Grass Carp (*Ctenopharyngodon idella*)
Ecological Risk Screening Summary

U.S. Fish and Wildlife Service, January 2024
Revised, May 2024
Web Version, 6/5/2024

Organism Type: Fish
Overall Risk Assessment Category: High

Photo: Ryan Hagerty, U.S. Fish and Wildlife Service. Public Domain. Available: https://www.flickr.com/photos/acrcc/37814721245/in/photostream (May 2024).

1 Native Range and Status in the United States

Native Range

From Nico et al. (2024):

"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

According to Nico et al. (2024), nonindigenous occurrences of *Ctenopharyngodon idella* have been reported in 46 U.S. States plus Puerto Rico, with no currently reported observations in

Alaska, Maine, Montana, or Rhode Island (Vermont is also mentioned in the quotation below as having no nonindigenous occurrences, but the species was reported in that State in 2022 according to other information in Nico et al. (2024)). Reported records may be for diploid or triploid Grass Carp. Triploid Grass Carp certified by the U.S. Fish and Wildlife Service are stocked under permit in many States (see Means of Introduction within the United States and Remarks, below).

From Nico et al. (2024):

"**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 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 Whitledge et al. (2021):

"Grass carp spawning has been documented in two tributaries to the western basin of Lake Erie, an area where most grass carp captures have been reproductively viable (diploid) individuals (Wieringa et al., 2017). Grass carp reproduction has occurred in the Sandusky River, Ohio, likely since at least 2011 (Chapman et al., 2013; Embke et al., 2016), and larval grass carp were collected in the Maumee River, Ohio in 2018 (https://www.usgs.gov/news/newly-hatched-invasive-grasscarp-found-maumee-river-ohio, accessed August 5, 2019)."

"Otolith microchemistry indicated that most wild grass carp likely originated in the Sandusky or Maumee rivers where spawning has previously been confirmed, but results suggested recruitment from at least one other Great Lakes tributary may have occurred."

From Brandenburg et al (2019):

"Grass Carp larvae collected in the Colorado River arm of Lake Powell [Utah], about 26 km downstream from the inflow, in 2015 and 2016, are evidence of the presence of a spawning population. These larvae were the first documentation of Grass Carp spawning in a river basin of the western United States. While Grass Carp reproductive biology suggests spawning occurred in the Colorado River or its tributaries upstream from Lake Powell, the sample location, age, and number of larvae collected pose the possibility of reservoir spawning."

According to GISD (2017), *C. Idella* has been introduced and is established (see Remarks for definition of established used during this assessment) in Puerto Rico.

Regulations

While effort was made to find all applicable regulations, this list may not be comprehensive.

Possession of all *Ctenopharyngodon idella* (i.e., triploid or diploid) is prohibited in the following States: Alaska (ADF&G 2023), Connecticut (Connecticut DEEP 2020), Hawaii (HDOA 2019), Kansas (KDWP 2023), Maryland (Code of Maryland Regulations 2022), Michigan (Michigan Compiled Laws 2022), Minnesota (Minnesota DNR 2022), Missouri (MDC 2023), Montana (Montana FWP 2023), Nevada (Nevada Board of Wildlife Commissioners 2022), New Hampshire (NHFG 2022), New Jersey (NJFW 2022), North Dakota (North Dakota Game and Fish Department 2023), Ohio (ODNR 2022), Rhode Island (Rhode Island DEM 2022), South Carolina (South Carolina Code of Laws 2022), and Wisconsin (Wisconsin DNR 2022).

Possession of triploid *Ctenopharyngodon idella* is regulated in the following States where diploid *C. idella* is prohibited: Arizona (Arizona Game and Fish Commission 2022), California (CDFW 2021), Colorado (CPW 2023), Delaware (Delaware DNREC 2023), Georgia (State of Georgia 2023), Louisiana (Louisiana Revised Statutes 2022), Massachusetts (MassWildlife 2014), North Carolina (North Carolina DEQ 2022), New Mexico (NMDGF 2023), Oregon (ODFW 2022), Tennessee (TWRA 2022), Texas (TPDW 2022), Virginia (Virginia DWR 2022), and Washington (WDFW 2022).

Possession of diploid *Ctenopharyngodon idella* is regulated in the following States: Alabama (ADCNR 2022), Arkansas (restricted to approved aquaculture, research/educational facilities; AGFC 2022), Iowa (Iowa NRC 2015), Kentucky (exclusive purpose for producing triploid grass carp; Kentucky Department of Fish and Wildlife Resources 2022), and Oklahoma (restricted to approved aquaculture, research/educational facilities; ODWC 2023).

Means of Introductions within the United States

From Nico et al. (2024):

"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). […] 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 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

This ERSS was previously published in April 2020. Revisions were completed to incorporate new information and conform to updated standards.

Ctenopharyngodon idella has been intentionally stocked outside its native range within the United States by State and Federal fishery managers to achieve fishery management objectives. Fish and wildlife management agencies are responsible for balancing multiple fish and wildlife management objectives. The potential for a species to become invasive is now one important consideration when balancing multiple management objectives and advancing sound, science-based management of fish and wildlife and their habitat in the public interest.

Due to widespread aquaculture and stocking of *Ctenopharyngodon idella* and individuals' longevity, terms such as "established" are used inconsistently in database sources and literature reviewed during this ERSS. This assessment considers established populations as those where evidence of natural reproduction has been observed and the population is not maintained through continuous stocking.

