […] Spawns for the first time at 3–4 years. Some females do not spawn every year. Spawns in May – June at temperatures above 15°C. In many populations, spawning migration starts in autumn (especially semi-adaromous individuals), slows down during winter and continues in spring. Migrate far upriver (100 km in Dniepr) to spawn. […] Males often defend spawning territories along shoreline. Females spawn from once a year over a few days (Rhine) to 1–3 portions, at 7–14 days intervals (Lake Ilmen). Eggs are sticky and egg size increases with age of female. Larvae and juveniles inhabit still water bodies, feeding on plankton. Survival of juvenile is high in backwaters and low in main channel of large rivers. Growth is faster in main river than backwaters. Juveniles 1–2 years old move from backwaters to river for feeding. If juveniles do not have an opportunity to leave backwaters, they are able to adapt but have a slower growth and reach maturity at a smaller size (stunted populations). In lower parts of large rivers, juveniles drift to brackish estuaries to forage when water level of flooded areas drops. Juveniles that forage in brackish waters enter lower parts of rivers to overwinter in freshwater. Juveniles mostly feed on zooplankton. Feeds on benthic invertebrates, which are dug out of fine bottom sediments, and also often on molluscs. May shift to particle feeding or even filter feeding at high zooplankton abundance."

Human Uses

From Froese and Pauly (2019a):

"Fisheries: highly commercial; aquaculture: commercial; gamefish: yes; bait: usually"

"The flesh is bony, insipid and soft [Billard 1997]. Marketed fresh or frozen. Eaten steamed, broiled, fried and baked [Frimodt 1995]."

"An important species in subsistence fishery [in Finland]."

"Important food fish in early-mediaeval times [in Poland] [Klyszejko et al. 2004]."

Diseases

Infection with spring viraemia of carp virus and koi herpes virus are OIE-reportable diseases (OIE 2019).

From Froese and Pauly (2019a):

"Black Spot Disease 1, Parasitic infestations (protozoa, worms, etc.)"

From Shaalan et al. (2017):

"*A.* [*Aeromonas*] *hydrophila* was isolated from naturally-infected common bream (*Abramis brama* L.), […]"

Liu et al. (2014) list *Aeromonas sobria* as a pathogen of *Abramis brama*.

Kempter et al. (2012) list *Abramis brama* as a carrier of **koi herpes virus**.

Froese and Pauly (2019b) list *Abramis brama* as a host for *Asymphylodora tincae*, *Caryophyllaeus laticeps*, *Catoptroides macrocotyle*, *Ergasilus briani*, *E. seiboldi*, *Gyrodactylus sommervillae*, *Neoergasilus japonicas*, *Paracoenogonimus ovatus*, *Phyllodistomum macrocotyle*, *P. dogieli*, *P. elongatum*, *P. massino*, *Sphaerostoma bramae*, and *Tylodelphys clavata*.

