Stone Moroko (*Pseudorasbora parva*)
Ecological Risk Screening Summary

U.S. Fish & Wildlife Service, September 2014
Revised, November 2018
Web Version, 8/7/2019

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1 Native Range and Status in the United States

Native Range

From Panov (2006):

"East Asian region including the basins of the rivers Amur, Yang-tze, Huang-ho, Japanese islands, western and southern parts of the Korean Peninsula and Taiwan."

According to NIES (2018), *P. parva* is native to the central and western parts of Japan.

From Gozlan et al. (2002):

"The topmouth gudgeon *Pseudorasbora parva* (Temminck & Schlegel) is a small cyprinid, originating from Japan, China, Korea and the River Amur catchment."

From Froese and Pauly (2018a):

"Asia: Amur to Zhujiang [Pearl River] drainages in Siberia, Korea and China [Kottelat and Freyhof 2007]."

"[In China:] Occurs in eastern China, from Gansu eastward to Jiangsu and southward to Guangxi. Native to Amur basin and Lake Khanka [Bogutskaya and Naseka 1996]. Also found in Lianzi Lake [Xie et al. 2001], the Tarim River [Walker and Yang 1999], and the Hanjiang, Dongjiang, Xijiang and Nandujiang rivers [Yue 1998]."

"[In Japan:] Occurs in Kawahara-oike Lake, Nagasaki [Azuma and Motomura 1998]. Also found in Futatsukawa Creek, Fukuoka Prefecture [Nagata and Nakata 1988]."

"[In South Korea:] Recorded from the Han, Nakdong, Kum and Youngsan rivers [Jang et al. 2002]."

"[In Mongolia:] Known from Lake Buir and Rivers Onon, Kherlen, Ulz, Khalkh and Orshuun [Kottelat 2006]."

"[In Russia:] Occurs in the Amur basin and Lake Khanka, as well as in the Suifun and Tumannaya Rivers [Reshetnikov et al. 1997]."

Status in the United States

Pseudorasbora parva is not documented as either introduced or established anywhere in the United States (including territories). No records of this species in trade in the United States were found.

From USFWS (2016a):

"The U.S. Fish and Wildlife Service (Service) is amending its regulations to add to the list of injurious fish the following freshwater fish species: Crucian carp (*Carassius carassius*), Eurasian minnow (*Phoxinus phoxinus*), Prussian carp (*Carassius gibelio*), roach (*Rutilus rutilus*), stone moroko (*Pseudorasbora parva*), […]"

"Four of the 11 species proposed as injurious are currently listed as prohibited in Michigan (stone moroko, […]"

From USFWS (2016b):

"The final action is to list the […] stone moroko (*Pseudorasbora parva*), […] as injurious species under the Lacey Act (18 U.S.C. 42, as amended; the Act), thereby prohibiting the importation and interstate transportation, with the goal of preventing the accidental or intentional introduction, establishment, and spread of these nonnative species into the United States. […] This listing, finalized as a regulation, will not prohibit the transportation of these 11 species within a State."

Means of Introductions in the United States

Pseudorasbora parva is not documented as either introduced or established anywhere in the United States (including territories).

Remarks

From Witkowski (2011):

"Potential hybridisation between *P. parva* and sunbleak *Leucaspius delineatus*, a threatened species in Europe, constitutes a serious threat (Gozlan, Beyer 2006)."

A previous version of this ERSS was published in 2014.

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From Fricke et al. (2018):

"**Current status:** Valid as *Pseudorasbora parva* (Temminck & Schlegel 1846)."

From ITIS (2018):

"Kingdom Animalia
 Subkingdom Bilateria
  Infraphylum Deuterostomia
   Phylum Chordata
    Subphylum Vertebrata
     Infraphylum Gnathostomata
      Superclass Actinopterygii
       Class Teleostei
        Superorder Ostariophysi
         Order Cypriniformes
          Superfamily Cyprinoidea
           Family Cyprinidae
            Genus *Pseudorasbora*
             Species *Pseudorasbora parva* (Temminck and Schlegel, 1846)"

Size, Weight, and Age Range

From Froese and Pauly (2018a):

"Maturity: L_m 3.0 range ? - ? cm
Max length : 12.5 cm TL male/unsexed; [Verreycken et al. 2011]; common length : 8.0 cm TL male/unsexed; [Berg 1964]; max. reported age: 5 years [Novikov et al. 2002]"

From Witkowski (2011):

"[…] most individuals are 80-90 mm in length and 17.1-19.2 g in body mass. Life span up to 3-4 years."

Environment

From Froese and Pauly (2018a):

"Freshwater; brackish; benthopelagic; pH range: ? - 7.0; dH range: ? – 15. […]; 5°C - 22°C [assumed to be recommended aquarium temperature] [Baensch and Riehl 1985]; […]"

From CABI (2018):

"The species is generally saline intolerant (Scott et al., 2007) and is known to disappear from fresh waters that suffer rises in salinity"

Climate/Range

From Froese and Pauly (2018a):

"Temperate; […]; 54°N - 22°N, 110°E - 141°E"

Distribution Outside the United States

Native

From Panov (2006):

"East Asian region including the basins of the rivers Amur, Yang-tze, Huang-ho, Japanese islands, western and southern parts of the Korean Peninsula and Taiwan."

According to NIES (2018), *P. parva* is native to the central and western parts of Japan.

From Gozlan et al. (2002):

"The topmouth gudgeon *Pseudorasbora parva* (Temminck & Schlegel) is a small cyprinid, originating from Japan, China, Korea and the River Amur catchment."

From Froese and Pauly (2018a):

"Asia: Amur to Zhujiang [Pearl River] drainages in Siberia, Korea and China [Kottelat and Freyhof 2007]."

