Grass Carp (diploid) (*Ctenopharyngodon idella* var. *diploid*)
Ecological Risk Screening Summary

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Photo (edited): U.S. Fish and Wildlife Service

1 Native Range and Status in the United States

Native Range

From Nico et al. (2018):

"Eastern Asia from the Amur River of eastern Russia and China south to West River of southern China (Lee et al. 1980 et seq.; Shireman and Smith 1983)."

Status in the United States

From Nico et al. (2018) [Records may be for diploid or triploid grass carp]:

"Grass Carp have been recorded from the following states and territories:

- Alabama (Guillory and Gasaway 1978; Boschung 1992; Kirk et al. 1994; Mettee et al. 1996; Rasmussen 1998; Bain 1990; Tucker 1979; Clugston 1990; Etnier, pers. comm.; Chapman, pers. comm.)
- Arkansas (Buchanan 1973; Guillory and Gasaway 1978; Conner et al. 1980; Zimpfer et al. 1987; Clugston 1990; Mississippi Museum of Natural Science 2004)
- Arizona (Minckley 1973; Guillory and Gasaway 1978; Lee et al. 1980 et seq.; Courtenay et al. 1984, 1991)
- California (Guillory and Gasaway 1978; Lee et al.1980 et seq; Courtenay et al. 1984, 1991; Dill and Cordone 1997; Thiery 1990)
- Colorado (Guillory and Gasaway 1978; Courtenay et al. 1984, 1991; Woodling 1985; Rasmussen 1998)
- Connecticut (Whitworth 1996)
- Delaware (Courtenay et al. 1984, 1991; Raasch and Altemus 1991; Rohde et al. 1994)
- Florida (Guillory and Gasaway 1978; Lee et al.1980 et seq.; Courtenay et al. 1984; Florida Game and Freshwater Fish Commission 1989, 1994; Burkhead and Williams 1991; Shafland 1996; Tseng 2002; Hill and Cichra 2005; Nico 2005; Charlotte Harbor NEP 2004; Colle et al 1989)
- Georgia (Guillory and Gasaway 1978; Lee et al. 1980 et seq.; Courtenay et al. 1984; Burkhead et al. 1997; Walters 1997)
- Hawaii (Maciolek 1984)
- Idaho (Courtenay et al. 1984, 1991; Idaho Fish and Game 1990)
- Illinois (Pflieger 1975; Anonymous 1977; Guillory and Gasaway 1978; Smith 1979; Lee et al.1980 et seq.; Phillips et al. 1982; Burr and Page 1986; Burr et al. 1996; Laird and Page 1996; Raibley 1995; Blodgett 1993; Rasmussen 1998; Illinois Natural History Survey 2004)
- Indiana (Anonymous 1977; Guillory and Gasaway 1978; Lee et al.1980 et seq.; Simon et al. 1992; Tilmant 1999)
- Iowa (Guillory and Gasaway 1978; Burr and Page 1986; Harlan et al. 1987; Courtenay et al. 1991; Young et al. 1997; Hatch and Schmidt 2002)
- Kansas (Guillory and Gasaway 1978; Courtenay and Williams 1992; Cross and Collins 1995; Rasmussen 1998)
- Kentucky (Lee et al. 1980 et seq.; Conner et al. 1980; Courtenay et al. 1984, 1991; Burr and Page 1986; Burr and Warren 1986; Etnier personal communication)
- Louisiana (Guillory and Gasaway 1978; Conner et al. 1980; Conner and Suttkus 1986; Zimpfer et al. 1987; Carp Task Force 1989; Rasmussen 1998)
- Maryland (Guillory and Gasaway 1978; Courtenay et al. 1984, 1991; Rohde et al. 1994, Starnes et al. 2011)
- Massachusetts (Courtenay et al. 1984, 1991; Hartel 1992; Hartel et al. 1996; USFWS 2005)

- Michigan (Guillory and Gasaway 1978; Lee et al. 1980 et seq.; Courtenay et al. 1984; Emery 1985; Cudmore-Vokey and Crossman 2000)
- Minnesota (Phillips et al. 1982; Courtenay et al. 1984, 1991; Hatch and Schmidt 2002; [Raibley] 1995)
- Mississippi (Guillory and Gasaway 1978; Courtenay et al. 1991; Courtenay 1993; Ross 2001; Schramm and Basler 2004)
- Missouri (Pflieger 1975, 1978, 1997; Guillory and Gasaway 1978; Brown and Coon 1991; Young et al. 1997; Rasmussen 1998; Raibley 1995; Mississippi Museum of Natural Science 2004; Etnier personal communication)
- Nebraska (Guillory and Gasaway 1978; Courtenay et al. 1984, 1991; Rasmussen 1998; USFWS 2005; Nebraska Parks and Game Commission, unpublished)
- Nevada (Courtenay et al. 1984, 1991; Deacon and Williams 1984; Vinyard 2001)
- New Hampshire (Guillory and Gasaway 1978; Lee et al. 1980 et seq.; Schmidt 1986)
- New Jersey initially in private hatcheries only (Guillory and Gasaway 1978; D. Mitchell and Soldwedel, personal communication)
- New Mexico (Guillory and Gasaway 1978; Courtenay et al. 1984, 1991; Cowley and Sublette 1987; Sublette et al. 1990)
- New York (Guillory and Gasaway 1978; Courtenay et al. 1984, 1991; Smith 1985; Schmidt 1986; Cudmore-Vokey and Crossman 2000; J. Freidhoff, pers. comm., W. Stone, pers. comm.)
- North Carolina (Guillory and Gasaway 1978; Lee et al. 1980 et seq.; Courtenay et al. 1984, 1991; Menhinick 1991; Rohde et al. 1994; Beshears 2004, 2005)
- North Dakota (Lee et al. 1980 et seq.; Owen et al. 1981; Power and Ryckman 1998; Rasmussen 1998)
- Ohio (Guillory and Gasaway 1978; Lee et al. 1980 et seq.; Courtenay et al. 1984, 1991; Chapman et al. 2013)
- Oklahoma (Guillory and Gasaway 1978; Lee et al. 1980 et seq.; Courtenay et al. 1984, Cashner and Matthews 1988; Pigg et al. 1992; Rasmussen 1998; USFWS 2005)
- Oregon (Lee et al. 1980 et seq.; Pauley et al. 1994; Kulla 2004)
- Pennsylvania (C. N. Shiffer, personal communication)
- South Carolina (Guillory and Gasaway 1978; Lee et al. 1980 et seq.; Courtenay et al. 1984, 1991; Foltz and Kirk 1994; Rohde et al. 1994)
- South Dakota (Guillory and Gasaway 1978; Lee et al. 1980 et seq.; Owen et al. 1981; Young et al. 1997)
- Tennessee (Guillory and Gasaway 1978; Ryon and Loar 1988; Etnier and Starnes 1993)
- Texas (Guillory and Gasaway 1978; Lee et al. 1980 et seq.; Conner and Suttkus 1986; Trimm et al. 1989; Howells [1992]; Howells 1993; Howells 1999; Red River Authority of Texas 2001; Texas Parks and Wildlife Department 2001; Yoon 2003; Anonymous 1994; Waldrip 1992)
- Utah (Courtenay et al. 1984, 1991; Sigler and Sigler 1996)
- Virginia (Guillory and Gasaway 1978; Lee et al. 1980 et seq.; Courtenay et al. 1984, 1991; Jenkins and Burkhead 1994; Rohde et al. 1994)
- Washington (Pauley et al. 1994; Fletcher, personal communication; Roesler 2003)

