Eurasian Minnow (*Phoxinus phoxinus*)
Ecological Risk Screening Summary

Web Version – September 2014


Photo: © CAFS From EOL (2014)

1 Native Range, and Status in the United States

Native Range
From Global Invasive Species Database (2012):

Albania, Armenia, Austria, Azerbaijan, Belarus, Belgium, BosniaHerzg, Bulgaria, China, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Ireland, Italy, Kazakhstan, Korea, Korea, Latvia, Liechtenstein, Lithuania, Luxembourg, Moldova Republic, Netherlands, Norway, Poland, Romania, Russian, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, Ukraine, and Uzbekistan (questionable).

Status in the United States
This species has not been reported in the United States.

Means of Introductions to the United States
This species has not been introduced to the United States.

Remarks
From Global Invasive Species Database (2012):

"The systemics of the genus Phoxinus are unclear, so several species may be confused under the name Phoxinus phoxinus. (Freyhof & Kottelat 2008)."

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing
From ITIS (2012):

"Kingdom Animalia
Phylum Chordata
Subphylum Vertebrata
Superclass Osteichthyes
Class Actinopterygii
Subclass Neopterygii
Infraclass Teleostei
Superorder Ostariophysi
Order Cypriniformes
Superfamily Cyprinoidea
Family Cyprinidae
Genus Phoxinus
Species Phoxinus phoxinus (Linnaeus, 1758)

Taxonomic Status: Valid"

Size, Weight, Age
From Froese and Pauly (2010):

"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)"

Environment
From Froese and Pauly (2010):

"Demersal; potamodromous (Riede 2004); freshwater; brackish; pH range: 7.0 - 7.5; dH range: 10 – 20."

Climate/Range
From Froese and Pauly (2010):

"Temperate; 2°C - 20°C (Riehl and Baensch 1991); 73°N - 37°N, 10°W - 179°E"

Distribution Outside the United States
From Froese and Pauly (2010):

"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. At least one country reports adverse ecological impact after introduction. Several species are confused under *Phoxinus phoxinus*."

Means of Introduction Outside the United States
From Sandlund (2008):

"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 (2010):

"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)."

Biology

From Froese and Pauly (2010):

"Gregarious (Spillman 1961). 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)."

Human uses

From Froese and Pauly (2010):

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

Diseases

None reported

Threat to humans

From Froese and Pauly (2010):

"Potential pest"

3 Impacts of Introductions

From Museth et al. 2007:

"The causes, effects and extent of minnow *Phoxinus phoxinus* introductions in Norway are reviewed to assess why the introductions have had severe effects, especially where brown trout *Salmo trutta* is the only fish species present. The natural distribution of minnow in Norway was mainly restricted to low altitude localities in the south-eastern part of the country and in some northern areas. The distribution area expanded considerably throughout the 1900s, especially in mountain areas, due in part to the use of minnows as live bait for angling. Although minnow densities do not seem unusually high in the relatively complex fish communities of its native range, the species can achieve very high population densities when introduced to communities with few fish species, such as in the numerous recently invaded lakes where brown trout was the only fish species present. The dense minnow populations in these lakes appear to have led to reduced recruitment and growth rates in the brown trout, with abundances on average 35% lower in lakes where minnow has been introduced. The success of minnow in harsh habitats demonstrates their phenotypic and ecological plasticity, but also implies that their original distribution in Norway was restricted by early immigration history and not by environmental limitations. This suggests that human-assisted spread of the species could have strong adverse effects in Scandinavia lakes of low fish species richness."

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."

From Hesthagen and Sandlund (2010):

"Affected habitats and indigenous organisms

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

"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 *P. phoxinus* caused major changes in the benthic community (Brittain *et al.* 1988, 1995 ; Næstad and Brittain 2010). Benthic 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 *P. phoxinus*' diet, while its occurrence in brown trout stomachs declined greatly. *Lepidurus arcticus* also virtually disappeared from the trout diet, probably due to minnow predation. In a Norwegian reservoir, introduced *P. phoxinus* 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). The degree of diet overlap and declining growth rates of both brown trout and *P. phoxinus* in Lake Øvre Heimdalsvatn indicate substantial competitive interactions between the two fish species (Museth *et al.* 2010)."