From USFWS (2024a):

"The U.S. Fish and Wildlife Service offers a triploid grass carp inspection service for natural resource agencies in the United States and in other countries, to help States and others protect their aquatic habitats. The inspection program is to provide assurance to these agencies, and others concerned about protecting aquatic resources, that shipments of grass carp alleged to be all sterile triploid carp, do not, within the confidence limits of the inspection program, contain naturally reproduction [sic] diploid carp."

"A triploid grass carp has three sets of chromosomes in every cell instead of the normal two. The additional set of chromosomes prevents the fish from reproducing. […] To control grass carp populations, many States allow only sterile 'triploid' grass carp to be used."

From Kinter et al. (2018):

"As an assurance to the receiving states that shipments of triploid grass carp contain no diploids (within the confidence limits of the program), the USFWS began inspecting shipments of grass carp at the point of fish production in 1985 (National Triploid Grass Carp Inspection and Certification Program; NTGCICP), and the program was formalized by the 104th U.S. Congress in 1995 (Mitchell and Kelly, 2006; Zajicek et al., 2011). In order for a triploid grass carp producer to participate in the NTGCICP, a site inspection and Memorandum of Agreement with the USFWS are required. Certified producers are then required to follow strict program standards to ensure only triploid grass carp are shipped (MICRA, 2015; Glennon, 2014). As a requirement of the NTGCICP, prior to shipment, producers must test the ploidy of each individual grass carp in the batches induced for triploidy and remove any diploids discovered prior to USFWS inspection and certification (Zajicek et al., 2011; Glennon, 2014). Subsequently, a USFWS inspector then oversees the testing of 120 randomly selected fish from batches determined to be 100% triploid by the producer. If all tested fish are triploid, certificates are then issued for each scheduled shipment and the batch of triploid carp can be shipped to vendors within permitting states."

From Jones et al. (2017):

"In contrast to North America, conservation of Grass Carp throughout their native range is of increasing concern to government agencies tasked with the protection of fisheries (Duan et al. 2009). Grass Carp represents one of the four most economically important fishes in China and it is abundance has declined in many areas (Jiang et al. 2010)."

From Nico et al. (2024):

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

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From ITIS (2024):

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)

According to Fricke et al (2024), *Ctenopharyngodon idella* is the current valid name for this species.

Size, Weight, and Age Range

From Froese and Pauly (2023):

"Maturity: L_m 68.2, range 58 - 79.2 cm
Max length: 150 cm TL [total length] male/unsexed; [Billard 1997]; common length: 10.7 cm SL [standard length] 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 (2023):

"Freshwater; brackish; benthopelagic; potamodromous [Riede 2004]; depth range 0 - 30 m [Shao and Lim 1991]. […] 0°C - 35°C [water temperature; Laird and Page 1996];"

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 m3 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. (2024):

“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).”

“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.”

Climate

From Froese and Pauly (2023):

"Subtropical; […] 50°N - 23°N, 100°E - 142°E [Shireman and Smith 1983]."

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. (2024):

"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 Bonham (2019):

"It has been introduced to about 80 countries worldwide, many of these introductions being secondary or tertiary introductions from countries other than China (FishBase, 2004; Froese and Pauly, 2019)."

According to GISD (2017), *C. idella* has been introduced and is established (see Remarks for definition of established used during this assessment) in the following countries: Afghanistan, Albania, Argentina, Armenia, Austria, Belarus, Belgium, Bhutan, Bolivia, Brazil, Cambodia, Colombia, Cote D'Ivoire, Cuba, Czech Republic, Estonia, Ethiopia, Finland, France, Guyana, Hungary, India, Indonesia, Iran, Iraq, Japan, Kazakhstan, Korea, Kyrgyzstan, Latvia, Mexico, Moldova, Mongolia, Myanmar, Netherlands, Nigeria, Panama, Peru, Philippines, Poland, Reunion, Romania, Serbia and Montenegro, Slovakia, Slovenia, South Africa, Sudan, Sweden, Tanzania, Thailand, Tunisia, Turkey, Turkmenistan, Ukraine, United Arab Emirates, United Kingdom, Uruguay, Uzbekistan, Vietnam.

In addition to the countries above, Froese and Pauly (2023) report *C. idella* as introduced and established (or probably established) in Guatemala and Jordan.

According to GISD (2017), *C. idella* is present in containment facilities in the following countries: Algeria, Azerbaijan, Bangladesh, Brunei Darussalam, Canada, Costa Rica, Croatia, Cyprus, Denmark, Egypt, Fiji, Germany, Greece, Honduras, Israel, Italy, Jamaica, Kenya, Laos, Malaysia, Mauritius, Morocco, Mozambique, Nepal, New Zealand, Pakistan, Rwanda, Singapore, Sri Lanka, and Taiwan.

From Cudmore and Mandrak (2004):

"Grass carp have been found in three provinces in Canada: Alberta, Saskatchewan and Ontario […] Grass carp was first captured in Canada in the Ontario waters of Lake Erie, west of Point Pelee in 1985. Other single-specimen captures subsequently occurred at three locations in Lake Huron, and a pond and a tributary of Lake Ontario, both in Toronto. In 2000, several thousand triploids were released into Loch Leven in Cypress Hills Provincial Park in Saskatchewan for weed control. There are no signs of reproduction (J. Keith, Conservation Data Centre, pers. comm.). In 2000 or 2001, 50-100 individual triploid grass carp escaped from an irrigation canal into Lake Newell, a large, 4 off-stream irrigation storage reservoir located near Brooks, Alberta. There are no signs of reproduction and it is unknown if any survivors remain (B. MacKay, University of Lethbridge, Aquaculture Centre, pers. comm.)."