- West Virginia (Guillory and Gasaway 1978; Lee et al. 1980 et seq.; Courtenay et al. 1991)
- Wisconsin (Guillory and Gasaway 1978; Becker 1983; Emery 1985; Burr and Page 1986; Mulvey 1990; Fago 1992)
- Wyoming (Courtenay et al. 1984, 1991; Stone 1995)
- Puerto Rico (Erdsman 1984)"

"**Status:** Grass Carp have been recorded from 45 states; there are no reports of introductions in Alaska, Maine, Montana, Rhode Island, and Vermont. It is known to have established populations in a number of states in the Mississippi River basin. Breeding populations have been recorded for the Mississippi River in Kentucky (Conner et al. 1980; Burr and Warren 1986), the Illinois and upper Mississippi rivers of Illinois and Missouri (Raibley et al. 1995), the lower Missouri River in Missouri (Raibley et al. 1995), the Mississippi River or its tributaries in the states of Arkansas (Conner et al. 1980), Louisiana (Conner et al. 1980; Zimpfer et al. 1987), Tennessee (Etnier and Starnes 1993), and presumably Mississippi (Courtenay et al. 1991). It is also established in the Ohio River in Illinois (Burr, personal communication); it was listed as established in Minnesota (Courtenay et al. 1991, but see Courtenay 1993), and in the Trinity River of Texas (Waldrip 1992; Webb et al. 1994; Elder and Murphy 1997). Courtenay (1993) listed Grass Carp as established in eight states, Arkansas, Kentucky, Illinois, Louisiana, Missouri, Mississippi, Tennessee, and Texas; an additional one, Minnesota, was included in an earlier listing of states with established populations (Courtenay et al. 1991). Stone (1995) listed this species as being established in Wyoming; however, Stone (personal communication) clarified his earlier report by stating that, as of early 1997, there is no evidence of natural reproduction in that state. Similar to a few other authors, he used the term 'established' to indicate that grass carp populations have persisted for many years, presumably because of their long life span and because of long-term maintenance of wild populations through continued stockings. Pearson and Krumholz (1984) mentioned several records from the Ohio River, including river mile 963 on the Illinois-Kentucky border and from the Falls of the Ohio, at Louisville, along the Kentucky-Ohio border. They also stated that the species had been stocked in many private ponds and lakes in the Ohio River basin. Sigler and Sigler (1996) stated that this species is no longer found in Utah, but they provide no details. Harvest of Grass Carp by commercial fishermen in the Missouri and Mississippi rivers of Missouri has exhibited a general climb. In 1996, the most recent available data, there was a record reported harvest, about 44,000 pounds, 8 percent of the total commercial fish harvest (J. W. Robinson, personal communication). Starnes et al. (2011) report Grass Carp as stocked and occasionally [*sic*] occurring in the lower Potomac River and C&O Canal near Plummers Island. Chapman et al. (2013) provided evidence for successful reproduction of Grass Carp in the Sandusky River in 2011."

From Zajicek et al. (2011):

"Currently, grass carp stocking is prohibited in Alaska, District of Columbia, Maine, Maryland, Massachusetts, Montana, Michigan, Minnesota, New Hampshire, North Dakota, Wisconsin, and Vermont. Diploid or triploid grass carp can be stocked in Arkansas, Colorado, Hawaii, Iowa, Mississippi, Missouri, and Nebraska. All other states restrict grass carp stocking to triploid fish (Vince Mudrak, USFWS, personal communication)."

"In response to potential negative ecological effects [of diploid grass carp], most states now require that the grass carp used for vegetation control be triploid (i.e., having three chromosome sets in each somatic cell rather than the normal two [diploidy]). The advantage in using triploid grass carp is that they […] are functionally sterile."

"On January 4, 1995, the 104th Congress established the USFWS [U.S. Fish and Wildlife Service] certified triploid grass carp program. Triploid grass carp producing farms voluntarily participate so that they might deliver fish to states that require the USFWS certification."

Means of Introduction into the United States

From Nico et al. (2018) [Stocking records may be for diploid or triploid grass carp when not specifically identified]:

"Both authorized and unauthorized stockings of Grass Carp have taken place for biological control of vegetation. This species was first imported to the United States in 1963 to aquaculture facilities in Auburn, Alabama, and Stuttgart, Arkansas. The Auburn stock came from Taiwan, and the Arkansas stock was imported from Malaysia (Courtenay et al. 1984). The first release of this species into open waters took place at Stuttgart, Arkansas, when fish escaped the Fish Farming Experimental Station (Courtenay et al. 1984). However, many of the early stockings in Arkansas were in lakes or reservoirs open to stream systems, and by the early 1970s there were many reports of Grass Carp captured in the Missouri and Mississippi rivers (Pflieger 1975, 1997). During the past few decades, the species has spread rapidly as a result of widely scattered research projects, stockings by federal, state, and local government agencies, legal and illegal interstate transport and release by individuals and private groups, escapes from farm ponds and aquaculture facilities; and natural dispersal from introduction sites (e.g., Pflieger 1975; Lee et al. 1980 et seq.; Dill and Cordone 1997). Some of the agencies that have stocked grass carp in the past include the Arkansas Game and Fish Commission, the Tennessee Valley Authority, the U.S. Fish and Wildlife Service, the Delaware Division of Fish and Wildlife, the Florida Game and Fresh Water Fish Commission, the Iowa Conservation Commission, the New Mexico Department of Fish and Game, and the Texas Parks and Wildlife Department. The species also has been stocked by private individuals and organizations. In some cases, Grass Carp have escaped from stocked waterbodies and appeared in nearby waterbodies. Stocking of Grass Carp as a biological control against nuisance aquatic plants in ponds and lakes continues. For instance, Pflieger (1997) stated that thousands of Grass Carp are reared and sold by fish farmers in Missouri and Arkansas."

From Zajicek et al. (2011):

"The grass carp *Ctenopharyngodon idella* is a fish […] that was first imported into the continental USA by the U.S. Fish and Wildlife Service (USFWS) in the early 1960s. A very practical and pragmatic goal triggered this importation, a goal set at the height of Rachel Carson's "Silent Spring" fame, to provide biological control for aquatic vegetation and reduce the use of herbicides in aquatic systems (Mitchell and Kelly 2006)."