"Introduction of *P. phoxinus* 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 *P. phoxinus* compared to pre-introduction of *P. phoxinus* (Borgstrøm *et al.* 1996). There was also a significant reduction in annual individual length increment after the establishment of *P. phoxinus* (Borgstrøm *et al.* 2010). The reduction of trout recruitment was probably due to to direct interactions with *P. phoxinus* in the littoral zone and possibly in the nursery streams (Museth *et al* 2010), and also as an indirect effect of interspecific competition in the littoral zone resulting in increased brown trout cannibalism (Borgstrøm *et al.* 2010)."

"A review of standard gill net catches of brown trout in more than 400 lakes in Norway indicates the general impact of *P. phoxinus* on brown trout biomass (Museth *et al.* 2007). Gill net catches of brown trout were on average 35% lower in lakes where minnow had been introduced. These finding are only for waters where *P. phoxinus* have been introduced, and might not be valid in natural conditions."

"Genetic effects
Vøllestad *et al.* (1999) has performed a genetic characterization of 34 populations of *P. phoxinus* throughout Norway. It was found that some of the alien populations of *P. phoxinus* on the Hardangervidda mountain plateau have a genetic history very different from that found among native *P. phoxinus*, with a unique mitochondrial DNA haplotype. These populations have probably been introduced from abroad. In the same mountain area, minnow populations were also found with a genetic background similar to that of native specimens. DNA fingerprint analyses showed a larger genetic variation within *P. phoxinus* populations which were assumed to be native, than among populations which have recently been introduced. However, large genetic variation was also found among some of the introduced populations, probably due to multiple invasions."

"Human health effects
No human health effects are expected."

"Economic and societal effects (positive/negative)
P. phoxinus is of no interest to fisheries or other human uses, except for the use as live bait. This is, however, illegal by law in Norway. It is also illegal to introduce fish species that are not native to the watercourse into Norwegian lakes or rivers."

From Sandlund (2008):

"Impact Summary

Category	Impact
Environment (generally)	Negative"

"Impact: Environmental
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)."

"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)."

"Risk and Impact Factors
Invasiveness
Abundant in its native range
Capable of securing and ingesting a wide range of food
Gregarious
Has a broad native range
Has high reproductive potential
Highly adaptable to different environments
Highly mobile locally
Invasive in its native range
Is a habitat generalist
Long lived
Proved invasive outside its native range
Tolerates, or benefits from, cultivation, browsing pressure, mutilation, fire etc"

"Impact outcomes
Altered trophic level
Damaged ecosystem services

Modification of natural benthic communities
Modification of nutrient regime
Negatively impacts aquaculture/fisheries
Reduced native biodiversity
Threat to/ loss of native species"

"<u>Impact mechanisms</u>
Competition - monopolizing resources
Pest and disease transmission
Predation"

"<u>Likelihood of entry/control</u>
Difficult/costly to control
Highly likely to be transported internationally accidentally
Highly likely to be transported internationally deliberately
Highly likely to be transported internationally illegally"

4 Global Distribution

Figure 1. Global distribution of *P. phoxinus*. Map from GBIF (2010).

5 Distribution within the United States

No known occurrences of this species within the US.

6 CLIMATCH

Summary of Climate Matching Analysis

The climate match (Australian Bureau of Rural Sciences 2010; 16 climate variables; Euclidean Distance) was high for the Great Lakes region and surrounding states, as well as New England, Central and High Plains, and parts of the California, Oregon, and Washington. Medium matches covered the remainder of the United States except the southern portions of Florida, Louisiana, Arizona, and California. Climate 6 match indicated that the US has a high climate match. The range for a high climate match is 0.103 and greater, climate match of *P. phoxinus* is 0.557.