"[In China:] Occurs in eastern China, from Gansu eastward to Jiangsu and southward to Guangxi. Native to Amur basin and Lake Khanka [Bogutskaya and Naseka 1996]. Also found in Lianzi Lake [Xie et al. 2001], the Tarim River [Walker and Yang 1999], and the Hanjiang, Dongjiang, Xijiang and Nandujiang rivers [Yue 1998]."

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"[In Mongolia:] Known from Lake Buir and Rivers Onon, Kherlen, Ulz, Khalkh and Orshuun [Kottelat 2006]."

"[In Russia:] Occurs in the Amur basin and Lake Khanka, as well as in the Suifun and Tumannaya Rivers [Reshetnikov et al. 1997]."

Introduced

According to CABI (2018), *Pseudorasbora parva* is introduced and invasive in Armenia, Kazakhstan, Laos, Uzbekistan, Austria, Belgium, Bulgaria, Czech Republic, France, Germany, Hungary, Italy, Netherlands, Poland, Romania, Russian Federation, Slovakia, Spain, Switzerland, United Kingdom, Ukraine, former Yugoslavia, Serbia and Montenegro, and Fiji. *P. parva* is introduced in Afghanistan, Iran, Taiwan, Turkey, Algeria, Albania, Greece, Lithuania, Moldova, and Sweden. *P. parva* is listed as present in Demark.

According to NIES (2018), *P. parva* is introduced in the northern parts of Japan as well as Okinawa Prefecture.

From Gozlan et al. (2002):

"Since its inadvertent introduction into Romanian ponds, neighbouring the lower course of the River Danube in 1960 and its successful reproduction in 1961 (Banarescu, 1964), *P. parva* has rapidly spread across continental Europe. This species first appeared in the Hungarian part of the River Danube in 1967, followed by its occurrence in Czechoslovakia in 1974 (River Tisa, Danube Basin; Zitman & Holčík, 1976). Later in 1982, it was found in Austria (Weber, 1984) and achieved its pan-Danubian distribution with its colonization of German watercourses (Arnold, 1985). Using the Danube-Rhine Canal and the River Rhine, *P. parva* was able to disperse into western European watercourses and is now found in Belgium and the Netherlands. During the 1970s *P. parva* was intentionally introduced to the Sarthe region of France (Allardi & Chancerel, 1988) and to the Skadar lake system of Albania (Knezevic, 1981) where it was intended as food for predatory fishes reared in hatcheries. Later, the Albanian population colonized the Macedonian, Greek (Bianco, 1988) and possibly also Thracian waters (Erk'akan, 1984). More recently, in the last decade, *P. parva* has colonized Kazakhstan, Uzbekistan (Arnold, 1990), and Turkey (Wildekamp et al., 1997), as well as reaching Iran (Coad & Abdoli, 1993). In <40 years, *P. parva* has colonized continental Europe from the east to west and is now present in Africa, i.e. Algeria (Perdices & Doadrio, 1992)."

"*Pseudorasbora parva* was first discovered in England in an ornamental pond in the Chilterns (Domaniewski & Wheeler, 1996). Since then, other established populations have been found in the wild, in large numbers, at several locations across the country […]."

From Witkowski (2011):

“From the initial introductions the species has within 50 years spread to almost entire Europe, northern Africa (Algieria), central Asia (Kazakhstas, Usbekhistan, Iran), either naturally or accidentally, with stocking material of other species (Arnold 1985, Coad and Abdoli 1990, Gozlan et. al 2002, Perdices and Doadrio 1992). […] Since the first introductions of *P. parva* outside its natural range, approximately 5 new countries were invaded in each decade, with an average of 3.9 years (SD=5.19) between the first introduction and the first detection (Gozlan et al. 2010a, Witkowski 2009).”

From Froese and Pauly (2018a):

“[In Algeria:] Established as isolated or rare [Kara 2011].”

“[In Afghanistan:] Occurs in Khanabad [Coad 1981].”

“[In Armenia:] Now inhabits all reservoirs of Ararat Valley and neighboring territories [Gabrielyan 2001].”

“[In Azerbaijan:] Has been recorded in the lower reaches of the Kuma River since 1981 [Reshetnikov et al. 1997].”

“[In Iran:] Caspian Sea and Namak Lake basins [Coad 1995].”

“[In Kazakhstan:] Introduced in Lake Balkhash and Irtysh river [*sic*] [Mitrofanov and Petr 1999].”

“[In Kyrgystan:] Occurs in Lake Issyk-kul.”

“[In Laos:] Introduced in the Mekong basin in northern Laos [Kottelat 2001].”

“[In Taiwan:] Collected from mangrove creeks in Shin-Feng, northwestern Taiwan [Kuo et a. 1999]. Reported from Peng-hu [Chen 2004].”

“[In Turkey:] Introduced into many European drainages, first record reported from Thrace. Also introduced to Antalya Basin, Karacaören I Dam Lake, Gelingüllü Dam Lake. Also observed at Filyos-Devrekcreek in 2005 [Innal and Erk'akan 2006]. Known from the European Mediterranean Sea watersheds and Anatolian Mediterranean Sea watersheds [Fricke et al. 2007].”

“[In Turkmenistan:] Tedzhen River basin [Coad 1995]. Recorded from the Kara Kum Channel. Reported since 1963 [Sal'nikov 1998].”

“[In Vietnam:] Known from the Ta Van River (22°18' N, 103°54' E), right tributary of the Red River, Hoang Lien Shon National Park in Lao Kai Province [Karabanov and Kodukhova 2013].”

“[In Albania:] Established in natural waters [Holcík 1991].”