From Mitchell and Kelly (2006):

"On 16 November 1963, the U. S. Fish and Wildlife Service Fish Farming Experimental Station at Stuttgart, Arkansas, became the first institution to import grass carp (*Ctenopharyngodon idella*) into the United States. This introduction was the result of at least seven years of effort to find an effective biological control for problematic aquatic weeds. The introduction was in keeping with a strong environmental and political mandate of that day to replace the broad use of chemicals with biological controls. For about 10 years, federal and state agencies and university systems strongly promoted introductions, spawning, and nationwide stocking of the grass carp. In 1966, the USFWS laboratory at Stuttgart, Arkansas, was apparently responsible for the first accidental release of grass carp to the environment. By 1972, grass carp were stocked in open water systems, documented in 16 states, and established in the Mississippi River system. All this occurred before the first private-sector commercial producers received and spawned the fish in 1972 and 1973, respectively."

Remarks

From Nico et al. (2018):

"**Synonyms and Other Names:** white amur, silver orf; *Ctenopharyngodon laticeps* Steindachner, 1866, *Leuciscus idella* Valenciennes in Cuvier and Valenciennes, 1844, *Ctenopharyngodon idellus*"

"DeVaney et al. (2009) performed ecological niche modeling to examine the invasion potential for Grass Carp and three other invasive cyprinids (Common Carp *Cyprinus carpio*, Black Carp *Mylopharyngodon piceus*, and Tench *Tinca tinca*). The majority of the areas where Grass Carp have been collected, stocked, or have become established had a high predicted ecological suitability for this species. Wittmann et al. (2014) used multiple machine learning methods to examine potential distribution of Grass Carp in the Great Lakes, finding suitable predicted habitat in all lakes but Superior."

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From ITIS (2018):

"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 *Ctenopharyngodon*
Species *Ctenopharyngodon idella* (Valenciennes in Cuvier and Valenciennes, 1844)"

"Current Standing: valid"

Size, Weight, and Age Range

From Froese and Pauly (2017):

"Maturity: L_m ?, range 58 - 79.2 cm
Max length : 150 cm TL male/unsexed; [Billard 1997]; common length : 10.7 cm SL male/unsexed; [Nichols 1943]; max. published weight: 45.0 kg [Skelton 1993]; max. reported age: 21 years [Shireman and Smith 1983]"

Environment

From Froese and Pauly (2017):

"Freshwater; demersal; potamodromous [Riede 2004]; depth range 0 - 30 m [Shao and Lim 1991]."

"Tolerant of a wide range of temperatures from 0° to 38°C, and salinities to as much as 10 ppt and oxygen levels down to 0.5 ppm."

From Pípalová (2006):

"Temperatures required for stimulation of sexual maturation, egg incubation, and survival of young range from 19 to 30 C, with an optimum of about 23 C (Stanley et al. 1978). Many other conditions (especially rapid change in water level of at least 1 m and flowing water with minimal velocity of 0.8 m s^{-1} and flow of the water volume roughly 400 m^3 s^{-1}) must be fulfilled to enable mating, egg laying and egg development of the grass carp (Stanley et al. 1978, Gangstad 1986)."

"Optimum water temperature for food consumption by the grass carp is 20 to 28 C under the condition of South Bohemian ponds (Krupauer 1989). Stroganov (1963) and Opuszyński (1972) reported similar ranges of optimum water temperature: 21 to 26 C and 25 to 28 C, respectively. Steady plant consumption begins at 10 to 16 C (Stroganov 1963, Kokord'ák 1978, Adámek and Sanh 1981, Krupauer 1989) and intensive feeding occurs when the water temperature reaches 20 C or higher. At 20 C, daily food intake by grass carp was 50% of its body weight, whereas at 22 C the consumption increased up to 120% of body weight. The upper temperature limit of the consumption of plants is about 35 C (Opuszyński 1972). A sudden temperature drop may disrupt feeding (Stroganov 1963, Hickling 1966, Krupauer 1989)."

From Nico et al. (2018):

“Fry and fingerlings have been reported to tolerate water temperatures from 0-40°C (Stevenson 1965; Vovk 1979), and Stevenson (1965) reported that fingerlings in small ponds in Arkansas survived 5 months under heavy ice cover.”

“The lethal low oxygen level for juveniles was <0.5 mg/L (Negonovskaya and Rudenko 1974). The maximum pH for culture of grass carp was reported as 9.24 (Liang and Wang 1993). Egg hatching was delayed below pH 6.5 and increased mortality and deformation of larvae occurred below pH 6.0 (Li and Zhang 1992).”

“Grass Carp appears to be tolerant of low levels of salinity, and may occasionally enter brackish-water areas. Fry (32-50 mm TL) survived transfer from freshwater to a salinity of 12 ppt (Chervinski 1977). Adults (2+ years) survived 10.5 ppt salinity for about 24 days and 17.5 ppt for 5 hours (Cross 1970).”

Climate/Range

From Froese and Pauly (2017):

“Subtropical; […]”

From Pípalová (2006):

“The grass carp is a native to […] latitudes 20° to 50° north and from longitudes 100° to 140° east (Fischer and Lyakhnovich, 1973).”

Distribution Outside the United States

Native

From Nico et al. (2018):

“Eastern Asia from the Amur River of eastern Russia and China south to West River of southern China (Lee et al. 1980 et seq.; Shireman and Smith 1983).”

Introduced

From CABI (2018):

“Grass carp have been introduced in about 80 countries worldwide and many are secondary or tertiary introductions from countries other than China (FishBase, 2004).”

Froese and Pauly (2017) report *C. idella* as introduced and established (or probably established) in the following countries: Afghanistan, Argentina, Armenia, Bangladesh, Belarus, Belgium, Bhutan, Cambodia, Costa Rica, Cuba, Czech Republic, Egypt, Ethiopia, Finland, France, Germany, Guatemala, Honduras, Hungary, India, Indonesia, Iran, Iraq, Italy, Ivory Coast, Japan, Jordan, Kazakhstan, Kyrgyzstan, Mexico, Morocco, Myanmar, Netherlands, New Zealand, Panama, Poland, Romania, Russia, Saudi Arabia, Serbia, Sudan, Thailand, Tunisia, Turkey, Turkmenistan, Uzbekistan, and Vietnam. In some of these countries, not every introduction attempt has resulted in establishment.

Froese and Pauly (2017) report *C. idella* as introduced and not established (or probably not established) in the following countries: Albania, Algeria, Austria, Bolivia, Brazil, Brunei, Bulgaria, Burundi, Canada, Colombia, Cyprus, Denmark, Dominican Republic, Estonia, Fiji, Greece, Israel, Kenya, Laos, Lesotho, Malawi, Malaysia, Mauritius, Mozambique, Pakistan, Peru, Philippines, Rwanda, Singapore, Slovakia, South Africa, Sri Lanka, Sweden, Switzerland, Taiwan, Tanzania, Uganda, United Kingdom, Zambia, and Zimbabwe.