Poelen et al. (2014) list *A. brama* as a host for the following additional parasites and pathogens: *Acanthocephalus anguillae*, *A. lucii*, *A. clavula*, *Allocreadium isoporum*, *Anguillicola crassus*, *Apharyngostrigea cornu*, *Apophallus muehlingi*, *A. donicus*, *Archigetes brachyurus*, *A. sieboldi*, *Ascocotyle coleostoma*, *Aspidogaster limacoides*, *A. conchicola*, *Asymphylodora demeli*, *A. markewitschi*, *A. kubanicum*, *A. imitans*, *Biacetabulum appendiculatum*, *Bothriocephalus acheilognathi*, *B. gowkongensis*, *Bucephalus polymorphus*, *Camallanus lacustris*, *Capillaria* sp., *Caryophyllaeides skrjahini*, *C. fennica*, *Caryophyllaeus mutabilis*, *C. fimbriceps*, *C. brachycollis*, *Clinostomum complanatum*, *Contracaecum squalii*, *C. micropapillatum*, *C. microcephalum*, *C. spiculigerum*, *Corynosoma strumosum*, *Cotylurus pileatus*, *Crowcrocaecum skrjabini*, *Cucullanus dogieli*, *Dactylogyrus similis*, *D. fallax*, *D. crucifer*, *D. auriculatus*, *D. wunderi*, *D. sphyrna*, *D. distinguendus*, *D. cornu*, *D. falcatus*, *D. propinquus*, *D. suecicus*, *D. simplicimalleata*, *D. nanus*, *D. minutus*, *D. chranilowi*, *D. cordus*, *D. cornoides*, *D. yinwenyingae*, *D. zandti*, *D. anchoratus*, *D. zandti*, *Desmidocercella numidica*, *Digramma interrupta*, *Diplostomum chromatophorum*, *D. clavatum*, *D. pseudospathaceum*, *D. gobiorum*, *D. rutili*, *D. helvetium*, *D. volvens*, *D. mergi*, *D. paracuadum*, *D. paraspathaceum*, *D. gasterostei*, *D. spathaceum*, *Diplozoon paradoxum*, *Echinorhynchus truttae*, *Eubothrium crassum*, *Goezia ascaroides*, *Goussia balatonica*, *Gryporhynchus cheilancristrotus*, *Gyrodactylus medius*, *G. gracilihamatus*, *G. elegans*, *G. cyprini*, *G. vimbi*, *G. gracilis*, *G. laevis*, *G. parvicopula*, *G. sprostonae*, *G. prostate*, *Hysteromorpha triloba*, *Ichthyocotylurus pileatus*, I. *platycephalus*, *I. variegatus*, *Khawia sinensis*, *Ligula monogramma*, *L. intestinalis*, *Mesostephanus appendiculatoides*, *Metagonimus yokogawai*, *Molnaria intestinalis*, *Monobothrium auriculatum*, *Myxobolus muelleri*, *M. bramae*, *M. parviformis*, *M. macrocapsularis*, *M. impressus*, *M. rotundus*, *M. hungaricus*, *M. dogieli*, *M. pseudodispar*, *Naegleria pagei*, *Neascus brevicaudatum*, *Neoechinorhynchus rutili*, *Opisthorchis felineus*, *Palaeorchis unicus*, *P. incognitus*, *Paracaryophyllaeus dubininae*, *Paradilepis scolecina*, *P. scolecina*, *Paradiplozoon bliccae*, *P. homoion*, *P. pavlovskii*, *Pellucidhaptor pricei*, *Philometra sanguinea*, *P. rischta*, *P. ovata*, *P. abdominalis*, *Phyllodistomum folium*, *P. pseudofolium*, *Pomphorhynchus laevis*, *Postdiplostomum brevicaudatum*, *P. cuticola*, *Proteocephalus torulosus*, *Pseudacolpenteron pavlovskii*, *Pseudamphistomum truncatum*, *Pseudocapillaria brevispicula*, *P. tomentosa*, *Raphidascaris acus*, *Rhabdochona denudate*, *Rhipidocotyle illense*, *R. campanula*, *Sanguinicola* cf. *inermis*, *S. volgensis*, *Schistotaenia macrorhyncha*, *Schulmanella petruschewskii*, *Sphaerostomum globiporum*, **Spring viraemia carp virus**, and *Triaenophorus nodulosus*.

Threat to Humans

No information on threats to humans from *Abramis brama* was found.

3 Impacts of Introductions

From Volta et al. (2013):

"Whilst a top-down effect by bream on the food web of Lake Montorfano was apparently relatively weak, a clear bottom-up effect was evident. Despite the fact that the external nutrient loading levels are now low (Buzzi pers. com.), significant increase in nutrient concentrations (both P and N) has occurred in recent years. In addition, enhanced ammonium concentrations were first recorded in the deeper water strata, subsequently followed by an increase through the whole water column. […] As nutrient concentrations increased in Lake Montorfano, phytoplankton abundance also increased. In addition, the algae community shifted to Cyanobacteria, dominated by *Aphanotece* spp. and *Anabaena* spp., which are able to fix nitrogen under anoxic conditions. Increase in contribution of cyanobacteria may further have reduced zooplankton grazing on phytoplankton (Gliwicz 2005)."

"Macrophyte coverage in Lake Montorfano showed a major decrease following the establishment of the bream population. Two surveys carried out in the 1980s (Provincia di Como 1985) and late 1990s (Garibaldi, data unpublished) described an aquatic vegetation characterized by six submerged species (*Ceratophyllum demersum*, *Myriophyllum spicatum*, *Najas marina*, *Potamogeton pusillus*, *P. lucens*, *P. perfoliatus*) and two floating-leaved species (*Trapa natans*, *Nynphaea alba*). In contrast, the early 2000s were characterized by an almost complete loss of submerged macrophytes, the aquatic vegetation (from shoreline to the middle of the lake) being composed of *Phragmites australis* and *Typha latifolia*, *T. natans*, *N. alba* and rare stands of *C. demersum* (Bianchi et al. 2000; Volta pers. obs.). This development is not surprising as vegetation is quickly lost when a critical turbidity is exceeded (Scheffer et al. 1993)."

