Eurasian Minnow (*Phoxinus phoxinus*)

Ecological Risk Screening Summary

U.S. Fish & Wildlife Service, August 2012
Revised, February 2019
Web Version, 8/28/2019

Photo: J. Renoult. Licensed under CC BY-SA 4.0 International. Available: https://api.gbif.org/v1/image/unsafe/https%3A%2F%2Fstatic.inaturalist.org%2Fphotos%2F16249424%2Foriginal.jpeg%3F1524597277. (March 2019)

1 Native Range and Status in the United States

Native Range

From Froese and Pauly (2019):

"Eurasia: basins of Atlantic, North and Baltic Seas, Arctic and northern Pacific Ocean, from Garonne (France) eastward to Anadyr and Amur drainages and Korea; Ireland (possibly introduced), Great Britain northward to 58°N. Scandinavia and Russia northernmost extremity, Rhône drainage. Recorded from upper and middle Volga and Ural drainages, Lake Balkhash

(Kazakhstan) and upper Syr-Darya drainage (Aral basin), but else identifications need verification."

From GISD (2019):

"Albania, Armenia, Azerbaijan, Belarus, Belgium, Bosnia And Herzegovina, Bulgaria, China, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Italy, Kazakhstan, Korea, Democratic People's Republic Of Korea, Republic Of Latvia, Liechtenstein, Lithuania, Luxembourg, Macedonia, The Former Yugoslav Republic Of Moldova, Republic Of Mongolia, Montenegro, Netherlands, Norway, Poland, Romania, Russian Federation, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, and the United Kingdom."

In addition to the above locations, Freyhof and Kottelat (2008) lists Andorra and Austria as locations where *Phoxinus phoxinus* is native. CABI (2019) lists *Phoxinus phoxinus* as localized in Egypt.

Status in the United States

No records of introductions of *Phoxinus phoxinus* in the United States were found.

Phoxinus phoxinus was officially listed as an injurious wildlife species in 2016 under the Lacey Act (18.U.S.C.42(a)(1)) by the U.S. Fish and Wildlife Service (USFWS 2016). The importation of Eurasian minnow into the United States, any territory of the United States, the District of Columbia, the Commonwealth of Puerto Rico, or any possession of the United States, or any shipment between the continental United States, the District of Columbia, Hawaii, the Commonwealth of Puerto Rico, or any possession of the United States is prohibited.

Means of Introductions in the United States

No records of introductions of *Phoxinus phoxinus* in the United States were found.

Remarks

A previous version of this ERSS was published in 2014. Revisions were done to incorporate new information and to bring the document in line with current standards.

From Dyldin and Orlov (2016):

"Berg (1949), as part of *Ph.* [*Phoxinus*] *phoxinus*, distinguished the following subspecies: *Ph. phoxinus colchicus* Berg, 1910–Colchis minnow (Western Caucasus) and *Ph. phoxinus ujmonensis* Kashchenko, 1899–Altai minnow (Ob River basin). Currently (Kottelat, 2006; Kottelat and Freyhof, 2007; Eschmeyer, 2015), they are considered in the rank of individual species *Ph. colchicus* and *Ph. ujmonensis*. Another subspecies, *Ph. phoxinus tumensis* Luo, 1996, described from the Jilin Province, China in East Asia, according to Eshcmeyer (2015) is a synonym of *Ph. phoxinus*, and Xu et al. (2014) distinguished it in a separate species *Ph. tumensis*. In addition, a number of nominal species described from East Asian waters are now generally regarded as synonyms of *Ph. phoxinus*, which requires separate studies.

According to Bogutskaya et al. (2008), a representative of the *Phoxinus* genus is still an undescribed form in the waters of Amur."

From Palandačić et al. (2017):

"The results of the revision showed that of the fourteen primary species hypotheses [fourteen proposed valid species], three were rejected, namely *P. ketmaieri*, *P. likai*, and *P. apollonicus*. For three species (*P. strandjae*, *P. strymonicus*, *P. morella*), further investigation with increased data sampling was suggested, while two primary hypotheses, *P. bigerri* and *P. colchicus*, were supported as secondary species [subspecies] hypotheses. Finally, six of the primary species hypotheses (*P. phoxinus*, *P. lumaireul*, *P. karsticus*, *P. septimanae*, *P. marsilii* and *P. csikii*) were well supported by mitochondrial but only limitedly corroborated by nuclear data analysis."