Froese and Pauly (2017) report *C. idella* as introduced into the following countries, with current status of the introduction unknown: Angola, Azerbaijan, Croatia, Guam, Guyana, Haiti, Hong Kong, Jamaica, Korea, Latvia, Moldova, Mongolia, Nepal, Nigeria, Papua New Guinea, Reunion, Ukraine, United Arab Emirates, and Uruguay.

Means of Introduction Outside the United States

From CABI (2018):

"The introductions were made mainly for aquaculture and/or aquatic weed control in both developing and advanced countries. In western Europe and USA, for example, the main interest in grass carp has been in using it as a biological weed control agent for which it has been introduced. In India, grass carp is one of the species used in the so-called composite culture of Indian major carp and Chinese carp (Pillay, 1990). In some other countries, grass carp were used primarily for research, but because of their fast growth and efficiency as a weed control agent they eventually became an important aquaculture species. In Hungary and several other European countries, grass carp has become a valuable species for sport fisheries (FishBase, 2004)."

Short Description

From Froese and Pauly (2017):

"Dorsal spines (total): 3; Dorsal soft rays (total): 7-8; Anal spines: 3; Anal soft rays: 7 - 11. No barbels. Snout very short, its length less than or equal to eye diameter. Postorbital length more than half head length [Eccles 1992]. 18 soft rays for caudal fin [Keith and Allardi 2001]. Diagnosed from rather similar species *Mylopharyngodon piceus* by having the following characters: body olive to brassy green above, silvery white to yellow below; body cylindrical; pharyngeal teeth laterally compressed, serrated, with a groove along grinding surface, usually in two rows, 2,5-4,2 [Kottelat and Freyhof 2007]."

From CABI (2018):

"Grass carp are heterosexual but external dimorphism is evident only at the onset of gonad maturity. The male grass carp has thick and long pectoral fins, extending freely like sharp knives whereas the female grass carp has thin and short pectoral fins that spread out like fans (NACA, 1989). Mature male fish develop pearl organs on the pectoral fins, head and opercula during spawning season but the females do not."

Biology

From Froese and Pauly (2017):

"Adults occur in lakes, ponds, pools and backwaters of large rivers [Page and Burr 1991], preferring large, slow-flowing or standing water bodies with vegetation. […] Feed on higher aquatic plants and submerged grasses; takes also detritus, insects and other invertebrates. […] Spawn on riverbeds with very strong current [Billard 1997]."

From GISD (2018):

"Sexual. Oviparous, external fertilization. Spawning occurs in summer months prompted by rising water levels of about 20cm or more and water temperatures of around 20° C. Grass carp migrate long distances to seek turbulent waters in which to spawn. Eggs are pelagic and left to drift downstream, hatching in 2-3 days. They must remain suspended during their incubation and are very much dependant [*sic*] on adequate oxygen flow, therefore usually require long river stretches [*sic*] of turbulent rising waters. Since they require these conditions for spawning, they are not able to reproduce in many introduced habitats. Grass carp have a tremendous reproductive capacity with females producing 500,000-700,000 eggs and over 1,000,000 eggs in its native range (FishBase, 2008; DPIF, 2004; GSMFC, 2005; Tu, 2003)."

From Nico et al. (2018):

"Typical habitat includes quiet waters, such as lakes, ponds, pools, and backwaters of large rivers, and individuals generally do not travel long distances except for the annual spawning migration (Mitzner 1978; Nixon and Miller 1978; Bain et al. 1990). Nevertheless, there are reports of juvenile Grass Carp traveling as far as 1,000 km from their original spawning grounds (Stanley et al. 1978). Shallow water is the generally preferred habitat, although deeper waters are used when temperatures decrease (Nixon and Miller 1978).

Human Uses

From Froese and Pauly (2017):

"Fisheries: minor commercial; aquaculture: commercial; gamefish: yes"

"One of the world's most important aquaculture species and also used for weed control in rivers, fish ponds and reservoirs [Frimodt 1995]. […] Utilized also fresh and eaten steamed, pan-fried, broiled and baked [Frimodt 1995]."

From GISD (2018):

"Grass carp have been used in Germany and the Netherlands for their positive effects on sportfish productivity, growth and survival. Apparently, the high productivity and consumption of plants ignored by many sportfish of grass carp result in faster organic breakdown and decreased retention of nutrients by plants, as well as more aerated, sunlit waters bearing more habitable space. Grass carp have also been used to effectively eliminate malarial mosquitos

(*Anopheles pulcherrimus*) from the Kara Kum Canal of the former Soviet Union. The mosquitos were believed to be eliminated as a result of extensive vegetation consumption by grass carp (Standish & Wattendorf 1987; Jacobson & Kartalia, 1994; Pierce, 1983; GSMFC, 2005)."

Diseases

From Froese and Pauly (2017):

"Water mold Disease (l.), Fungal diseases
Fish louse Infestation 1, Parasitic infestations (protozoa, worms, etc.)
Columnaris Disease (l.), Bacterial diseases
Water mold Disease (e.), Fungal diseases
Columnaris Disease (e.), Bacterial diseases
Columnaris Disease (m.), Bacterial diseases
SVC [Spring Viraemia of Carp], Viral diseases
Myxidium Infection 1, Parasitic infestations (protozoa, worms, etc.)
Trichodina Infection 1, Parasitic infestations (protozoa, worms, etc.)
Trichodina Infection 2, Parasitic infestations (protozoa, worms, etc.)
Trichodina Infection 3, Parasitic infestations (protozoa, worms, etc.)
Tripartiella Infestation, Parasitic infestations (protozoa, worms, etc.)
Bothriocephalus Infestation 2, Parasitic infestations (protozoa, worms, etc.)
Trichodina Infection 5, Parasitic infestations (protozoa, worms, etc.)
Trichodina Infection 5, Parasitic infestations (protozoa, worms, etc.)
Myxobolus Infection 1, Parasitic infestations (protozoa, worms, etc.)
Fish louse Infestation 1, Parasitic infestations (protozoa, worms, etc.)
Dactylogyrus Gill Flukes Disease, Parasitic infestations (protozoa, worms, etc.)
Trichodinosis, Parasitic infestations (protozoa, worms, etc.)
Sporozoa-infection (*Myxobolus* sp.), Parasitic infestations (protozoa, worms, etc.)
Anchorworm Disease (*Lernaea* sp.), Parasitic infestations (protozoa, worms, etc.)
Piscinoodinium Infection, Parasitic infestations (protozoa, worms, etc.)
Capillaria Infestation, Parasitic infestations (protozoa, worms, etc.)
Gonad Nematodosis Disease, Parasitic infestations (protozoa, worms, etc.)
Spiroxys Infestation, Parasitic infestations (protozoa, worms, etc.)
Grass Carp Picornavirus, Viral diseases
Grass Carp Haemorrhagic Disease Reovirus, Viral diseases
Unclassifed Grass Carp Virus, Viral diseases
Sanguinicola Infection 1, Parasitic infestations (protozoa, worms, etc.)
Anchor worm Disease, Parasitic infestations (protozoa, worms, etc.)"