"Our results indicate a substantial shift in the fish community from dominance of open water zooplanktivorous species to dominance of zoobenthivorous such as bream and pumpkinseed. What triggered the sharp declines in small native cyprinids in Lake Montorfano is unknown, but the deterioration of the ecological status of the lake [triggered by the bream invasion] might have played a major role."

"In conclusion, Lake Montorfano has recently shifted towards a more turbid state with higher nutrient concentrations despite the fact that the external nutrient loading levels are now stable and low. This environmental deterioration followed the introduction and successful establishment of non-native bream in the late 1990s. Furthermore, this cyprinid has recently become the dominant fish species in the lake. The present study results suggest that bream may have contributed to the observed changes in the ecological status of the ecosystem via bottom-up mechanisms, while top-down effects were less apparent."

From Xi et al. (2016):

"The freshwater bream (*Abramis brama*) is a native cyprinid species in most European drainage basins, and has been introduced into the Ob and Yenisei river basins (Ren et al. 2002, Huo et al. 2010). Consequently, *A. brama* had spread to the upper part of the River Irtysh (China), where it became a dominant species of captured wild fish annually since 1970s (Huo et al. 2010). In the present investigation, *C. laticeps* were found only in *A. brama* with moderate prevalence rate of

(40%), which indicate that *C. laticeps* has most probably been introduced with its typical host [*A. brama*] into the River Irtysh basin."

From Zhang and Jiang (2016):

"Eight of these species (e.g. *Sander lucioperca*, *Leuciscus baicalensis*, and *Abramis brama orientlis*, […]) spread along the Ili River and drove endemic *Racoma argentatus* and *R. pseudaksaiensis* to extinction in the early 1990s (Ren, 1998)."

From Alamanov and Mikkola (2011):

"[…] and Bream grazes on the developing eggs of Issyk-Kul and Schmidt's Dace *Leuciscus schmidti* (Konurbaev et al. 2005) [in Lake Issyk-Kul]."

4 Global Distribution

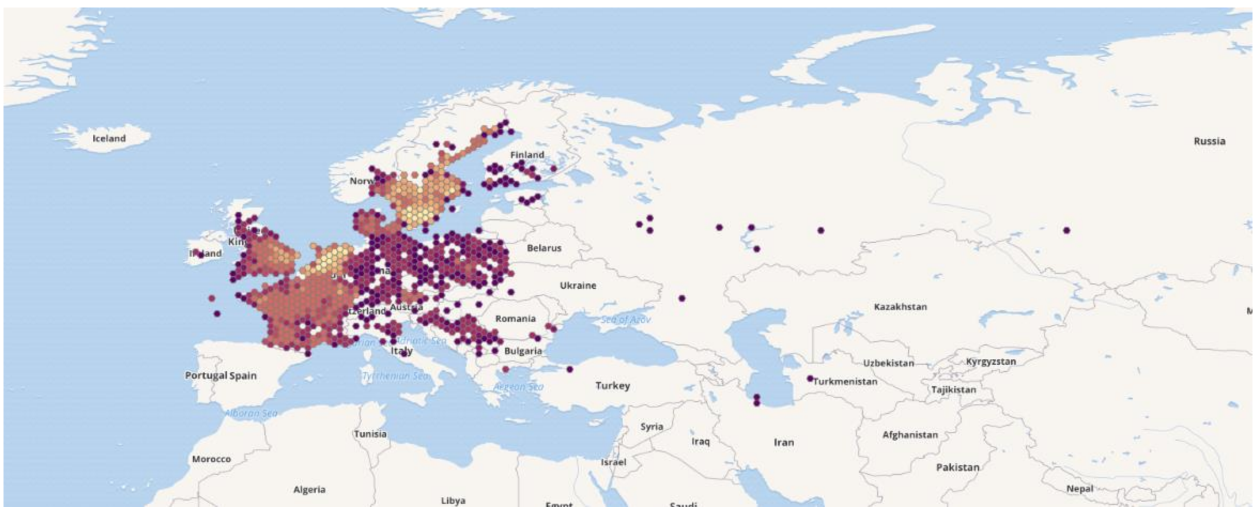

Figure 1. Known global distribution of *Abramis brama*. Locations are all in Europe and Western Asia. Map from GBIF Secretariat (2019). The locations in the ocean west of France are the result of incorrectly negated longitude for observations made in eastern France and were not used to select source points for the climate match.