“[In Austria:] Present in Neusiedler See [*sic*] [Wolfram-Wais et al. 1999].”

“[In Belarus:] Reported as naturalized in Belarus. Recorded from Dnieper (1998) [Semenchenko et al. 2009].”

“[In Belgium:] Appears in large numbers and is widespread in all river basins in Flanders (Belgium).”

“[In Czech Republic:] This species has produced stable and viable populations in natural waters [Lusk et al. 2004]. Introduced in the 1960s. Reintroduced in 1981-82 all over the Czech republic [*sic*]. […] Distributed in southeast Bohemia and south Moravia.”

“[In France:] Widely distributed in the Rhône, the Loire and the Seine [Billard 1997].”

“[In Greece:] Known from Lake Mikra [Rosecchi et al. 1993] and Lake Megali in Prespa [Crivelli et al. 1997].”

“[In Italy:] Naturalized in 1988. Established in Northern Italy, expanding in central Italy [Bianco and Ketmaier 2001]. Found in the River Po in 1990 as reported from FISH Magazine of the Institute of Fisheries Management, Nottingham UK. Introduced accidentally into the Po and Tevere basins [Gandolfi et al. 1991], Tuscany [Tiralongo and Gnisci 2014]. Recorded for the 1st time in the Grosseto Province, now established in the middle and lower courses of the Ombrone, Albegna and Fiora. […] Is also locally abundant [Bianco and Ketmaier 2001]. […] Has been reported in the shallow marine waters of the Tyrrhenian Sea [Tiralongo and Gnisci 2014].”

“[In Montenegro:] Recorded from the River Moraca [Kováí and Sanda 2007].”

“[In Poland:] Invaded shallow, densely vegetated lakes, fish ponds, canals and ditches. […] Reintroduced in 1990. Naturalized and acclimatized [Grabowska et al. 2010].”

“[In United Kingdom:] Population in Cumbria (Ratherheath Tarn) was rotenone eradicated in 2005. London (Epping Forest) introduction eradicated by depletion; a few specimens found in R. Cole and Lower Lee by M. Carter, and specimens of *L. souffia* reported in Thames by Araujo et al. (1999) were probably *P. parva*. But establishment not confirmed. FISH Magazine of the Institute of Fisheries Management, Nottingham UK. Found reproducing population in ornamental lake in Chilterns, UK.”

Means of Introduction Outside the United States

From Gozlan et al. (2002):

“The type of introduction (accidental or deliberate) as well as dispersal into different watercourses in England is still unclear but the only introduction known to have taken place, occurred during the mid-1980s at Crampmoor Fisheries, Hampshire (M. Stollery, pers. com.).”

From Froese and Pauly (2018a):

"Introduced in 1961 with fry of *Ctenopharyngodon idella* from middle Changjiang [Yangtze] [Kottelat and Freyhof 2007]."

From Witkowski (2011):

"Only in a few instances *P. parva* was introduced purposefully, as an ornamental fish (Beyer 2004) or as a food for predatory fishes in hatcheries (Cakic et al. 2004). In a great majority of cases it was an accidental introduction or natural expansion of the range through river systems."

Short Description

From Froese and Pauly (2018a):

"Dorsal spines (total): 3; Dorsal soft rays (total): 7; Anal spines: 3; Anal soft rays: 6. Mouth superior and transverse; 6 branched anal rays; barbels absent; distal margin of dorsal convex; large adults with sexually dimorphic coloration [Kottelat 2001]."

"Males are larger than females, wit [*sic*] much deeper body and darker and brighter coloration. Males show bluish grey breeding coloration and few, very large nuptial tubercles on snout [Kottelat and Freyhof 2007]."

Froese and Pauly (2018a) also list 32–38 lateral line scales, 1 pectoral spine, 11–14 pectoral rays, 1 pelvic spine, and 7 pelvic rays.

From CABI (2018):

"*P. parva* populations occurring in European fresh waters display a wide morphological variability, significantly differing from one another (Kotusz and Witkowski, 1998; Záhorská et al., unpublished [2009]). However, there appears to be little variability amongst introduced European populations, with the greatest morphological variation appearing to be between native and non-native populations (Louette et al., 2002). […] Mouth is transverse and positioned superiorly. It does not have barbels."

From Witkowski (2011):

"*P. parva* has an elongate body, slightly flattened on sides, resembling that of the species of the genus *Gobio*. […] The head is somewhat flattened in its anterior part. The mouth is clearly in top position. The dorsal and anal fins are short. The caudal fin is big and deeply incised, with both parts of similar size. The ventral fins are located slightly anterior to the dorsal fin. The throat is covered with scales. The lateral line is complete, running in the middle of sides. The scales are large and cycloidal. […] The coloration is similar in both sexes, with greay [*sic*] back, light sides and belly, passing from yellowish-green to silver. Young individuals have a dark stripe along the body sides; it disappears with age. In caudal part of the scales pigment forms characteristic lunate spots. The fins are pale, light yellow, only on the dorsal fin there is a darker stripe, running obliquely backwards (Berg 1949, Kotusz and Witkowski 1998, Šebela and Wohlgemuth 1984, Witkowski 1991a,b)."

"The sexual dimorphism becomes pronounced during spawning. In males breeding tubercles appear on the head. The greatest accumulation of sharp tubercles (ca. 14) is located in the anterior part of the head, on the frons, near nostrils and below and above the eye. Few tubercles (ca. 4) are observed also on the lower lip. In that period the males darken distinctly, and their fins become black while the operculum gets violet. The females become clearly lighter (Anhelt and Tiefenbach 1991, Berg 1949, Movčan and Kozlov 1978, Muchačeva 1950)."