"Introductions often brought with it the parasitic tapeworm *Bothriocephalus opsarichthydis* (synonym of *B. acheilognathi*) [Kottelat and Whitten 1996]."

Spring viraemia of carp is an OIE-listed disease.

Threat to Humans

From Froese and Pauly (2017):

"Potential pest."

3 Impacts of Introductions

From Pípalová (2006):

"Stocking of grass carp can both directly and indirectly influence the water body. Primary consequences of grass carp feeding include a selective decrease or elimination of aquatic plant biomass and the release of nutrient-rich excrements into the water. […] The amount of aquatic plants consumed by grass carp and its selectivity depends on many factors, but especially on grass carp stocking density, grass carp age, temperature conditions, the length of time the fish have been in the pond, and on the quantity and quality of food present. In temperate climates grass carp prefer submersed and floating aquatic plants, although it will eat almost any type of vegetation when its preferred food is not available (Stroganov 1963, Fischer 1968, Sutton 1977, Lembi et al. 1978)."

"Indirect consequences of grass carp feeding depend on the intensity of the direct changes. Undigested plant material released in the fish faeces can cause changes of water quality, sediment chemistry and thus also changes in communities of producers including aquatic macrophytes and phytoplankton and consumers (i.e., zooplankton, zoobenthos, fish, amphibians and water birds). It is assumed that increased phytoplankton abundance will increase the abundance of zooplankton and zoobenthos, from which planktonivorous fish can profit (e.g., Bettoli et al. 1990). However, reduction or especially elimination of aquatic plants, which serve as spawning and feeding habitat, as well as shelter for the community of producers (especially phytophilous animals), can negatively influence these communities."

"Once an aquatic plant is consumed, a niche becomes available for other plants. What species, if any, will replace the species removed by the grass carp depends mostly on grazing pressure (stocking density and temperature) and its duration. Spread of species not eaten by the grass carp (Kogan 1974, Vinogradov and Zolotova 1974, Fowler and Robson 1978, Madsen and Beck 1997, Li 1998), or regrowth of a preferred species (Cassani et al. 1995, Fowler and Robson 1978) can occur following grass carp stocking. Grass carp feeding, if selective for the indigenous plants, might also further support spreading of alien species (Catarino et al. 1997)."

"Approximately one half of the nutrients in ingested plant material are used and digested by the grass carp, the other half passes the gut as partly digested, partly fragmented material (Stroganov 1963, Hickling 1966, Stanley 1974a, Stanley 1974b). […] While it is naturally assumed that this nutrient release could accelerate eutrophication of waters (Hansson et al. 1987), this has not been clearly demonstrated under field conditions."

"In ponds stocked with grass carp, a significant increase in Fe, Mg and P-PO_4^{3-} concentrations was reported in the sediment (Terrell 1975)."

"Elimination of macrophytes increased blue-green algae abundance in the phytoplankton community almost 9 times (from 7000 units per ml to 61000 units within 6 years). However the blue-green algae dominated only during the peak phytoplankton season (June-October) in Lake Conroe (8,100 ha) in the southern U.S. (Maceina et al. 1992). Kogan (1974) likewise reported the dominance of the blue-green alga *Microcystis aeruginosa* Kütz. after grass carp had eliminated *Myriophyllum spicatum* L. Three years after grass carp introduction into Clear Lake, the concentration of Chlorophyta (almost 27 times, from 7% to 30%) and Bacillariophyta (almost 3 times, from 3% to 14%) increased. Blue-green algae were dominant, but decreased from 81% to 65% in Florida lakes (Richard et al. 1984). Holdren and Porter (1986) reported shifts in dominant taxa and relative abundances of green and blue-green algae and diatoms, with a general shift to smaller species occurring after grass carp stocking."

"Grass carp do not markedly affect zoobenthos directly by feeding (Terrell and Terrell 1975). However, it can be inferred that grass carp feeding on aquatic macrophytes also ingest phytophilous zoobenthos. For example, George (1982) reported that in canals stocked with grass carp, the snails (*Bulinus* sp. and *Biomphalaria* sp.) that adhere to the leaves of *Potamogeton* spp. were eaten along with the leaves. Changes in benthos corresponded most closely to changes in aquatic vegetation (Gasaway 1979, van der Zweerde 1982), which stabilize sediments and provide additional substrate in the form of root masses and decaying material (Schramm and Jirka 1989). Zoobenthos also responded to changes in water quality following removal of aquatic macrophytes (Gasaway 1979). Zoobenthos became more than twice as abundant as it had been before grass carp introduction in the reservoirs of Amudarja River (Turkmenistan), because the annual die-off of vegetation was prevented by the presence of grass carp, and oxygen content and water quality were improved (Aliev 1976)."

"Petr (2000) reviewed the biological control of aquatic plants using fish and its impact on other fish. The feeding activity of grass carp reduces the spawning substrate for phytophilous fish or shelters for predatory fish and their prey. It can also indirectly influence the life of some other fish that are dependent on phytophilous animals (van Zon 1977).

Use of grass carp to control nuisance aquatic vegetation may reduce habitat quality for waterfowl especially because the food requirements of the grass carp and some species of water birds overlap (Venter and Schoonbee 1991, McKnight and Hepp 1995, Benedict and Hepp 2000). Massive plant removal and associated habitat simplification and thus degradation contributed to amphibian declines (Murphy et al. 2002)."

From GISD (2018):

"Grass carp (*Ctenopharyngodon idella*) are voracious feeders. Many of their introductions have been for the control of aquatic vegetation. However, they are known to completely eliminate aquatic plants in introduced habitats altering trophic structure and inflicting widespread detrimental effects on ecosystems. They may also feed selectively on softer plants thereby enhancing development of tougher plants. Grass carp remove macrophyte cover, eliminate spawning substrate, disturb sediment and muddy waters, reduce water quality, increase nutrients in waters accelerating eutrophication, decrease oxygen levels, and promote alagal [*sic*] bloom. They compete with native invertebrates and fish for food and other important resources. Reported impacts on native fishes include the reduction of bluegill, sunfish, smelt, bully, and pike populations. Grass carp are believed to impact waterfowl by reducing aquatic vegetation, an essential food source. Significant declines of gadwall (*Anas stepera*), American wigeon (*Anas americana*), and American coot (*Fulica americana*) have been reported following grass carp introductions. They carry diseases and parasites which are transmittable to other fish and are believed to be the main vector for Asian tapeworms (*Bothriocephalus opsarichthydis*) known to infect several fishes in Canada including common carp (*Cyprinus carpio*), golden shiner (*Notemigonus crysoleucas*), fathead minnow (*Pimephales promelas*), channel catfish (*Ictalurus punctatus*). One record cites grass carp as the vector for the infection of endangered woundfin (*Plagopterus argentissimus*) (Standish & Wattendorf 1987; Jordan, 2003; Jacobson & Kartalia, 1994; Nico *et al*. 2006; GSMFC, 2005; McKnight & Hepp, 1995; Mitchell, 1986; Elvira, 2001)."