From Milardi et al. (2015):

"Natural recruitment has been detected in several countries: Mexico, Japan, the Philippines, Taiwan and the United States (e.g. Tsuchiya 1979; Chapman et al. 2013). Although introduced into all European countries (Welcomme 1988), natural recruitment of grass carp has been reported solely for eastern European countries (Kottelat and Freyhof 2007), in particular in the Danube River drainage basin (Opuszyński 1972), where it was introduced first, probably in historical times."

"We also documented the first analytical evidence of grass carp recruitment in the study area [Po River in northern Italy] and, to our knowledge, in Western Europe."

From Stanley (1976):

"Grass carp (*Ctenopharyngodon idella*) spawned after they were introduced into the Volga, Ili, Terek, Amu-Darya, and Kuban Rivers, and the Kara-Kum Canal of the Soviet Union; the Tone River of Japan; the Ah Kung Tien Reservoir of Taiwan; the Pampangi River of the Philippines; and the Rio Balsas and the Bodegas Lake system of Mexico."

From Opuszynski and Shireman (1995):

"In the Philippines, Chinese carp were introduced in1962 and in 1967, when the United Nations sponsored fish production in ponds located in the Pampanga River system. Grass and silver carp have been caught in the river since these introductions, but not in great numbers. Although spawning has not been observed or verified, the local fisheries staff believe natural spawning takes place not only in the Pampanga River but also in the Ango River, the other major river in central Luzon."

"Grass carp fry were captured in the Rio Tepalcatepec of the Rio Balsas system in the State of Guerrero in 1974. Reproduction occurred in the tributaries during the summer floods and the eggs were washed into the Rio Tepalcatepec where they hatched. The second spawning site was identified in the lake system of Lago Bodegas in the State of Hidalgo."

From Lin et al. (2022):

"Grass carp have been introduced and are now successfully established in several countries, where they have sometimes become invasive. In particular, grass carp have established self-sustaining populations in Eurasian rivers, such as the Amu River and Syr Darya (Central Asia); the Ganges (South Asia), Kuban (South Russia), Danube (Central and East Europe), and […] (Bogutskaya et al., 2017; Chapman et al., 2013; Chen et al., 2012; Singh et al., 2013; Song et al., 2009)."

From Weyl and Martin (2016):

"[…] it was believed that they would effectively be unable to reproduce under natural conditions in South Africa. Once it was realized that the species was, in fact, capable of reproducing in the wild in South Africa, provincial conservation agencies such as CapeNature required that only certified triploid sterile fish could be used under permit for stocking dams."

"There has been growing evidence of an increasing population of grass carp in the Vaal River system since 2005 (Kruger 2005), […] These records are evidence of the existence a viable breeding population in the Vaal River. Also, in January 2015 juvenile fish were captured and photographed from a section of the Vaal River between Bothaville and Wolwespruit (27.397432° S, 26.436522° E)"

Means of Introduction Outside the United States

From Bonham (2019):

"The introductions were made mainly for aquaculture and/or aquatic weed control in both developing and developed countries. In western Europe and the USA, for example, the main interest in the species has been in using it as a biological weed control agent, for which purpose it has been introduced. In India, it 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, it was used primarily for research, but because of its fast growth and efficiency as a weed control agent, it eventually became an important aquaculture species. In Hungary and several other European countries, it has become a valuable species for sport fisheries (FishBase, 2004). It is a highly adaptable and tolerant species, which may explain its widespread and successful introductions, but in many countries, introduced grass carp do not reproduce or become established in confined bodies of water due to their strict requirements for reproduction – they need flowing water and a warm climate."

Short Description

From Froese and Pauly (2023):

"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 [Keith and Allardi 2001]. 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].”

Biology

From Froese and Pauly (2023):

“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. 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. Feed on higher aquatic plants and submerged grasses; takes also detritus, insects and other invertebrates. One of the world's most important aquaculture species and also used for weed control in rivers, fish ponds and reservoirs [Frimodt 1995]. Spawn on riverbeds with very strong current [Billard 1997]. […] Considered as a pest in most countries because of the damages made to submerged vegetation [Kottelat 2001].”

From Bonham (2019):

“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.”

From GISD (2024):

“[Reproduction:] 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 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 Jones et al. (2017):

“Spawning periods typically range from late April or early May, end in late June or early July in the native range (Yangtze River [China]) and are triggered by water temperature and hydrograph, with the latter believed to be the primary cue (Duan et al. 2009, Zhang et al. 2012, Kocovsky et al. 2012). The minimum flow increase needed to trigger spawning should last 1–2 days, with a daily 30 increase exceeding 300–500 m3/s/s but, if this increase is absent, a flash flood at the spawning grounds may also trigger Grass Carp to spawn (Wang et al. 2013b).”

“If the water temperature drops below 18 °C, spawning activity will stop, with the optimal temperature for breeding being 21–24 °C (Duan et al. 2009, Wang et al. 2013b).”