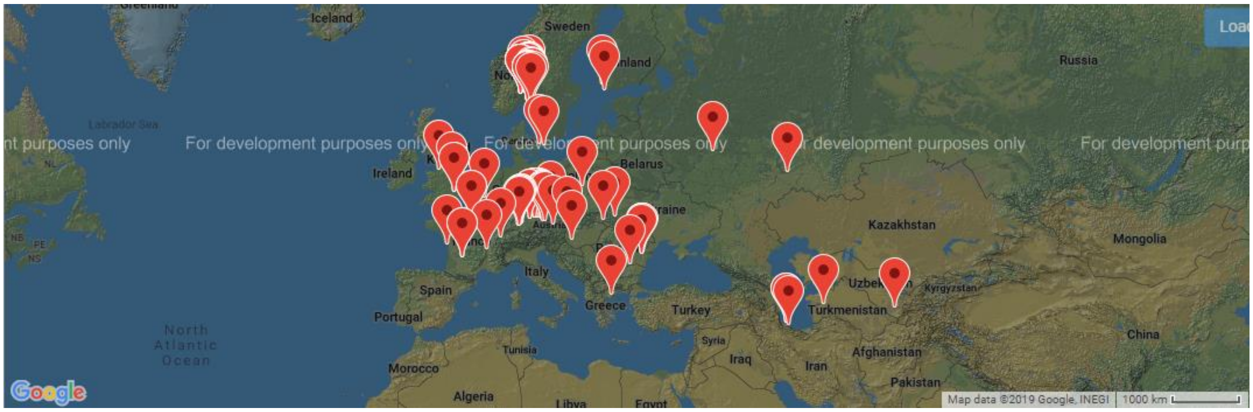

Figure 2. Additional known global distribution of *Abramis brama*. The additional locations are in western Asia in Uzbekistan and Russia. Map from VertNet (2019).

Additional observation locations in Eastern Europe and western Asia are given by Froese and Pauly (2019a), in western Siberia by Yadrenkina (2012), and northwestern China by Xi et al. (2016).

There is a population of *Abramis brama* in Mexico but it is cultured in that lake (Miranda et al. 2012). The authors did provide the location of culture but since it is unknown if the population would be self-sustaining in the absence of aquaculture activities it was not used to select source points for the climate match.

5 Distribution Within the United States

No records of *Abramis brama* in the wild in the United States were found.

6 Climate Matching

Summary of Climate Matching Analysis

The climate match for *Abramis brama* to the contiguous United States was high in the Great Lakes basin and west through the upper Midwest and upper Great Plains. There were pockets of high match throughout the west and in southern California. The southern Atlantic Coast, Gulf Coast, much of the southern border, and the Pacific Northwest had low matches. Everywhere else had a medium match. The Climate 6 score (Sanders et al. 2018; 16 climate variables; Euclidean distance) for contiguous United States was 0.510, high. The range for a high climate score is 0.103 and above. Most States had high individual climate scores, except for Kansas, North Carolina, and Tennessee which had medium scores, and Alabama, Florida, Georgia, Louisiana, Mississippi, South Carolina, and Texas which had low scores.