"*Ctenopharyngodon idella* has altered trophic structure and food chains of introduced habitats of Greece (Leonardos [et al.], 2008). The introduction of *Ctenopharyngodon idella* to Lake Pamvotis resulted in a significant reduction of submerged macrophytes and the near dissapearance [*sic*] of endemic Epirus minnow (*Phoxinellus epiroticus*), the native Epirus barbell (*Barbus albanicus*) and and [*sic*] *Squalius pamvoticus* by means of habitat reduction, egg predation, and reduction of habitat (Leonardos [et al.], 2008)."

"Stocking of *Ctenopharyngodon idella* in Parkinsons Lake, New Zealand resulted in reduced the size and abundance of native New Zealand smelt (*Retropinna retropinna*) and the New Zealand common bully (*Gobiomorphus cotidianus*) (Mitchell 1986)."

From CABI (2018):

"Overstocking of grass carp cause [*sic*] a large influx of nutrients derived from the carp faeces and a fast or substantial decrease of macrophytes in lakes and ponds. Adverse effects of overstocking of grass carp in various countries as reviewed by Shireman and Smith (1983) include:

- phytoplankton blooms (USSR, Yugoslavia, Romania, India)
- a decrease in the invertebrate numbers and diversity (USSR and USA)
- disruption of macroinvertebrate food base and consequent reduction in centrarchid biomass in a reservoir (USA)
- reduction in the spawning sites for other fishes such as the largemouth bass and bluegill, *Lepomis macrochirus* (USA)
- and prevention of spawning by pike, *Esox lucius*, and perch, *Lucioperca fluviatilis*, in small Russian lakes."

"Changes in water quality in lakes as a result of drastic reduction of macrophytes by the grass carp include a decrease in dissolved oxygen and increase in carbon dioxide levels in a lake in Yugoslavia, and increase in Kjeldahl nitrogen and significant decrease in pH in a lake in Florida (USA) (Shireman and Smith, 1983). On the other hand, the presence of grass carp improved oxygen levels in a reservoir (USSR) since grass carp drastically reduced the macrophytes that normally cause low dissolved oxygen during seasonal die-offs and decomposition."

"Contradictory results have been reported concerning grass carp interaction with other species since many factors influence the effects of grass carp introduction in a body of water. In his review, Petr (2000) reported that removal of aquatic vegetation (*Hydrilla verticillata*, *Myriophyllum spicatum* and *Ceratophyllum demersum*) by grass carp in a lake system (Lake Conroe) result in the decline of some fish species (e.g., small phytophilic, *Lepomis* spp., bluegill, *Lepomis machrochirus*, and crappie, *Pomoxis* spp.) and a nearly fivefold increase in the density of threadfin shad, *Dorosoma petenense*. The sportfish community changed from the original largemouth bass-crappie-hybrid striped bass (*Morone chrysops* x *M. saxatilis*) fishery to a channel catfish-white bass-hybrid striped bass-largemouth bass-black crappie, after vegetation removal. The littoral fish community also shifted from a sunfish and shad community to one that included large numbers of cyprinids, inland silversides, *Menidia beryllina*, and channel catfish. In many other lakes, there was no consistent trend on the effect of aquatic macrophyte removal in that some grass carp lakes supported excellent fish populations and some did not."

"Grass carp affects other fish species by interfering with their reproduction, broadening or narrowing their food base, and decreasing their refugia (Shireman and Smith, 1983). Overfeeding of grass carp on aquatic vegetation affects habitats for migrating and wintering waterfowl because the native aquatic plants preferred by grass carp are also important food for the waterfowl and habitat for invertebrate food items (Welcomme, 1988; Petr, 2000). Grass carp has also been reported to compete for plant food with crayfish, *Procambarus clarkii*, in small ponds leading to a decrease in crayfish production."

"In the USA, various tests have shown that the golden shiner virus that causes mortalities in golden shiners, *Notemigonus crysoleucas*, is the same as the grass carp reovirus which must have been imported into the country along with the introduction of grass carp (McEntire et al., 2003)."

From Cudmore et al. (2017):

"A meta-analysis of the effects of Grass Carp stocking on the environment found a significant cumulative effect of Grass Carp on the overall abiotic environment (Wittmann et al. 2014). Specifically, in areas where Grass Carp was present, water hardness, alkalinity, conductivity and salinity measurements increased significantly. Dissolved oxygen, nitrogen, phosphorus, and sediment metal concentrations increased slightly, whereas pH, and phytoplankton/chlorophyll a values decreased slightly (Wittmann et al. 2014)."

4 Global Distribution

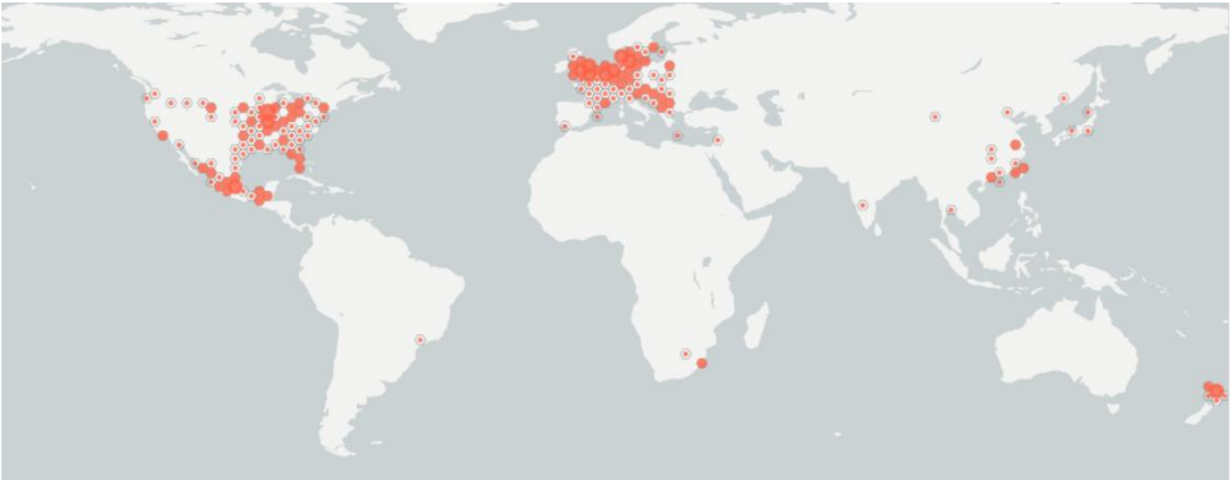

Figure 1. Reported global distribution of *Ctenopharyngodon idella*. Map from GBIF Secretariat (2017). Larger circles indicate a higher number of reported observations for a location. Occurrences were not included in the climate matching analysis if the country was listed as one of those where establishment has not occurred or is uncertain in Distribution Outside the United States, above (Froese and Pauly 2017). The occurrence reported in northwestern China appears to result from a coordinate error (GBIF Secretariat 2017) and was excluded from the climate matching analysis. Additionally, *C. idella* is only reported as established in Japan in Chiba and Ibaraki Prefectures in eastern Japan (NIES 2018); other reported occurrences were excluded from the climate matching analysis.