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From Fricke et al. (2019):

"**Current status:** Valid as *Phoxinus phoxinus* (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 *Phoxinus*
Species *Phoxinus phoxinus* (Linnaeus, 1758)"

Size, Weight, and Age Range

From Froese and Pauly (2019):

"Maturity: L_m 5.1, range 5 - 5.8 cm
Max length : 14.0 cm TL male/unsexed; [Muus and Dahlström 1968]; common length : 7.0 cm TL male/unsexed; [Muus and Dahlström 1968]; max. reported age: 11 years [Kottelat and Freyhof 2007]"

From CABI (2019):

"Common size is 6-10 cm, with a maximum of 14-15 cm. The growth rates and age and size at maturation of *P. phoxinus* varies greatly with factors such as population density and numerous environmental factors (Lien, 1981; Myllylä et al., 1983; Mills and Eloranta, 1985; Mills, 1987; 1988; Museth et al., 2002)."

From Frost (1943):

"The minnow is one of the smallest British fresh- water fishes. The largest specimen taken during the present work measured 82 mm. (3 3 in.) and weighed 6 6 g. Specimens of 80 mm. were not often found, the general run of adult fish being from 50 to 65 mm. long. It is alleged that big minnows occur in the high tarns of the Lake District, and Day (1880) mentions that specimens 7 in. long were taken from a stream running into Wastwater. Minnows investigated by Tack from waters in western Germany were as much as 119 mm. in length."

Environment

From Froese and Pauly (2019):

"Freshwater; brackish; demersal; pH range: 7.0 - 7.5; dH range: 10 - 20; potamodromous [migrates only within freshwater] [Riede 2004]. […]; 2°C - 20°C [water temperature] [Riehl and Baensch 1991]; […]"

Climate/Range

From Froese and Pauly (2019):

"Temperate; […]; 73°N - 37°N, 10°W - 179°E"

Distribution Outside the United States

Native

From Froese and Pauly (2019):

"Eurasia: basins of Atlantic, North and Baltic Seas, Arctic and northern Pacific Ocean, from Garonne (France) eastward to Anadyr and Amur drainages and Korea; Ireland (possibly introduced), Great Britain northward to 58°N. Scandinavia and Russia northernmost extremity, Rhône drainage. Recorded from upper and middle Volga and Ural drainages, Lake Balkhash (Kazakhstan) and upper Syr-Darya drainage (Aral basin), but else identifications need verification."

From GISD (2019):

"Albania, Armenia, Azerbaijan, Belarus, Belgium, Bosnia And Herzegovina, Bulgaria, China, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Italy, Kazakhstan, Korea, Democratic People's Republic Of Korea, Republic Of Latvia, Liechtenstein, Lithuania, Luxembourg, Macedonia, The Former Yugoslav Republic Of Moldova,

Republic Of Mongolia, Montenegro, Netherlands, Norway, Poland, Romania, Russian Federation, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom."

In addition to the above locations, Freyhof and Kottelat (2008) lists Andorra and Austria as locations that *Phoxinus phoxinus* is native to.

In addition to the countries listed above, CABI (2019) lists *Phoxinus phoxinus* as localized in Egypt.

Introduced

According to Froese and Pauly (2019), *Phoxinus phoxinus* is introduced in Ireland and Morocco.

According to CABI (2019), *Phoxinus phoxinus* is introduced in Norway.

From GISD (2019):

"Ireland, Isle of Man, and Uzbekistan"

Means of Introduction Outside the United States

From GISD (2019):

"*Phoxinus phoxinus* was initially spread in Norway by fisherman using the fish as live bait."

From CABI (2019):

"Originally, minnows were spread because fishermen used them as live bait for catching species like brown trout (*Salmo trutta*), Arctic charr (*Salvelinus alpinus*), perch (*Perca fluviatilis*) and pike (*Exos lucius*) (Huitfeldt-Kaas, 1918). This practice is considered to be the main reason for most introductions throughout the 1900s. However, minnows have also been accidentally introduced in a large number of lakes together with stocked hatchery-reared brown trout (Borgstrøm, 1973; Lura and Kålås, 1994). Brown trout stocking has been routinely done especially in lakes modified as hydropower reservoirs, in order to compensate for reduced natural recruitment (Vøllestad and Hesthagen, 2001). These reservoirs are often located in the upper sections of watersheds. Whenever minnows were introduced, they were able to subsequently migrate downstream and become established in more lakes. This frequently occurred during the 1960s and 1970s. Minnows have also been spread through tunnels constructed for hydropower development between watersheds. In a few cases minnows have been intentionally introduced to provide forage fish for brown trout. In one case minnows were introduced as a control measure against the locally bothersome 'Tune fly' (Simuliidae) (Halleraker and Hesthagen, 1994)."