“The semi-buoyant eggs of Grass Carp develop to hatching while drifting in river currents and will not likely survive if they fall to the bottom (George and Chapman 2015). As such, Grass Carp eggs are considered to require discernible current that creates turbulence to keep them afloat. Due to these flow requirements, unobstructed stretches in large rivers of 28–100 km are typically considered necessary for […] carp eggs to successfully develop (George and Chapman 2015), along with a water velocity exceeding 0.7 m/s (Kocovosky et al. 2012).”

“Grass Carp larvae must reach nursery habitats, such as inundated vegetation, soon after hatching to avoid predation and obtain food (Hargave and Gido 2004).”

“Grass Carp feeding preferences have been investigated for all life stages (Cudmore and Mandrak 2004, Schofield et al. 2005), particularly with respect to the use of Grass Carp in aquaculture and to control aquatic weeds (Cassani et al. 2008). In general, Grass Carp are reported to most commonly feed on Hydrilla (*Hydrilla verticillata*) and pondweeds (*Pontamogeton* spp.) and the most commonly avoided macrophytes are reported in the genera *Nymphaea*, *Potamogeton*, *Myriophyllum*, *Nuphar*, and *Nypha*; however, feeding preference changes under different environmental conditions (Dibble and Kovalenko 2009).”

Human Uses

From Jones et al. (2017):

“Grass Carp is also extensively used as a means of biocontrol for aquatic vegetation (Pípalová 2006). For example, Grass Carp has been used to control (*Hydrilla verticallata*), Peruvian Watergrass (*Luziola peruviana*), Hornwort (*Ceratophyllum demersum*), *Egeria najas*, and *E. densa* (Wells et al. 2003, Kirk and Henderson 2006, Stich et al. 2013, Manuel et al. 2013, Silva et al. 2014). Grass Carp has been extensively stocked worldwide with the intent to reduce aquatic vegetation and the use of herbicides in aquatic systems (Table 1 [in source material]). Grass Carp is one of the top ten fish species most often introduced or transferred (Froese and Pauly 2015). In 2000, an estimated 1 million Grass Carp (usually around 4–6 cm fingerlings) were stocked for weed control and valued at USD 3 million to U.S. producers (Shelton and Rothbard 2006).”

From Froese and Pauly (2023):

“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 (2017):

“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

***Ctenopharyngodon idella* has been documented as a carrier of spring viraemia of carp virus (SVCV). Spring viraemia of carp is a disease listed by the World Organisation of Animal Health (2024).**

According to Poelen et al. (2014), *C. idella* is a host of or can carry the following parasites and pathogens: *Aeromonas hydrophila, Aeromonas veronii, Allocreadium ctenopharyngodonis, Allocreadium qinjiangensis, American grass carp reovirus, Amurotrema dombrowskajae, Andrias davidianus ranavirus, Apharyngostrigea cornu, Aquareovirus C, Aquareovirus G, Aspidogaster amurensis, Aspidogaster conchicola, Asymphylodora japonica, Balantidium, Bothriocephalus, Bothriocephalus acheilognathi, Bothriocephalus gowkongensis, Brentisentis, Camallanus cotti, Carassotrema, Carassotrema heterorchis, Carassotrema koreanum, Carassotrema schistorchis, Carassotrema wui, Carp sprivivirus, Caryophyllaeides fennica, Cedecea davisae, Centrocestus, Centrocestus formosanus, Cetobacterium somerae, Circuitiocoelium opsariichthydis, Citrobacter braakii, Citrobacter freundii, Clonorchis sinensis, Common midwife toad virus, Cyprinid herpesvirus, Cyprinid herpesvirus 3, Dactylogyrus, Dactylogyrus ctenopharyngodonis, Dactylogyrus inexpectatus, Dactylogyrus lamellatus, Dactylogyrus vaginulatus, Dactylogyrus vistulae, Dactylogyrus yinwenyingae, Digramma interrupta, Diplostomum, Diplostomum indistinctum, Diplostomum paraspathaceum, Diplostomum rutili, Diplostomum spathaceum, Diplozoon, Diplozoon paradoxum, Dollfustrema vaneyi, Echinochasmus, Echinochasmus japonicus, Echinochasmus perfoliatus, Entamoeba, Enterobacter amnigenus, Eudiplozoon nipponicum, Grass carp virus, Gyrodactylus ctenopharyngodontis, Gyrodactylus ctenopharyngodontis, Gyrodactylus elegans, Gyrodactylus katharineri, Haemogregarina, Haplorchis pumilio, Haplorchis taichui, Ichthyophthirius multifiliis, Khawia sinensis, Laribacter hongkongensis, Ligula intestinalis, Metagonimus yokogawai, Myxobolus aligarhensis, Myxobolus intrachondrealis, Myxobolus oviformis, Myxobolus pfeifferi, Neocladorchis wujiangensis, Neoechinorhynchus rutili, Neogryporhynchus cheilancristrotus, Nyctotheroides cordiformis, Opalina ranarum, Orientotrema, Paradiplozoon marinae, Pike fry sprivivirus, Pike fry-like rhabdovirus, Platydidymus kui, Pomphorhynchus laevis, Posthodiplostomum cuticula, Pseudacolpenteron pavlovskii, Pseudocapillaria tomentosa, Pulvinifer macrostomum, Reovirus GCRV104, Sanguinicola armatus, Sanguinicola incognita, Sanguinicola magnus, Sinoichthyonema amuri, Skrjabillanus schigini, Spring viraemia of carp virus, Strigeidae, Tetrahymena, Thelohanellus, Trichodina, Trichodina domerguei, Tylodelphys clavate, Valipora campylancristrota, Yersinia ruckeri, Zschokkella nova*.