5 Distribution within the United States

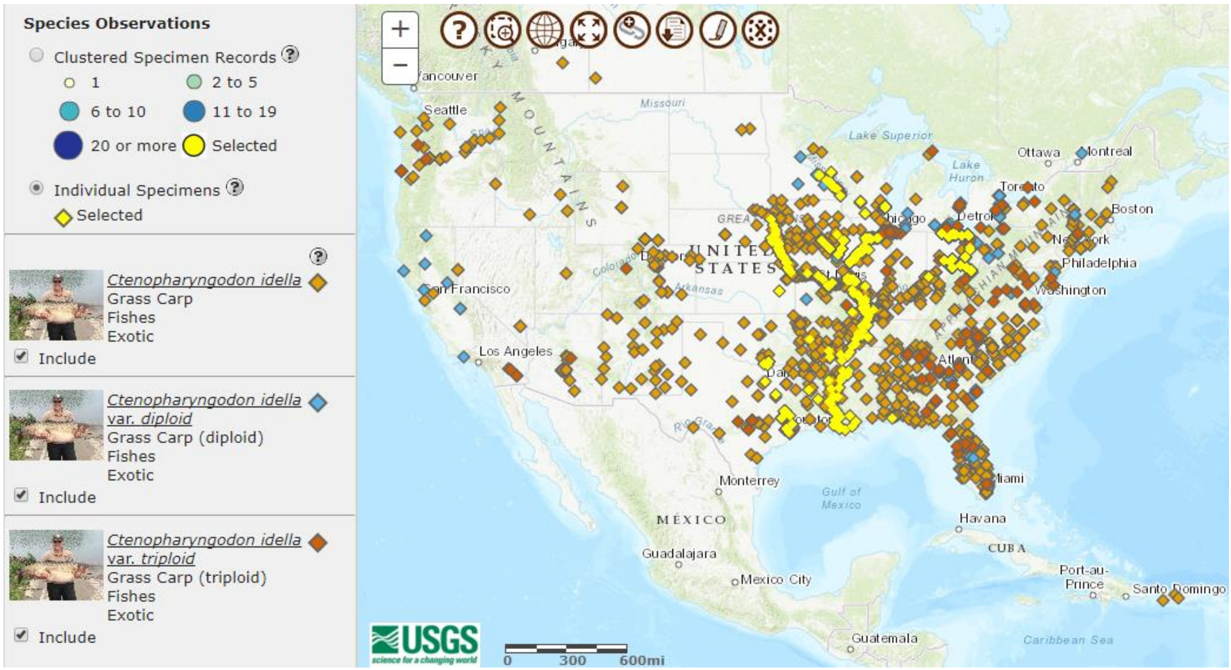

Figure 2. Reported distribution of *Ctenopharyngodon idella* in the United States. Map from Nico et al. (2018). Yellow highlighted points indicate locations where *C. idella* was reported as established. Not shown is one record from the island of Hawaii, where an introduction of *C. idella* was reported as failed in 1968, and one record from Kauai, Hawaii, where *C. idella* was reported as stocked in 1996.

6 Climate Match

Summary of Climate Matching Analysis

The climate match (Sanders et al. 2014; 16 climate variables; Euclidean Distance) was classified as high for all states in contiguous U.S. Locally, the highest matches corresponded roughly to the current established range of *Ctenopharyngodon idella* in the Mississippi River basin and along the Gulf Coast. Climate 6 score indicated that the contiguous U.S. has a high climate match overall. Scores indicating a high climate match are those 0.103 and greater; Climate 6 score for *C. idella* was 0.802.