Short Description

From Froese and Pauly (2019):

"Dorsal spines (total): 3; Dorsal soft rays (total): 6-8; Anal spines: 3; Anal soft rays: 6 - 8; Vertebrae: 38 - 40. Diagnosed from its congeners in Europe by having lateral line usually reaching beyond anal fin base, a midlateral row of vertically elongated blotches whose depth is about 1/3-1/2 of body depth at same position, often fused in a midlateral stripe (in preserved individuals), caudal peduncle depth 2.6-3.1 times in its length, patches of breast scales separated by unscaled area or (rarely) connected anteriorly by 1-2 rows of scales, snout length 29-34% HL (1.1-1.4 times eye diameter), and anal fin origin in front of base of last dorsal ray [Kottelat and Freyhof 2007]. Caudal fin with 19 rays [Spillman 1961]."

From CABI (2019):

"*P. phoxinus* has a torpedo-shaped body, with 80-100 small cycloid scales along the lateral line.

P. phoxinus has variable colours, but are normally brownish green on the back, separated from the whitish belly by numerous brown and black blotches along the side, sometimes uniting to form a stripe. Males are brightly coloured during spawning, with white flashes at the fins, reddish pectoral and pelvic fins, a black throat, green along the sides and a scarlet belly (Maitland, 2004)."

From Frost (1943):

"The external features of *Phoxinus* vary but little with the individual fish, but some of them are affected by age and sexual conditions. The scales, which are small (large ones are only about 0.9 mm. long), cover the body except for an area of variable extent on the belly between the pelvic and pectoral fins. Bade (1901-2) says that they are also absent from places on the back, but I found no such bare patches. Scales first appear when the fish is about 16 mm. long, when it would be approximately 5 months old.

The colouring of the adult minnow, except in the breeding season, is as follows: the back and the sides in the region of the lateral line have a background colour of dark olive brown, overcast on the flanks with a golden or copper bronze iridescence. The ventral surface is yellowy white with a silver sheen. A thin golden stripe runs down the side, a little above the lateral line, from the operculum to the tail. There is a series of vertical black stripes down the sides. The top of the head is dark olive brown and the opercula are bronzed. The paired fins are golden brown and the dorsal, anal and caudal fins are dark in colour.

Young sexually immature minnows (*c*. 25–35 mm.) have the dark colouring and stripes on the back, which has an almost mauve bronze sheen over it; the golden iridescence of the sides is missing, and the belly is silver white. These young fish have a black line running down the side from head to tail, a feature which is absent in bigger fish, and Tack (1940) indicates that this line is replaced by the vertical stripes in the older and sexually mature specimens."

Biology

From Froese and Pauly (2019):

"Found in a wide range of cold and well oxygenated habitats from small, fast-flowing streams to large Nordic lowland rivers and from small upland lakes to large oligotrophic lakes. Usually occurs in association with salmonid fishes [Kottelat and Freyhof 2007]. Feeds on algae, plant debris (in rivers), mollusks, crustaceans and insects [Billard 1997]. Spawns over clean gravel areas in flowing water or on wave-washed shores of lakes. Overwinters in coarse substrate or in deep pools with low current [Kottelat and Freyhof 2007]. Migrates upstream for spawning in shallow gravel areas. Important laboratory fish, for research on sensory organs of fishes. Mean maximum age is 6 years [Wüstemann and Kammerad 1995]. Locally threatened due to pollution and excessive stocking of species of Salmo [Kottelat and Freyhof 2007]."

From Freyhof and Kottelat (2008):

"Gregarious, rheophilous [thrives in running water]. Lives up to 11 years, usually up to 4-5 years. Spawns for the first time at two years. Spawns in April-June at temperatures above 10°C. Some individuals spawn even during autumn. Spawns in shoals, fractional spawner, females deposit the sticky eggs deep into clean gravel. Feeds on invertebrates, algae and detritus."