Threat to Humans

From Froese and Pauly (2024):

"Potential pest"

From Jones et al. (2017):

"Numerous studies, particularly in China, have identified the accumulation of metals in the tissues of Grass Carp, which may represent a potential food safety issue as the reported values exceed the guidelines for human consumption (Liu et al. 2012, Zhuang et al. 2013)."

"*Laribacter hongkongensis* is a recently discovered bacterium associated with gastroenteritis and traveler's diarrhoea and has been found in the intestines of Grass Carp from markets in Hong Kong and Guangzhou in southern China (Lau et al. 2007, Feng et al. 2012)."

"Grass Carp has also been responsible for human death (Lam et al. 2004, Karatas 2010). The consumption of raw gallbladders of Grass Carp is used as a folk remedy in Asian countries (particularly China), which can result in acute renal failure and hepatitis due to the toxicity (nephrotoxicity) of Grass Carp bile (Chen and Huang 2013, Asakawa and Noguchi 2014)."

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-PO43- 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).”

From GISD (2017):

“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 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 [*C. idella*] 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 Bonham (2019):

"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 [sic] 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)."

From Jones et al. (2017):

"In two review studies, the effects of alien invasive fish species were examined on a country scale. In Algeria, the introduction of Grass Carp into Obuira Lake led to the eradication of beds of submerged vegetation and reedbeds as well as increased turbidity, which has been linked to subsequent negative effects on the fish population and on wintering ducks using the lake (Kara 2012). […] In Poland, several lakes have reduced fishing of Pikeperch (*Sander lucioperca*), Northern Pike (*Esox lucius*), Tench (*Tinca tinca*), Common Bream (*Abramis brama*), Roach

(*Rutilus rutilus*), White Bream (*Abramis bjoerkna*), and European Perch (*Perca fluviatilis*) following Grass Carp introduction, as well as the depletion of wild fowl fauna, particularly those feeding on soft aquatic vegetation (e.g., the coot *Fulica atra*, and swans *Cygnus* sp.) (Grabowska et al. 2010)."

"Grass Carp can also influence the macrophyte composition through selective feeding. Krupska et al. (2012) reported changes in the composition of charophyte communities following Grass Carp introduction to a lake in western Poland, as well as a general decline in the number of aquatic macrophytes species. In an earthen pond (GA, U.S.) stocked with >100,000 juvenile, triploid Grass Carp, selective feeding by Grass Carp eliminated most palatable plants from the community and promoted the persistence of the chemically defended and unpalatable *Micranthemum umbrosum* (Parker et al. 2006)."

"Negative effects on native fish species can also be exerted by Grass Carp through the transmission of harmful parasites. For example, a number of *Dactylogyrus* spp. have been introduced to Iran with Grass Carp (Shamsi et al. 2009). It is unknown to what extent these species could jump hosts, but, as most native species in Iran are also cyprinids, the possibility cannot be ruled out (Shamsi et al. 2009). In the Czech Republic, the introduction of Grass Carp was accompanied by the introduction of the tapeworm species *Bothriocephalus gowkongensis*, which subsequently caused considerable losses in Common Carp cultures (Lusk et al. 2010)."

Possession of *Ctenopharyngodon idella* is regulated in numerous States, see Status in the United States.

4 History of Invasiveness

The History of Invasiveness for *Ctenopharyngodon idella* is classified as High. *C. idella* has been introduced to over 80 countries worldwide with naturally reproducing populations documented in several countries beyond its native range. *C. idella* is one of the most commonly reared aquaculture species globally, primarily for biocontrol of aquatic plants but also as a food source. This has led to widespread escapement (intentional and unintentional) of both triploid and diploid fish globally. Numerous peer-reviewed literature sources have documented negative impacts of introductions including altered trophic structures, loss of biodiversity, reduced water quality, and spread of pathogens.