Biology

From Froese and Pauly (2018a):

"Found in a wide variety of habitats, most abundantly in well vegetated small channels, ponds and small lakes [Kottelat and Freyhof 2007]. Adults occur in cool running water. Feed on small insects, fish and fish eggs [Billard 1997], and plant material [Kottelat and Freyhof 2007]. Usually breed in habitats with still or very slow-flowing water [Kottelat and Freyhof 2007]. Females spawn 3-4 times in a season [Kottelat and Freyhof 2007]. Males clear the surface of the spawning site and guard the eggs until they hatch [Kottelat and Freyhof 2007]. Regarded as pest which competes with the fry of other species due to its high reproductive rate [Welcomme 1988]."

"Nests under stones and the male cleans the cavity with its pearl organs. Eggs adhere to the ceiling of the cavity. The male leaves the nest before the eggs hatch. Females spawn 3-4 times during a season [Kottelat and Freyhof 2007]."

From Gozlan et al. (2002):

"[…] *P. parva* life history characteristics, including reproductive behaviour (batch spawner and nest guarder), early sexual maturity (after 1 year) […]"

"[…] this species has the ability to spawn on any smooth surfaced object, such as branches, leaves and artificial substrata (Maekawa et al., 1996). This plasticity in use of spawning substratum could aid dispersal of the eggs from upstream to downstream on floating objects and even between different catchments via canal connections."

From Witkowski (2011):

"*P. parva* spawns when one year old. In the Amur river [*sic*] basin the spawning starts when the water reaches the temperature of 15-19 ^{o}C (May-August), whereas in Europe it spawns earlier – in April-June (Giurca and Angelescu 1971, Baruš et al. 1984). The fertility of *P. parva* ranges from a few hundred to a few thousand eggs: Amur – 388-3060; Czech Republic – 2018-5326; Danube - 610-3200; Dnieper – 800-4200. The eggs are ellipsoidal (major diameter 2.0- 2.5 mm), sticky and yellowish. The species belongs to the indifferent (litho-phytophilous) reproductive guild (Baruš et al. 1984, Kozlov 1974, Movčan and Smirnov 1981, Muchačeva 1950). The spawning is multi-litter and takes place in the littoral. The eggs are laid on plants, sand, stones, mollusc shells and other substrata. Before spawning the female carefully cleans the substratum for egg-laying. During one act it lays up to several dozen eggs. One male may spawn with a few consecutive females. The male guards the eggs till hatching, and aggressively drives away other, often larger, fish (Šebela and Wohlgemuth 1984). The embryonic development at the water temperature of 20-28 °C takes 4-8, and the larval development 41-42 days (Kozlov 1974, Makajeva and Zaki Mochamed 1982, Półtorak 1995, Šebela and Wohlgemuth 1984)."

Human Uses

From Froese and Pauly (2018a):

"Fisheries: of no interest; aquarium: commercial"

"[…] used as bait and for feeding other fish [Spratte and Hartmann 1998]."

From Gozlan et al. (2002):

"Although, regulations regarding the importation, movement and keeping of *P. parva* in England exist (Import of Live Fish Act licence), it may be impossible to prevent and control other introductions, due to the increasing market for ornamental species."

From CABI (2018):

"Owing to its potential threat to aquatic biodiversity, *P. parva* has been listed under the species of fish whose keeping or release in any part of England and Wales is prohibited except under the authority of a license (Defra, 2004)."

From Witkowski (2011):

"In Denmark, regular trade with *P. parva* for aquarists was seen in 2004 (Olesen, pers. comm.)."

Diseases

Koi herpesvirus is an OIE-reportable disease (OIE 2018).

From Pospichal et al. (2018):

"Even though we found CyHV-3 DNA [koi herpesvirus] in koi tissue only in one sample after cohabitation with topmouth gudgeon [*P. parva*] (stressed by removal of skin mucus), it seems appropriate to consider topmouth gudgeon as a new potential carrier of this virus. However, in the future it will be necessary to confirm this finding in further experiments utilizing diverse experimental set-ups."

From Panov (2006):

"Being a vector of infectious diseases (including *Spherotecum destruens*), it constitutes a serious threat to both native and farmed fish in Europe."

From Witkowski (2011):

"Parasite specific to *P. parva* that has been reported is *Dactylogyrus squameus* and this has facilitated their dispersal to the Czech and Slovak Republics and Italy (Galli et al. 2007, Ondraćkova et al. 2004). A range of native generalist pathogens are associated with invasive *P. parva*, these are typically zoosporic fungi (Czeczuga et al. 2002), parasites such as *Diplostomum spataceum* in Georgia (Kakalova and Shonia 2008) and viruses such as fry rhabdovirus (PFR) in Germany (Ahne and Thomsen 1986). This virus which causes acute disease of *Esox lucius* fry has been isolated from *P. parva*. The two most severe parasite found associated with *P. parva* in its invasive range are *Anguillicola crassus* and rosette agent *Sphaerothecum destruans* (Gozlan et al. 2005, 2009, 2010b)."

According to Froese and Pauly (2018b), *Pseudorasbora parva* is a host for *Ergasilus briani*, *Neoergasilus japonicus*, *Gyrodactylus parvae*, *Lernaea cyprinacea*, and *Urorchis imba*.