From CABI (2019):

"*P. phoxinus* displays considerable variability in life-history traits, i.e. in age and size at sexual maturity, growth rate and longevity (Mills, 1988). Age at maturity has been recorded over a gradient from 0+ to 6+, in fast and slow growing populations, respectively (Museth et al., 2002). Sexual maturity occurs at a smaller body size and at a lower age in lowland localities compared with those located at a higher altitude and latitude. In most cases, however, size at maturity deviates little from 50 mm. In the river Utsjoki in Finnish Lapland, maturity was strongly size-dependent and delayed until the fish reached 5, 6 or even 7 years of age, with a maximum age of 13 years at a length of only 75 mm (Mills, 1988). In Norway, sexual maturity in minnows has been recorded at between 2 and 15 years. In the alpine lake Øvre Heimdalsvatn, minnows of age 4 and 5 years made up about 67% of the spawning stock (Museth et al., 2002). All mature individuals were larger than 50 mm in length, and only a few specimens were smaller than 55 mm. whereas no minnows older than 3 years were recorded in River Frome, UK (Mills, 1988), the oldest individual in the alpine lake Øvre Heimdalsvatn was 13 years (Museth et al., 2002).

In Norway, *P. phoxinus* spawns mainly in June and July, depending on altitude and latitude. The fish spawn in shoals over stones and gravel, either in running water or in shallow areas close to the shore line. The adhesive eggs stick to the substratum. In Øvre Heimdalsvatn, spawning activity was observed only 4-8 days after ice break in early June, with the spawning period lasting about 3 weeks (Museth et al., 2002). The adhesive yellow eggs of about 1.0-1.5 mm in diameter hatch after 5-10 days. Individual fecundity is between 200 and 1000 eggs.

It may appear that sexually mature minnows change behaviour towards spawning time, becoming more susceptible to fish predation (Museth et al., 2005)."

Human Uses

From Froese and Pauly (2019):

"Fisheries: minor commercial; aquarium: commercial; bait: usually"

Diseases

No records of OIE-reportable diseases (OIE 2019) were found for *Phoxinus phoxinus*.

According to Poelen et al. (2014), *Phoxinus phoxinus* is host to *Gyrodactylus laevis*, *Gyrodactylus jussii*, *Gyrodactylus macronychus*, *Gyrodactylus pannonicus*, *Dactylogyrus borealis*, *Gyrodactylus aphyae*, *Gyrodactylus magnificus*, *Gyrodactylus phoxini*, *Schulmanella petruschewskii*, *Acanthocephalus clavula*, *Paracaryophyllaeus gotoi*, *Schistocephalus nemachili*, *Diplostomum phoxini*, *Pomphorhynchus laevis*, *Ligula intestinalis*, and *Buddenbrockia plumatellae*.

Threat to Humans

From Froese and Pauly (2019):

"Potential pest [FAO 1997]"

3 Impacts of Introductions

From CABI (2019):

"Impacts on native ecosystems have not been well documented, except in the case of allopatric brown trout, where establishment of *P. phoxinus* leads to reduced brown trout densities."

"*P. phoxinus* may introduce new parasites where they become established. In some sub-alpine lakes in southern Norway introduced minnows caused infection with new parasite species in snails, mussels and different insects, but not in brown trout (Hartvigsen, 1997).

In Norway, survey net catches of brown trout in lakes with and without introduced European minnows demonstrated a 35% reduction in catches in lakes where brown trout were sympatric with introduced minnows (Museth et al., 2007).

The abundance of important food items for brown trout may show a significant decline after the introduction of *P. phoxinus*. In Lake Øvre Heimdalsvatn, the introduction of minnows caused major changes in the benthic community (Brittain et al., 1988; 1995). Zoobenthos diversity declined, with a marked increase in numbers of oligochaetes and small forms, especially chironomids. There was also a marked decline in numbers of *Gammarus lacustris*, especially the proportion of larger individuals. However, total benthic densities remained similar to pre-introduction. *G. lacustris* formed a major component of the diet of minnows, while it's [*sic*] occurrence in brown trout stomachs declined greatly. *Lepidurus arcticus* also virtually disappeared from the trout diet, probably due to minnow predation. In another Norwegian reservoir, introduced European minnows fed on the planktonic stages of *L. arcticus*, and after a

few years adult specimens became an insignificant part of the diet of brown trout (Borgstrøm et al., 1985).