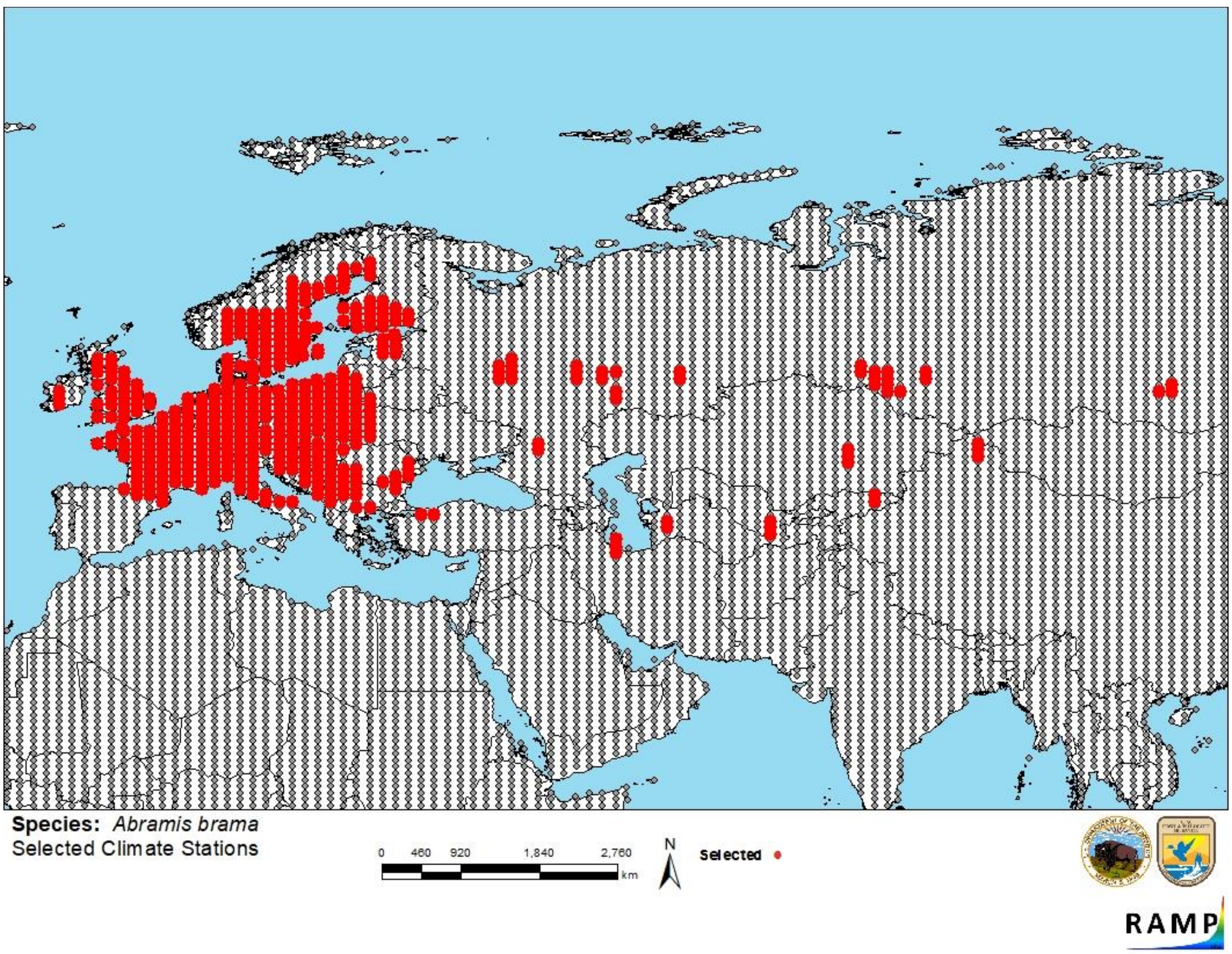

Figure 3. RAMP (Sanders et al. 2018) source map showing weather stations in Europe and Asia selected as source locations (red) and non-source locations (gray) for *Abramis brama* climate matching. Source locations from Yadrenkina (2012), Xi et al. (2016), Froese and Pauly (2019a), GBIF Secretariat (2019), and VertNet (2019). Selected source locations are within 100 km of one or more species occurrences, and do not necessarily represent the locations of occurrences themselves.