Poelen et al. (2014) list the following additional parasites of *P. parva*: *Philometroides pseudorasbori*, *Metorchis orientalis*, *Schulmanella petruschewskii*, *Acanthocephalus opsariichthydis*, *Pallisentis ussuriense*, *Ancyrocephalus* sp., *Dactylogyrus facetus*, *Bivaginogyrus obscurus*, *Dactylogyrus yinwenyingae*, *Gyrodactylus gobioninum*, *Exorchis oviformis*, *Echinochasmus milvi*, *Metagonimus yokogawai*, *Liolope copulans*, *Neidhartia pseudorasbora*, *Clinostomum complanatum*, *Pseudexorchis* sp., *Cyathocotyle orientalis*, *Cyathocotyle prussica*, *Echinochasmus japonicus*, *Echinochasmus perfoliatus*, *Microparyphium* sp., *Centrocestus armatus*, *Haplorchis pumilio*, *Asymphylodora japonica*, *Orientotrema* sp., *Urorchis acheilognathi*, *Isoparorchis hypselobagri*, *Pseudocapillaria tomentosa*, *Pomphorhynchus laevis*, *Archigetes sieboldi*, Chinese River Fluke (*Clonorchis sinensis*), and American grass carp reovirus.

Threat to Humans

From Froese and Pauly (2018a):

"Is considered a pest in culture ponds where it competes with cultured species like *Cyprinus carpio*."

From Panov (2006):

"No human health effects have been reported."

3 Impacts of Introductions

From Britton et al. (2010b):

"In conclusion, this study quantified several ecological consequences of *P. parva* introduction on a fish assemblage; not only did they subsequently dominate the fish community, but their trophic overlap with resident fishes resulted in depressed growth rates (and so production) and shifts in trophic position. Thus, examination of the study's null hypothesis indicated it was only partially valid; through establishment of a sustainable population of *P. parva* and their integration into the foodweb, consequent trophic interactions did result in a measurable ecological impact on *R. rutilus* through depressed somatic growth, although this had not been concomitant with a change at the level of community composition. As these outputs revealed a negative ecological consequence of *P. parva* introduction and establishment, they can be used to better inform and refine existing risk assessment protocols and management decision-making tools for this highly invasive species."

From CABI (2018):

"It is reported that the introduction of *P. parva* has negatively impacted upon the diversity of species in Puntee Alberete wetland in Italy (SEHUMED, 2000). *P. parva*, which has been introduced accidentally into freshwater ecosystems in China, not only has little commercial value but has made three species of Schizothoracine fishes endangered to near extinction (Liang, personal communication as stated in Ping and Yiyu, 2004). In Tashkent in the former USSR, a number of fishes including *P. parva*, which were accidentally introduced, together with *Ctenopharyngodon idella* resulted in declines in local species through superior growth and fecundity (Rosenthal, 1976 as stated in FAO, 2004). *P. parva* is known to host non-native diseases of threat to native species (Cesco et al., 2001), including the rosette agent (Gozlan et al., 2005, 2006)."

From Witkowski (2011):

"Where it occurs in masses in fish ponds, it competes for food with farmed fish species (Kozlov 1974, Movčan and Smirnov 1981). Most importantly it consumes larger species of planktonic crustaceans which results in an increase in the quantity of phytoplankton, and further in increasing eutrophication of the water bodies (Adamek and Sukop 2000). Besides, it feeds on juvenile stages of many locally valuable native fish species (Žitnan and Holčik 1976). Potential hybridisation between *P. parva* and sunbleak *Leucaspius delineatus*, a threatened species in Europe, constitutes a serious threat (Gozlan, Beyer 2006)."

"Being a vector of infectious diseases, it constitutes a serious threat to both native and farmed fishes in Europe. Parasite specific to *P. parva* that has been reported is *Dactylogyrus squameus* and this has facilitated their dispersal to the Czech and Slovak Republics and Italy (Galli et al. 2007, Ondraćkova et al. 2004). A range of native generalist pathogens are associated with invasive *P. parva*, these are typically zoosporic fungi (Czeczuga et al. 2002), parasites such as *Diplostomum spataceum* in Georgia (Kakalova and Shonia 2008) and viruses such as fry rhabdovirus (PFR) in Germany (Ahne and Thomsen 1986). This virus which causes acute disease of *Esox lucius* fry has been isolated from *P. parva*. The two most severe parasite found associated with *P. parva* in its invasive range are *Anguillicola crassus* and rosette agent *Sphaerothecum destruans* (Gozlan et al. 2005, 2009, 2010b). The identification of *P. parva* as a healthy carrier for the intercellular parasite *S. destruans* is a concern in that this pathogen has been responsible for mass mortalities of salmonid fishes in USA (Arkush et al. 1998) and has since been associated with the decline of native European fish species including *Leucaspius delineatus* (Gozlan et al. 2010a,b)."

"In open waters of southern Europe *P. parva* has probably contributed to a decrease in abundance or even disappearance of some autochthonous cyprinids (*Scardinius erythrophthalmus*, *Carassius carassius*, *Rhodeus sericeus*, *Gobio gobio*, *Leucaspius delineatus*) (Giurca and Angelescu 1971, Žitnan and Holčik 1976). According to Bănărescu (1999) and Rosecchi et al. (1993) in rivers the species has probably modified the structure of the native communities of aquatic invertebrates. In ponds, during a mass occurrence, it depletes food basis of farmed species (carp), decreasing their productivity (Adamek and Sukop 2000)."

From Gozlan et al. (2005):

"[…] we show here how a recently introduced fish, the invasive Asian cyprinid *Pseudorasbora parva*, is causing increased mortality and totally inhibiting spawning in an already endangered native fish, the European cyprinid *Leucaspius delineatus*. This threat is caused by an infectious pathogen, a rosette-like intracellular eukaryotic parasite that is a deadly, nonspecific agent."

"[…] since its introduction in 1960 into Romanian ponds near the River Danube, the Asian topmouth gudgeon, *P. parva*, has spread rapidly throughout Europe [Gozlan et al. 2002] and has locally coincided with *L. delineatus* extinction [Giurca et al. 1971; Wolfram-Wais et al. 1999].