Introduction of European minnows may also cause reduced recruitment in brown trout. In Lake Øvre Heimdalsvatn, the cohort size of age-class 4 was reduced by approximately 50% during a period in sympatry with minnows compared to the situation before the introduction of minnows. There was no significant change in annual individual length increment (Borgstrøm et al., 1996). It is uncertain whether the reduction of trout recruitment was due to direct interactions with minnows in the nursery streams, or an indirect effect caused, for example, by increased brown trout cannibalism. Minnows may prey on salmonid larvae (Huusko and Sutela, 1997)."

From Næstad and Brittain (2010):

"The littoral benthos of the subalpine lake, Øvre Heimdalsvatn, has been documented in a series of investigations carried out in 1972, 1976, 1985 and 2000. During this 28-year period there have been major changes in the benthos of the lake following the introduction of European minnow (*Phoxinus phoxinus*) into the lake where brown trout (*Salmo trutta*) was formerly the sole species. In 1972 Ephemeroptera, Trichoptera, Plecoptera and *Gammarus lacustris* dominated the macrobenthos, constituting 85% of faunal numbers, while Chironomidae and Oligochaeta made up only c. 6%. However, by 1976, chironomids and oligochaetes had increased in relative abundance, while *G. lacustris* declined. This trend towards a dominance of chironomids and oligochaetes was confirmed in 1985 and 2000, although absolute numbers of Ephemeroptera, Plecoptera and Trichoptera increased in 2000 relative to 1972 values. *Gammarus lacustris* had a 2-year life cycle in Øvre Heimdalsvatn. In 1972 there were significantly more females than males, but by 1976 and through to 2000 there were greater numbers of males. Despite this reduction in females, numbers of juveniles increased, although mortality, probably due to increased predation from minnows, was higher than earlier. The introduction of the alien species, the European minnow, into Øvre Heimdalsvatn has clearly changed the composition and structure of the littoral macroinvertebrate benthos."

4 Global Distribution

Figure 1. Known global distribution of *Phoxinus phoxinus*. Map from GBIF Secretariat (2019).

5 Distribution Within the United States

No records of introductions of *Phoxinus phoxinus* in the United States were found.

6 Climate Matching

Summary of Climate Matching Analysis

The climate match for *Phoxinus phoxinus* for the contiguous United States was generally high. There were areas of low match in the West Coast, southern border, and Gulf Coast. The climate match was high throughout the Northeast and to the Canadian border in the Midwest as well as along the Rocky Mountains from Montana to New Mexico. The rest of the West tended to have a medium climate match. The Climate 6 score (Sanders et al. 2018; 16 climate variables; Euclidean distance) for the contiguous United States was 0.393, high (scores 0.103 and greater are classified as high). All States had high individual Climate 6 scores, except for California, Georgia, Kansas, Nevada, and South Carolina, which had medium scores, and Alabama, Florida, Mississippi, and Texas, which had low scores.