5 Global Distribution

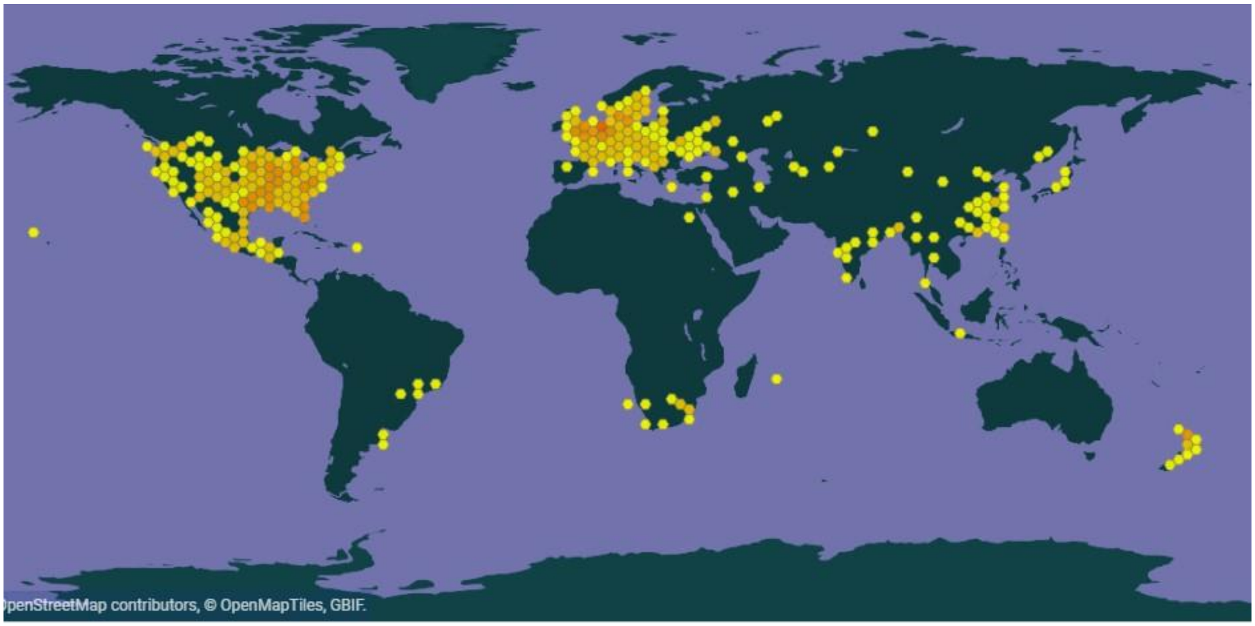

Figure 1. Reported global distribution of *Ctenopharyngodon idella*. Map from GBIF Secretariat (2023). Observations are reported from Asia, Europe, Africa, New Zealand, South America, and North America. Due to widespread aquaculture and stocking of *C. idella*, most observations do not represent established populations. This assessment considers established populations as those where evidence of natural reproduction has been observed and not maintained through continuous stocking. Locations where natural reproduction has been reported and were subsequently used in the climate matching analysis include those within the native range (i.e., eastern Asia), portions of the United States, southwestern Mexico, eastern South Africa, Japan, Taiwan, Philippines, northern India, western Asia, and southeastern Europe.

The location of a population in the Philippines was given in Stanley (1976).

6 Distribution Within the United States

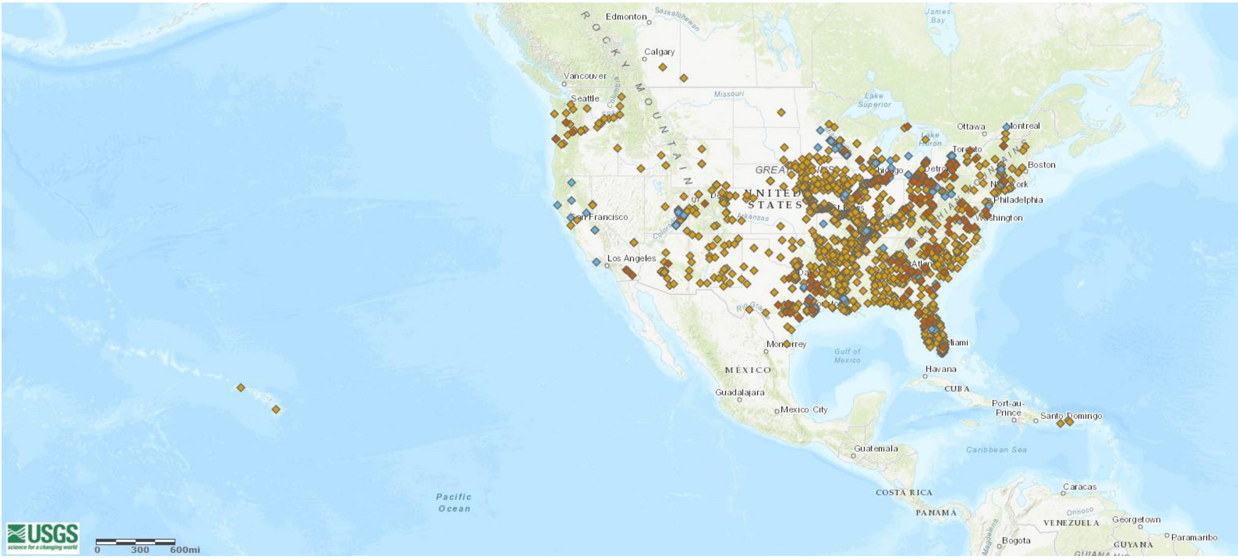

Figure 2. Reported distribution of *Ctenopharyngodon idella* in the United States. Map from Nico et al. (2024). Observations are reported from most of the country including Hawaii and Puerto Rico. Blue, red, and orange diamonds indicate diploid, triploid, or unknown ploidy observations, respectively. Due to widespread stocking and aquaculture of *C. idella*, most observations do not represent established populations. This assessment considers established populations as those populations where evidence of natural reproduction has been documented and are not maintained through continuous stocking. Locations where natural reproduction has been reported and that were subsequently used in the climate matching analysis include points in the Southeast, Midwest, western Lake Erie drainage, and southeastern Utah.

7 Climate Matching

Summary of Climate Matching Analysis

The highest climate match for *Ctenopharyngodon idella* in the contiguous United States was found throughout the Mississippi River drainage where this species has been introduced and established. Additional areas of high match were found in the Appalachian Range, Great Lakes, Southeast, Northern Plains, Southern Plains, and portions of the Intermountain West. Low matches were generally restricted to the northern Pacific Coast and Cascade-Sierra Mountains. The overall Climate 6 score (Sanders et al. 2023; 16 climate variables; Euclidean distance) for the contiguous United States was 0.942, indicating that Yes, there is establishment concern for this species. The Climate 6 score is calculated as: (count of target points with scores ≥ 6)/(count of all target points). Establishment concern is warranted for Climate 6 scores greater than or equal to 0.002 based on an analysis of the establishment success of 356 nonnative aquatic species introduced to the United States (USFWS 2024b). There is some uncertainty regarding the status of established populations of *C. idella* globally as use of terms such as "established" are used inconsistently in database sources and literature reviewed during this ERSS. Additionally, the geographic scope of where natural reproduction has been documented in large river systems is often not well described or comes from historic sources.