In laboratory experiments […], we found that the holding water of *P. parva* acted as an absolute inhibitor of spawning for *L. delineatus* (no eggs produced in *P. parva* water compared with 1,596 + 840 in control, clean water), and caused a large increase in fish mortality (69 + 3% deaths in the treatment group, compared with 16 + 2%; […]). These results were confirmed in a large natural outdoor pond, where *L. delineatus* populations declined by 96% over three spawning seasons (2002–04; […]) after being mixed with *P. parva*, despite an increase of 13% in the year before *P. parva* arrived (2001; […]). Spawning was totally inhibited in *L. delineatus* after *P. parva* was introduced.

We found that the decline in *L. delineatus* (caused by total inhibition of spawning, loss of body condition, and death) that resulted from sharing water with *P. parva* was caused by an infectious organism. Histological findings from moribund *L. delineatus* indicated extensive infection of visceral organs, including the reproductive tissues, with an obligate intracellular eukaryotic pathogen […] similar to the lethal rosette agent *Sphaerothecum destruens* [Arkush et al. 2003] that infects Chinook salmon, *Oncorhynchus tshawytscha*, and Atlantic salmon, *Salmo salar*."

"Preliminary examination indicates that other cyprinids, such as the fathead minnow *Pimephales promelas*, are also susceptible to this pathogen, which causes effects identical to those in *L. delineatus* […]. […] Cohabitation studies are a recognized method for detecting carrier states for different fish pathogens [St. Hilaire 2001; Gilad 2002] and, as our results illustrate, they are currently the most reliable way to detect a healthy carrier.

Our results have three important implications. First, the most invasive fish species in Europe [*P. parva*] [Gozlan et al. 2002] is a healthy host for a deadly, nonspecific pathogen that could threaten aquaculture trade, including that of salmonids. […] Third, this pathogen could pose a threat to the conservation of European fish diversity."

From Britton et al. (2010a):

"In the space of 3 years and through the expenditure of approximately £190,000 […], *P. parva* distribution in the UK appears to have been brought under relative control and their threat to the UK fish fauna substantially reduced."

"In a recent economic impact assessment that incorporated *P. parva* control in conjunction with their present and estimated future distribution, and their impact on the economic value of fisheries resources, the present value of losses (PVL) attributable to *P. parva* was £3063.5 M (Defra 2005). However, this value was calculated using control costs that are now outdated and their refinement using data in Table 3 [in source material] and Britton et al. (2008) reduces the PVL to £2879.7 M."

From Froese and Pauly (2018a):

"Caused the extinction of three endemic fish species in Lake Lugu, Sichuan Province [China] [Welcomme 1988]."

"[In Poland:] Impact severe, displaced several species of limnophilous and stagophilous fishes."

4 Global Distribution

Figure 1. Known global distribution of *Pseudorasbora parva*. Locations are in Albania, Algeria, Armenia, Austria, Azerbaijan, Belgium, Bosnia and Herzegovina, Bulgaria, China, Croatia, Czech Republic, Denmark, France, Germany, Greece, Hong Kong, Hungary, Iran, Italy, Japan, Kosovo, Kyrgyzstan, Laos, Luxembourg, Macedonia, Montenegro, Morocco, Myanmar, Netherlands, North Korea, Poland, Romania, Russian Federation, Serbia, Slovakia, Slovenia, Spain, South Korea, Taiwan, Turkey, Ukraine, and the United Kingdom. Map from GBIF Secretariat (2018). The northernmost locations in England were not used to select source points for the climate match, they no longer represent established wild populations (Britton et al. 2010a).

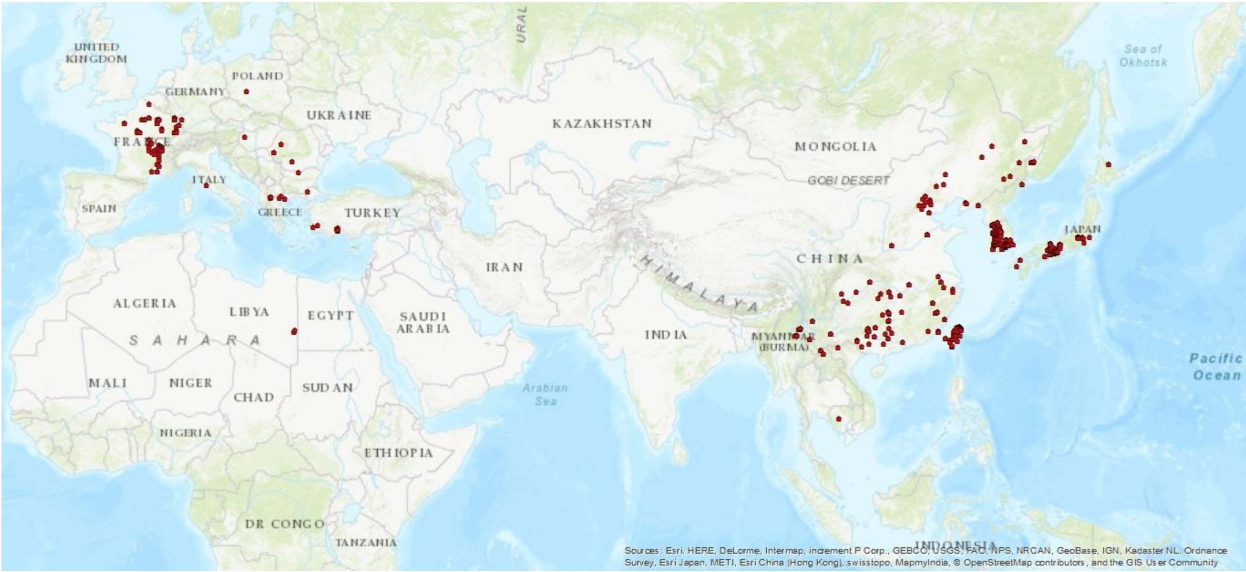

Figure 2. Additional known global distribution of *Pseudorasbora parva*. Locations are in France, Italy, Poland, Hungary, Romania, Bulgaria, Greece, Turkey, Libya, Cambodia, Myanmar, Laos, Vietnam, China, Taiwan, South Korea, Japan, North Korea, and Russia. Point records from Froese and Pauly (2018a). Map created with ArcGIS® by ESRI.