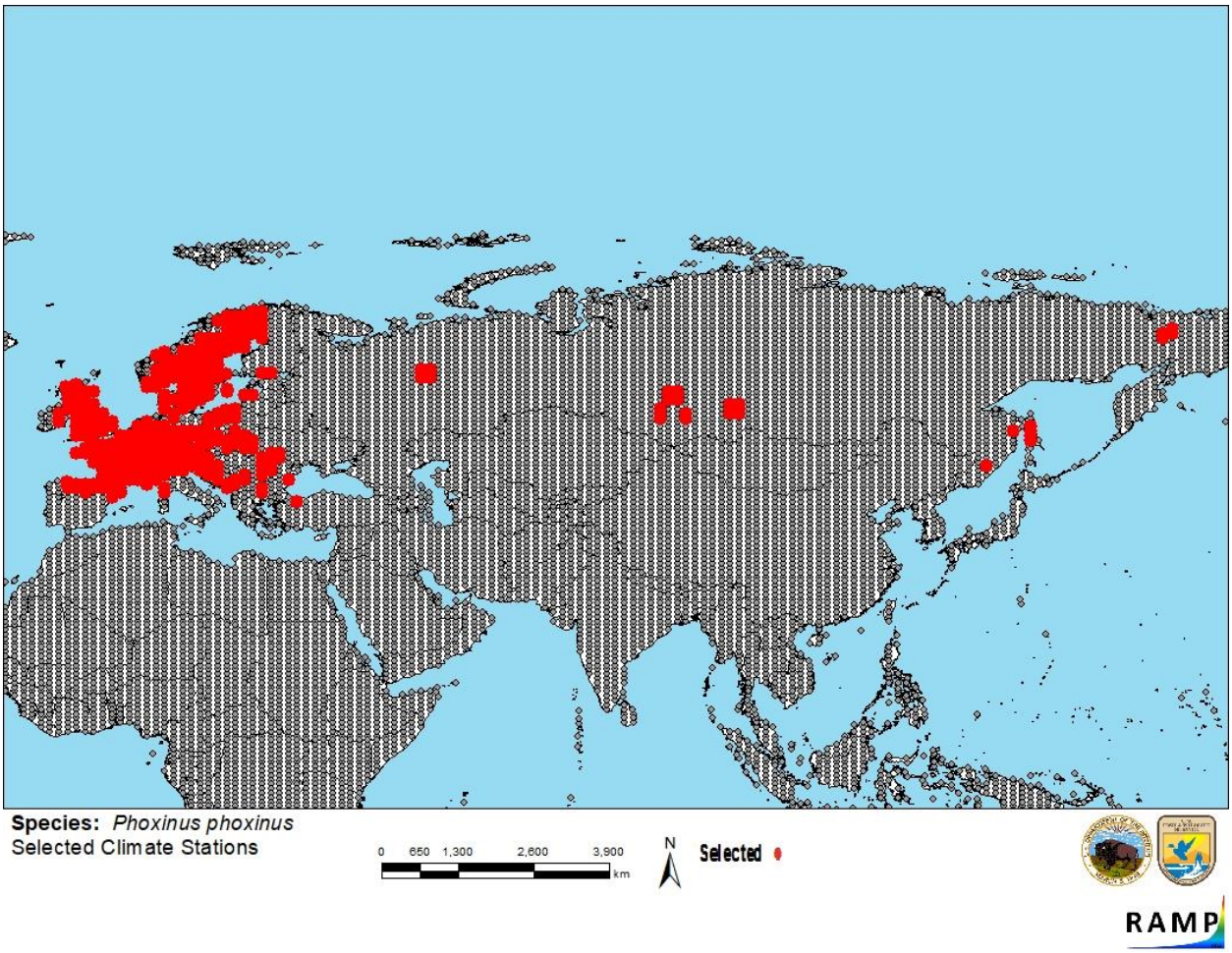

Figure 2. RAMP (Sanders et al. 2018) source map showing weather stations in Europe and Russia selected as source locations (red) and non-source locations (gray) for *Phoxinus phoxinus* climate matching. Source locations from GBIF Secretariat (2019). Selected source locations are

within 100 km of one or more species occurrences, and do not necessarily represent the locations of occurrences themselves.