Projected climate matches in the contiguous United States under future climate scenarios are available for *Ctenopharyngodon idella* (see Appendix). These projected climate matches are provided as additional context for the reader; future climate scenarios are not factored into the Overall Risk Assessment Category.

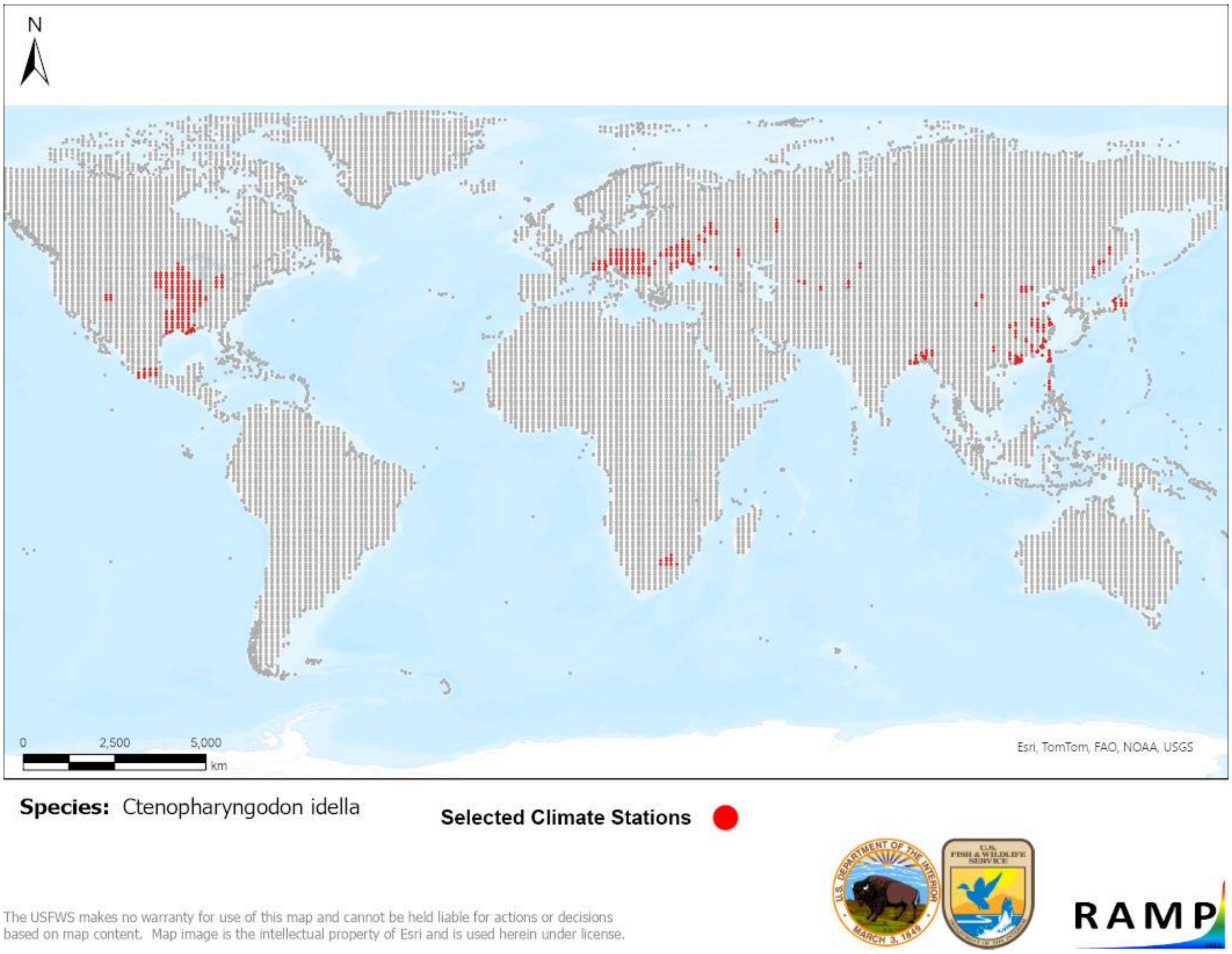

Figure 3. RAMP (Sanders et al. 2023) source map showing weather stations in North America (United States, Mexico) southeastern Europe, western, central, and eastern Asia, and South Africa selected as source locations (red) and non-source locations (gray) for *Ctenopharyngodon idella* climate matching. Source locations from Stanley (1976) and GBIF Secretariat (2023). Selected source locations are within 100 km of one or more species occurrences, and do not necessarily represent the locations of occurrences themselves.