Figure 3. Additional known global distribution of *Pseudorasbora parva*. Locations are in Mongolia, Taiwan, China, Romania, Japan, Cambodia, Kyrgyzstan, Russia, South Korea, Iran, and Germany. Map from VertNet (2018).

An additional location in northern Algeria is given in Perdices and Doadrio (1992).

5 Distribution Within the United States

Pseudorasbora parva is not documented as either introduced or established anywhere in the United States (including territories).

6 Climate Matching

Summary of Climate Matching Analysis

The climate match for *Pseudorasbora parva* was mostly high across the contiguous United States. There were areas of low match along the northern Pacific Coast and a few small areas in the Great Plains and inland Louisiana. Everywhere else was medium to high. The Climate 6 score (Sanders et al. 2018; 16 climate variables; Euclidean distance) for contiguous United States was 0.746, high (scores 0.103 and greater are classified as high). All States had high individual Climate 6 scores except for Alabama which had a medium score and Louisiana which had a low score.

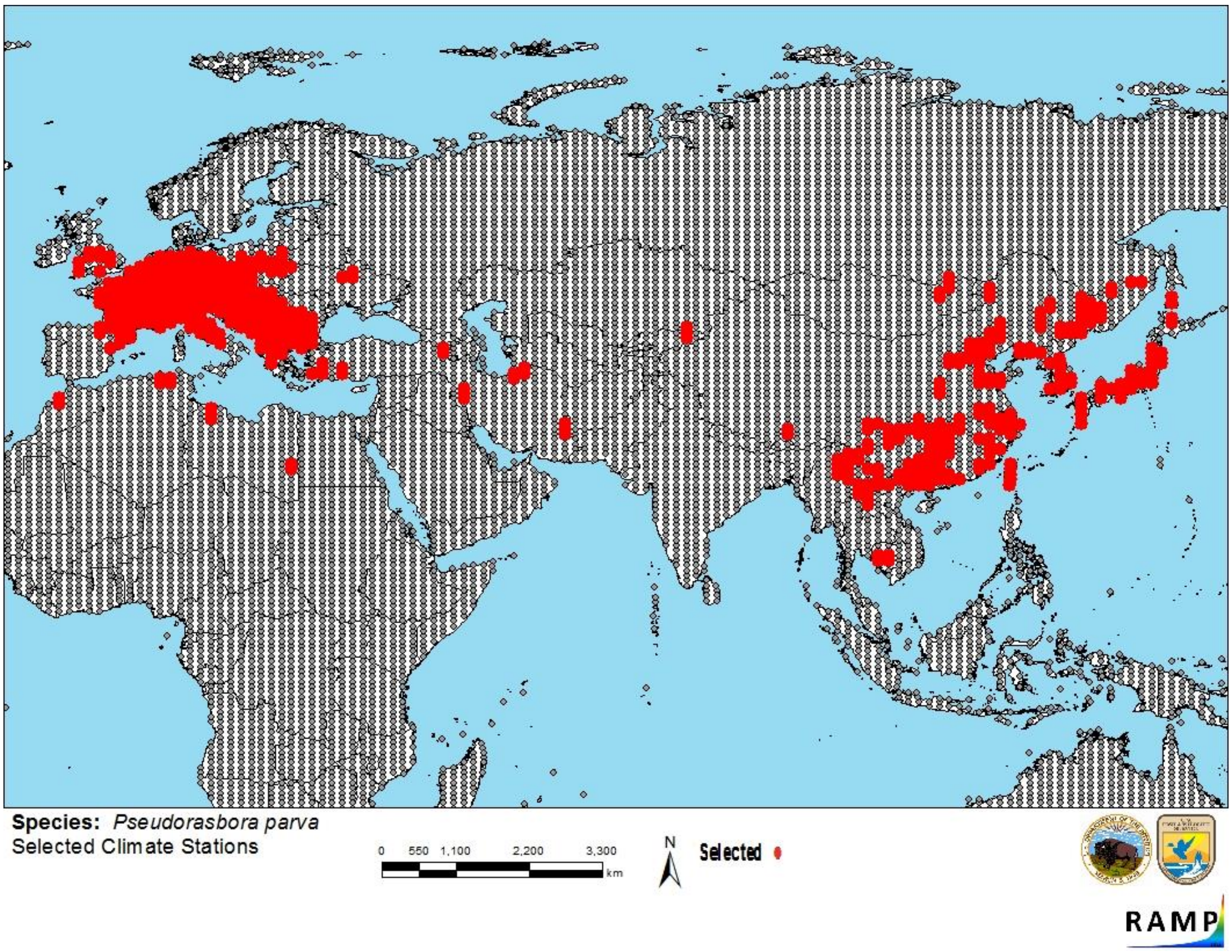

Figure 4. RAMP (Sanders et al. 2018) source map showing weather stations in Europe, northern Africa, the Middle East, and Asia selected as source locations (red) and non-source locations (gray) for *Pseudorasbora parva* climate matching. Source locations from Britton et al. (2010a), Froese and Pauly (2018a), GBIF Secretariat (2018), Perdices and Doadrio (1992), and VertNet (2018). Selected source locations are within 100 km of one or more species occurrences, and do not necessarily represent the locations of occurrences themselves.