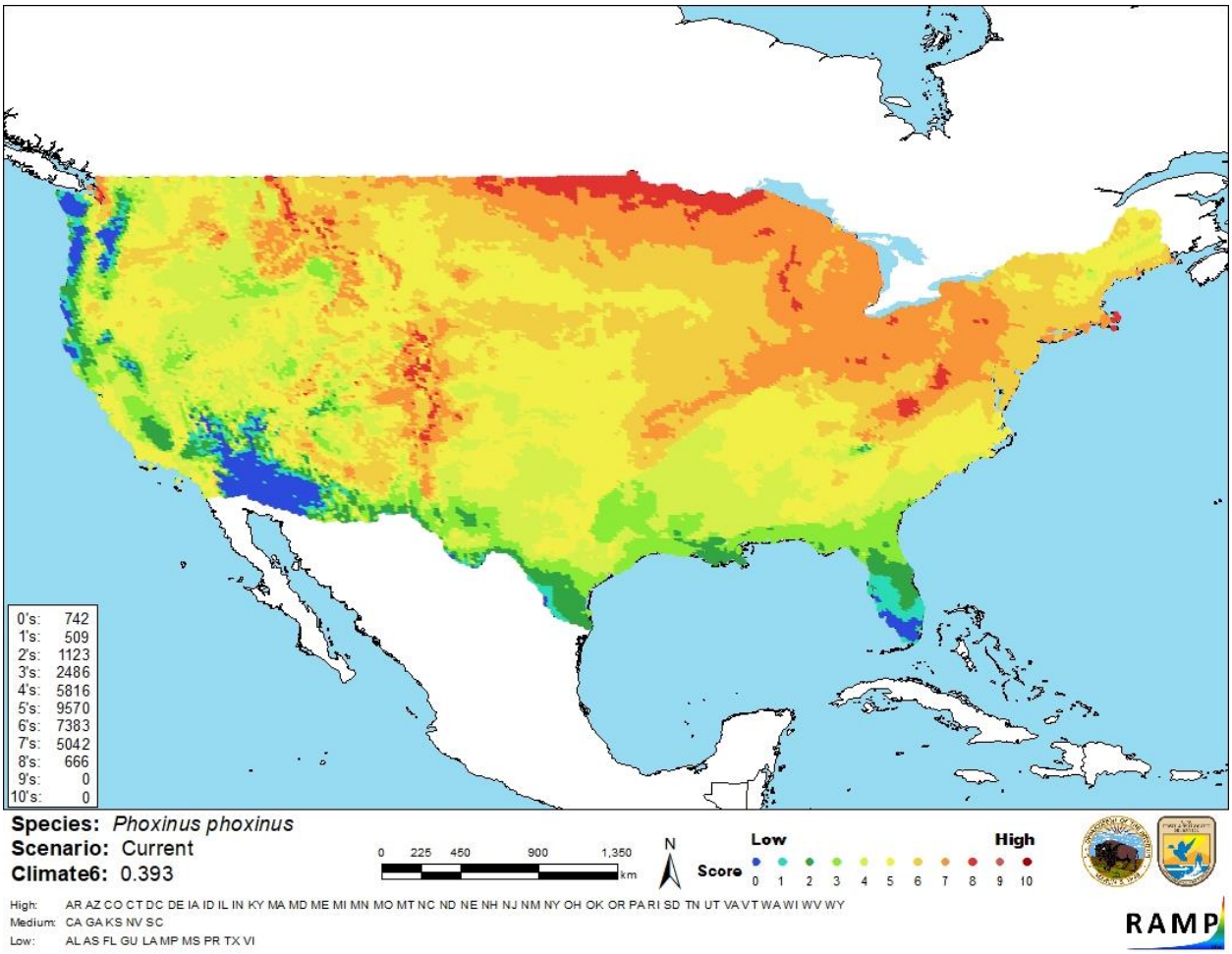

Figure 3. Map of RAMP (Sanders et al. 2018) climate matches for *Phoxinus phoxinus* in the contiguous United States based on source locations reported by GBIF Secretariat (2019). 0 = Lowest match, 10 = Highest match.

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

Certainty of assessment for *Phoxinus phoxinus* is high. Information on the biology, distribution, and impacts of this species is readily available from peer-reviewed source. Information on introductions resulting in established populations were available from reliable sources.

Information on impacts was available from a peer-review source and a reliable scientific database. While there may be some taxonomic confusing with regard to validity of other *Phoxinus* species or subspecies, there is no indication that those issues affect the conclusions that can be drawn from the literature cited in this ERSS.

8 Risk Assessment

Summary of Risk to the Contiguous United States

Eurasian Minnow (*Phoxinus phoxinus*) is a freshwater fish native throughout Europe and northern Russia. The species generally feeds on algae, plant debris, mollusks, crustaceans, and insects in both its native and introduced range. Humans have used this fish as live bait, which has been recorded as the main vector for introductions. The history of invasiveness is high. This species has spread through the use of live bait and also through the stocking of Brown Trout, where *P. phoxinus* has been mistaken for juvenile Brown Trout and stocked with them in lakes and rivers. *P. phoxinus* has been known to alter the benthic community where they are introduced and they consume Brown Trout young, resulting in trout decline in areas where *P. phoxinus* is present. *P. phoxinus* was listed as an injurious wildlife species in 2016 under the Lacey Act by the U.S. Fish and Wildlife Service, thereby prohibiting its importation. Climate match with the contiguous United States is high. Almost the entire eastern two-thirds of the contiguous United States had a high or medium climate match. Low climate matches were found along the Pacific Coast and the United States-Mexico border. The certainty of assessment is high. The biology, distribution, and history of invasiveness of the species is well documented. 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:** Several species are confused under *Phoxinus phoxinus*. Listed as injurious species in United States.
- **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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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.

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