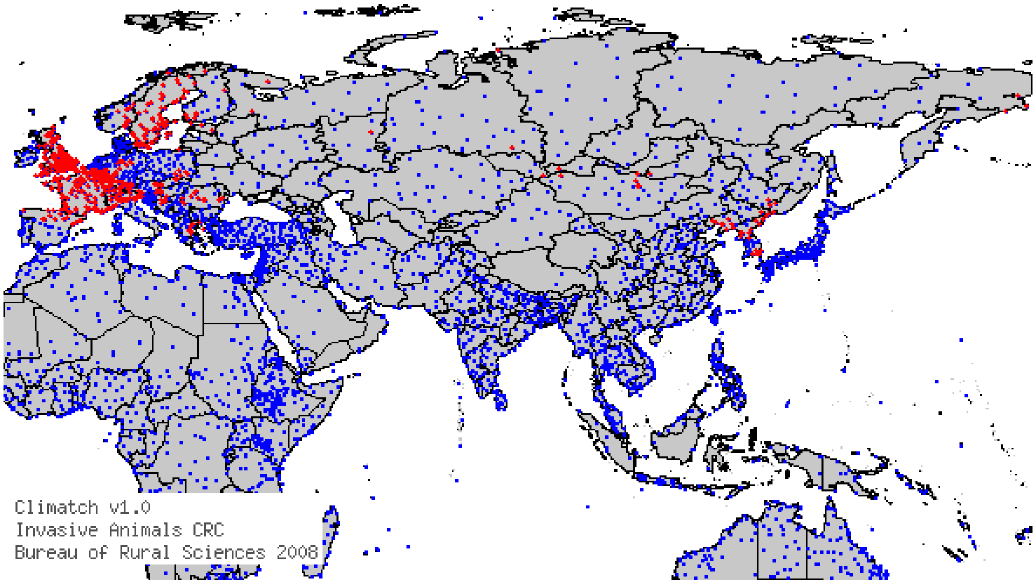

Figure 2. CLIMATCH (Australian Bureau of Rural Sciences 2010) source map showing weather stations selected as source locations (red) and non-source locations (blue) for *P. phoxinus* climate matching. Source locations from GBIF (2010).

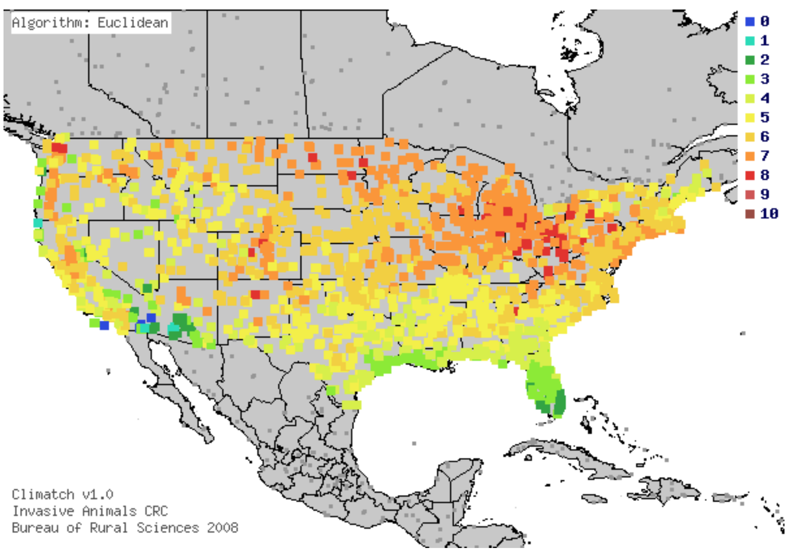

Figure 3. Map of CLIMATCH (Australian Bureau of Rural Sciences 2010) climate matches for *P. phoxinus* in the continental United States based on source locations reported by GBIF (2010). 0= Lowest match, 10=Highest match.

Table 1. CLIMATCH (Australian Bureau of Rural Sciences 2010) climate match scores

CLIMATCH Score	0	1	2	3	4	5	6	7	8	9	10
Count	4	7	45	130	227	465	604	448	51	0	0
Climate 6 Proportion =		0.557	(High)								

7 Certainty of Assessment

Information on this species is abundant, both on its biology and on the impacts caused by introduction of this species. Certainty of this assessment is high.

8 Risk Assessment

Summary of Risk to the Continental United States

Establishment and adverse impacts occurring in at least one country in Eurasia. History of invasiveness is relatively high, but the species has not been introduced to the U.S. Introduction of this species to the U.S. would likely impact the Great Lakes region and other regions of high climate match. Likely introduction pathways would be as baitfish or accidental with importation of other fish. Climate match with the US is very high.

Assessment Elements

- **History of Invasiveness(See Section 3):** High
- **Climate Match (See Section 6):** High
- **Certainty of Assessment (See Section 7):** High
- **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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