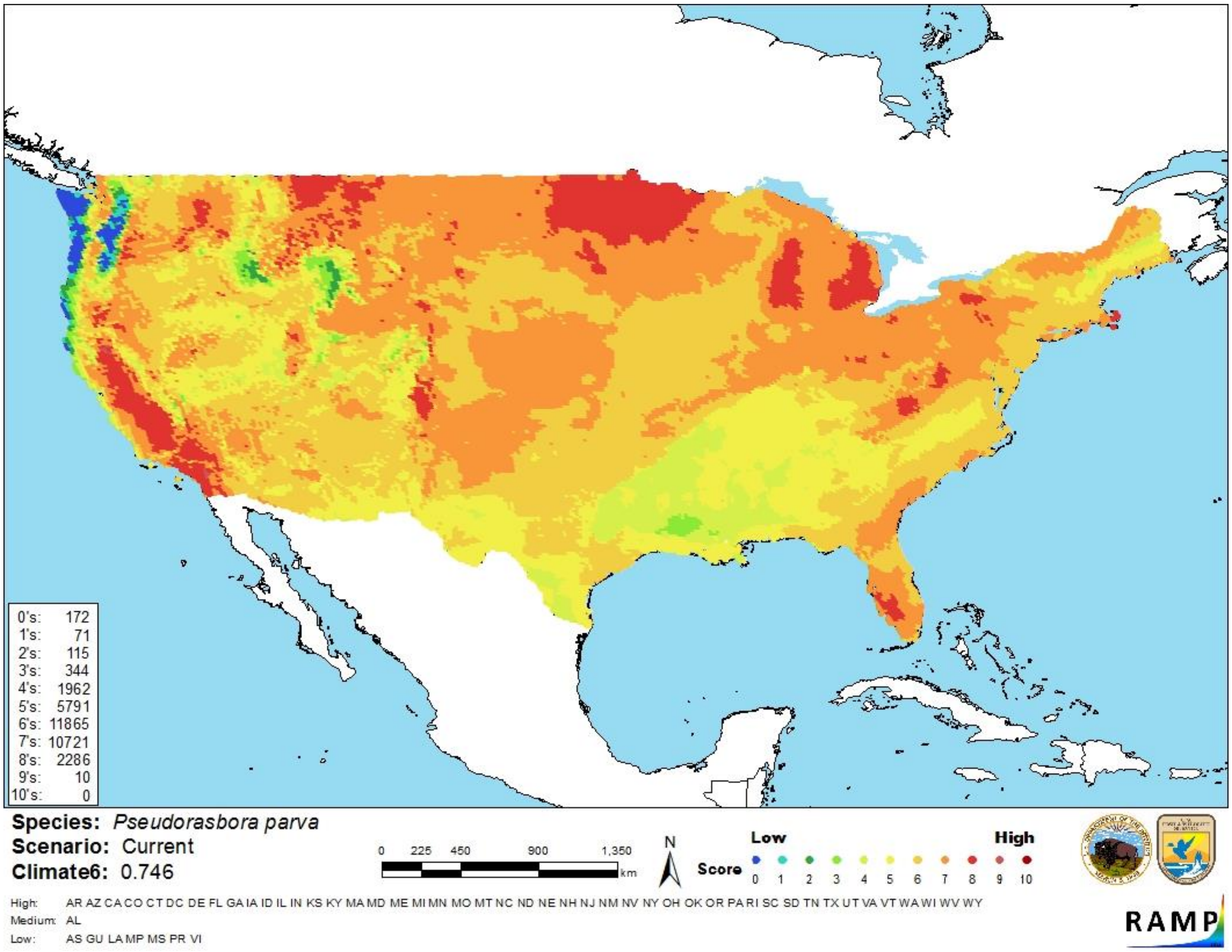

Figure 5.Map of RAMP (Sanders et al. 2018) climate matches for *Pseudorasbora parva* in the contiguous United States based on source locations reported by Britton et al. (2010a), Froese and Pauly (2018a), GBIF Secretariat (2018), Perdices and Doadrio (1992), and VertNet (2018). Counts of climate match 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

Information on the biology, invasion history, and impacts of this species is sufficient to give an accurate description of the risk posed by this species. Sources of information come from peer reviewed literature and grey literature. Certainty of this assessment is high.

8 Risk Assessment

Summary of Risk to the Contiguous United States

Stone Moroko (*Pseudorasbora parva*) is a species of cyprinid native to Pacific drainages in northeastern Asia. *P. parva* has been used commercially, as feed and bait, and in the ornamental trade. The history of invasiveness is high. The species was inadvertently and purposefully introduced, and then spread on its own, into various portions of Europe. It has been a contaminant of shipments of other species to Europe from Asia. *P. parva* competes for food with farmed fish species, feeds on juvenile stages of many locally valuable native fish species, and is a vector of infectious diseases (including *Spherotecum destruens*) that constitutes a serious threat to both native and farmed fishes. *P. parva* has been documented as a cause of or implicated in significant declines in native species in Europe. The climate match is high. There were very few areas of the contiguous United States that did not have medium or high matches. All states but two had high individual climate scores. The certainty of assessment is high. 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): High**
- **Remarks/Important additional information:** *Pseudorasbora parva* may be a carrier of koi herpesvirus which is an OIE-reportable disease.
- **Overall Risk Assessment Category: High**

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