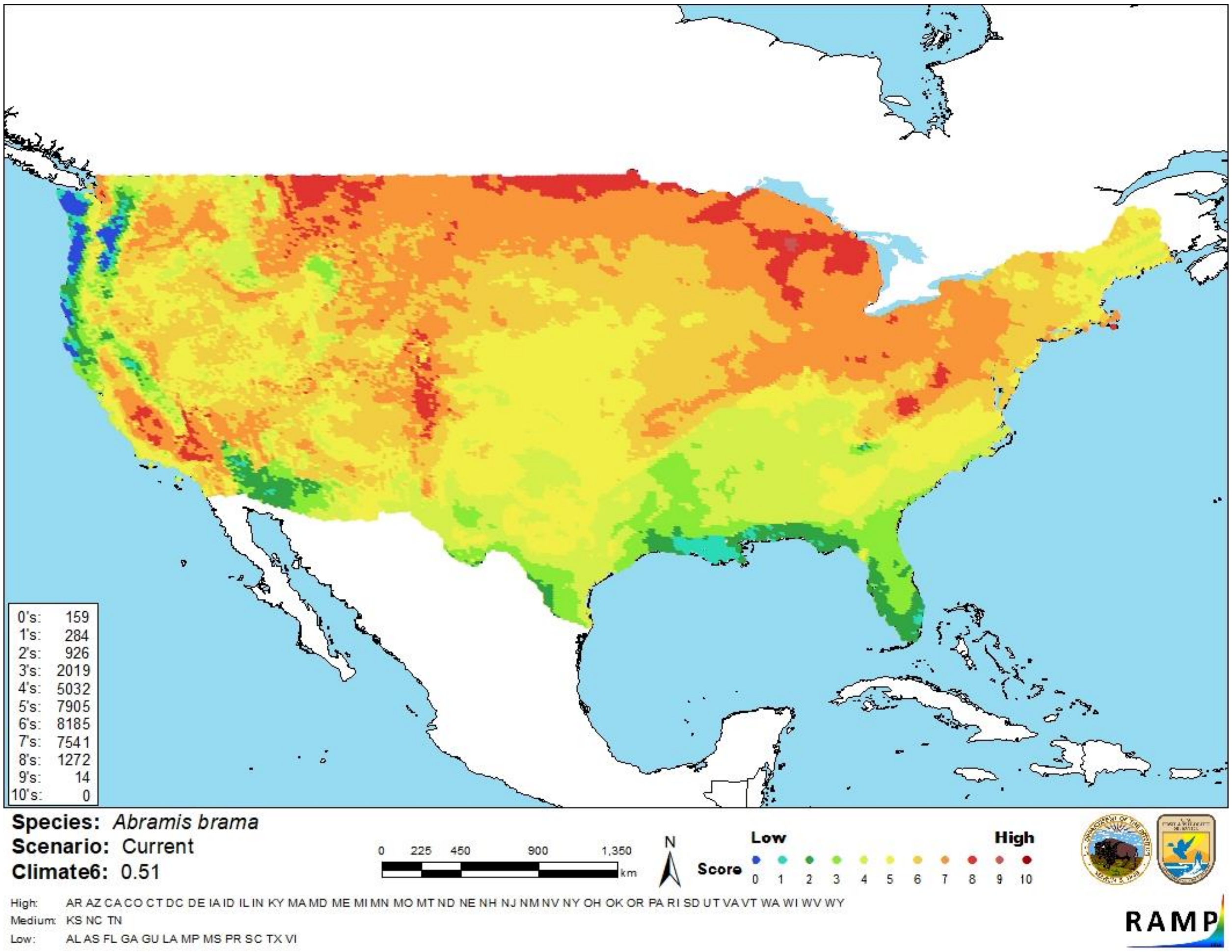

Figure 4. Map of RAMP (Sanders et al. 2018) climate matches for *Abramis brama* in the contiguous United States based on source locations reported by Yadrenkina (2012), Xi et al. (2016), Froese and Pauly (2019a), GBIF Secretariat (2019), and VertNet (2019). Counts of climate match scores are tabulated on the left. 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 is medium. Peer-reviewed literature on the biology, ecology, and distribution associated with *Abramis brama* as well as information on its history of invasiveness is available. There is enough information on impacts of introduction to make a determination on history of invasiveness. However, the methods of the studies showing impacts of introduction were not always clear hence a medium certainty instead of high.

8 Risk Assessment

Summary of Risk to the Contiguous United States

Bream (*Abramis brama*) is a large sized cyprinid fish native to much of Europe. It has a long history of use by humans, dating back to its use as a food source in the middle ages. The history of invasiveness is high. It has been introduced to new water bodies throughout most of Europe and much of western Asia. Introductions have been intentional for creating fisheries and unintentional as a possible bait dump or contamination. Established populations have had negative impacts including changes to the abiotic conditions of a lake, reductions in native plants and fish, and the co-introduction of a non-native parasite. The climate match to the contiguous United States is high. There are areas of high match stretching from the central Great Lakes basin to southern California. The certainty of assessment is medium, there is a preponderance of evidence. 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: Host for two OIE-reportable diseases.**
- **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.

Alamanov, A., and H. Mikkola. 2011. Is biodiversity friendly fisheries management possible on Issyk-Kul Lake in the Kyrgyz Republic? AMBIO 40:479–495.

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