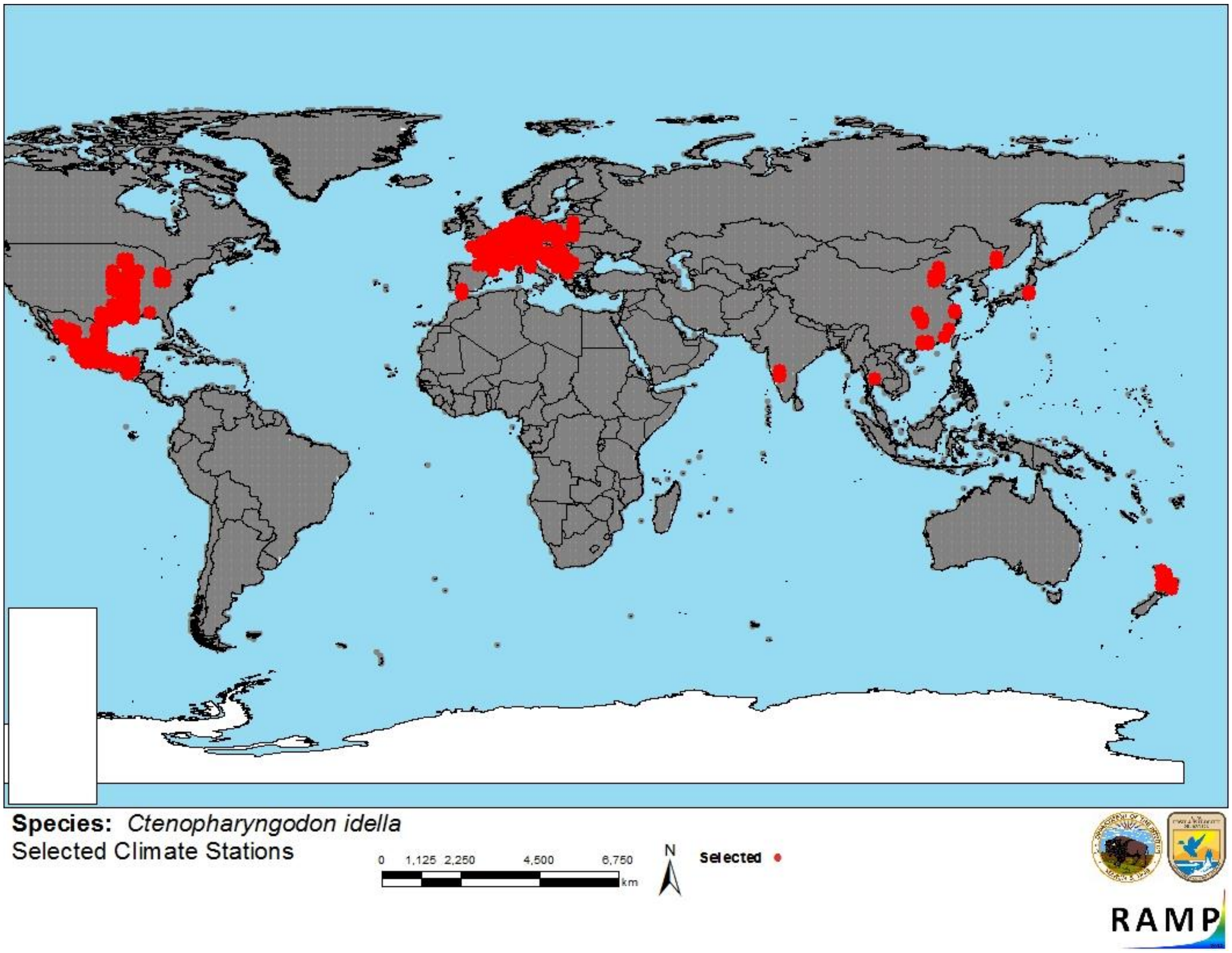

Figure 3. RAMP (Sanders et al. 2014) source map showing weather stations selected as source locations (red) and non-source locations (gray) for *Ctenopharyngodon idella* climate matching. Source locations from GBIF Secretariat (2017) and Nico et al. (2018).

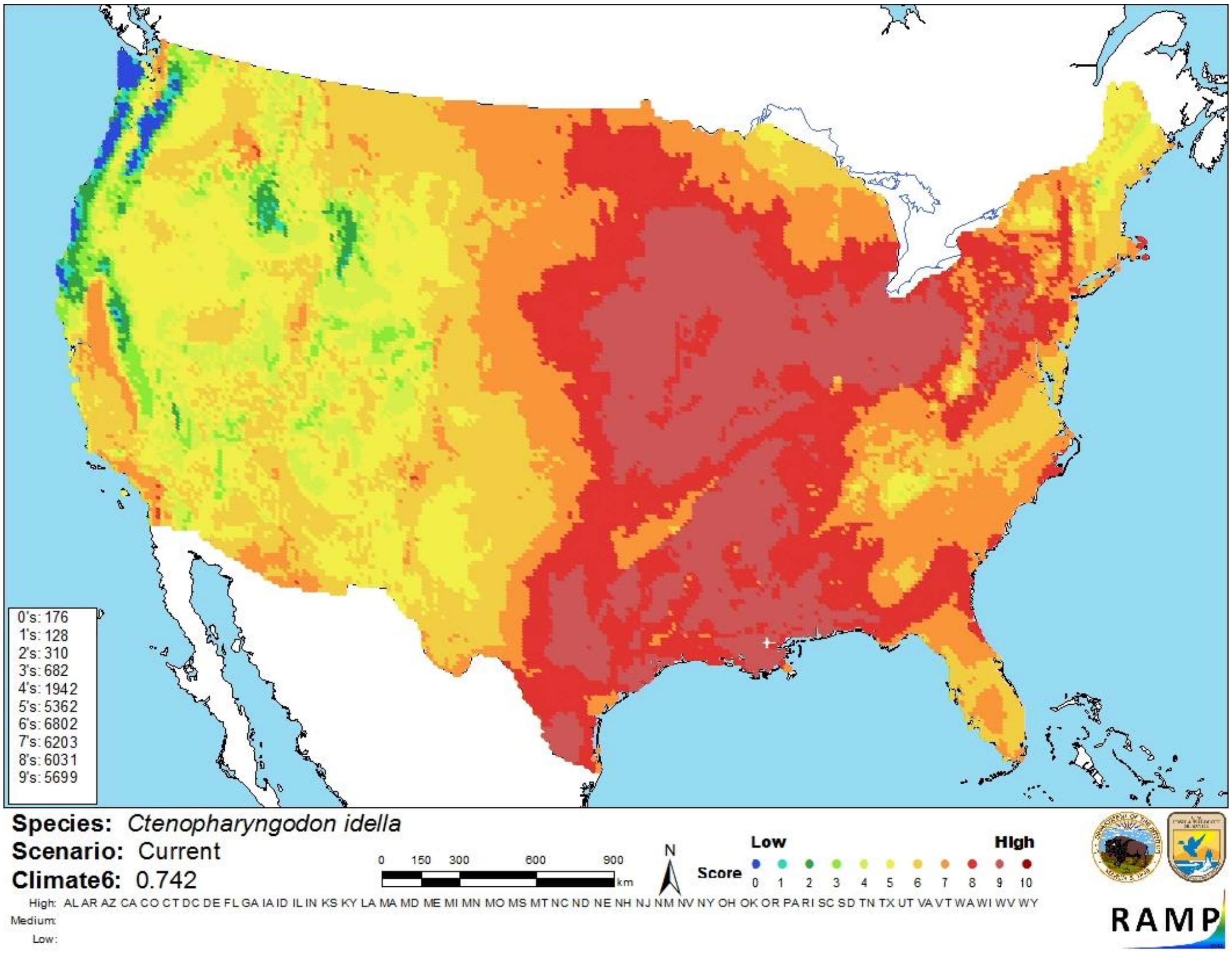

Figure 4. Map of RAMP (Sanders et al. 2014) climate matches for *Ctenopharyngodon idella* in the contiguous United States based on source locations reported by GBIF Secretariat (2017) and Nico et al. (2018). Counts of climate match scores are tabulated on the left. 0=Lowest match, 10=Highest match.

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, distribution, and impacts of *Ctenopharyngodon idella* is readily available although it is not always clear if the information is about diploids or triploids. Negative impacts from introductions of diploids of this species are adequately documented in the scientific literature. No further information is needed to evaluate the negative impacts the species is having where introduced. Certainty of this assessment is high.

8 Risk Assessment

Summary of Risk to the Contiguous United States

Ctenopharyngodon idella is a freshwater fish native to the Amur River system in Asia. This species consumes aquatic plants and invertebrates. It is commonly raised in aquaculture for sportfishing and for weed control. *C. idella* has established in the United States and Europe, where it causes a variety of impacts. This species removes aquatic vegetation, causing changes in the food web and in the physical habitat of an ecosystem. This species promotes algal blooms and may compete with native species for food. *C. idella* also carries several diseases, including one that is OIE-reportable. Climate match with the contiguous U.S. is high, especially in the Mississippi River basin. Overall risk for this species is high. The risk characterization of this ERSS is limited to diploid (able to reproduce) grass carp. Grass carp, particularly those that have been sterilized as triploids, are utilized for biocontrol of aquatic vegetation. The risk characterization between diploid and triploid grass carp will differ, but a more in-depth risk analysis would be needed to characterize risks associated with triploid grass carp (for example see Zajicek et al. 2009).

Assessment Elements

- **History of Invasiveness (Sec. 3): High**
- **Climate Match (Sec. 6): High**
- **Certainty of Assessment (Sec. 7): High**
- **Remarks/Important additional information: Host of at least 30 diseases/parasites, including the OIE-reportable Spring Viraemia of Carp.**
- **Overall Risk Assessment Category: High**

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