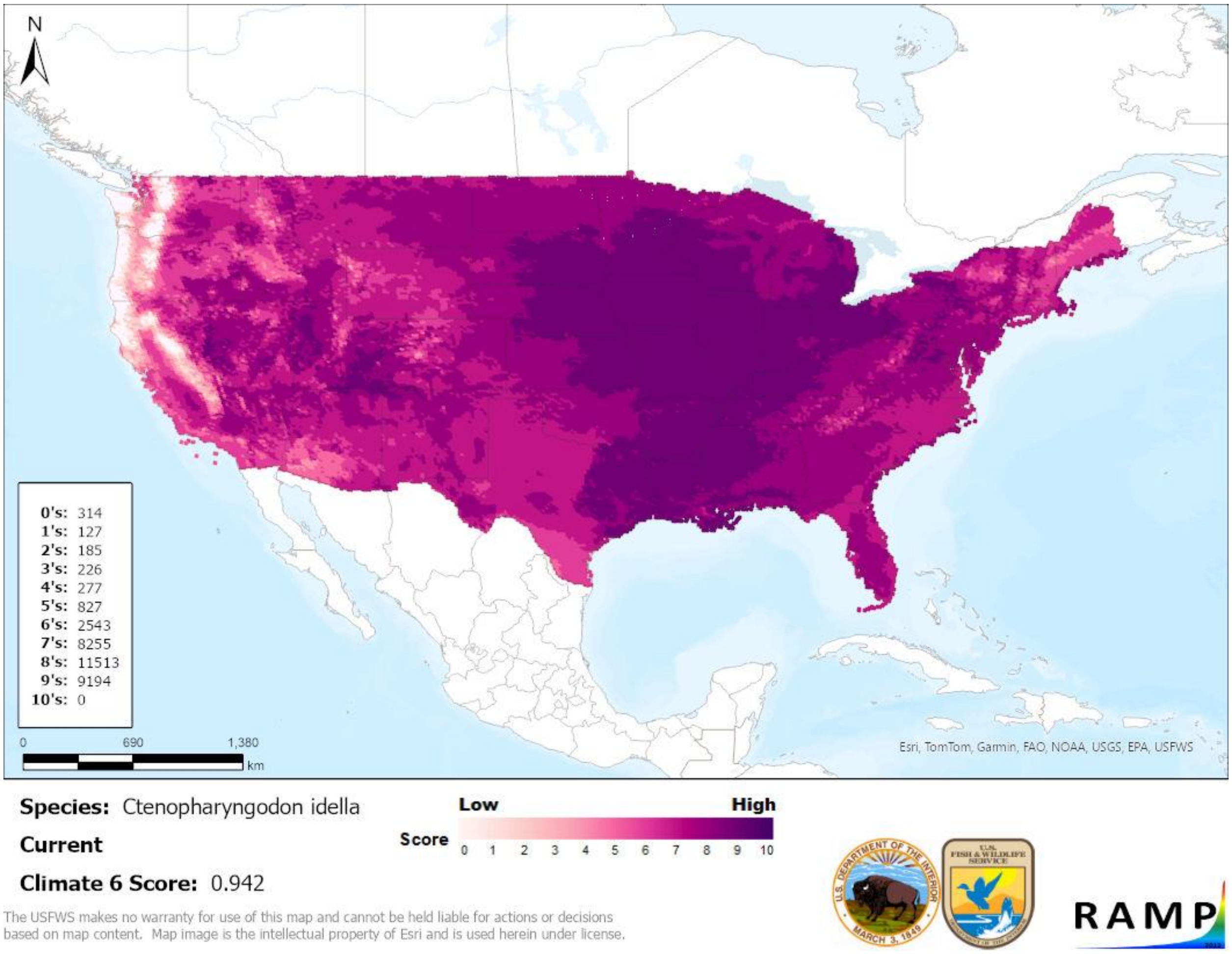

Figure 4. Map of RAMP (Sanders et al. 2023) climate matches for *Ctenopharyngodon idella* in the contiguous United States based on source locations reported by Stanley (1976) and GBIF Secretariat (2023). Counts of climate match scores are tabulated on the left. 0/Pale Pink = Lowest match, 10/Dark Purple = Highest match.

8 Certainty of Assessment

The Certainty of Assessment for *Ctenopharyngodon idella* is classified as High. Information on the biology, distribution, and impacts of *C. idella* is readily available and negative impacts from worldwide introductions of this species are adequately documented in the scientific literature. In the United States, both triploid and diploid Grass Carp have been stocked or introduced in areas where evidence of natural reproduction has been documented, including throughout the Mississippi River, western Lake Erie, and Colorado River drainages. There is some uncertainty regarding the status of populations of *C. idella* listed as "established" globally, as use of terms such as "established" was inconsistent in database sources and literature reviewed during this ERSS and did not always correspond to the definition of "established" used in this screening tool (see Remarks). Additionally, the geographic scope of where natural reproduction has been documented in large river systems is often not well described or comes from historic sources. However, the issues with the interpretation of the term "established" are not thought to be significant enough to impact the interpretation of the climate matching results which would impact the certainty of assessment classification.

9 Risk Assessment

Summary of Risk to the Contiguous United States

Ctenopharyngodon idella, Grass Carp, is a freshwater fish that is native to eastern Asia from the Amur River in eastern Russia to southern China. It is commonly used for aquaculture and as a biocontrol for aquatic vegetation. Spawning occurs in summer months with rising water levels and warmer water temperatures. The History of Invasiveness for *C. idella* is classified as High because this species has been introduced to over 80 countries worldwide with documented negative impacts. Established populations, i.e., those with natural reproduction, have been documented in North America (United States, Mexico), southeastern Europe, western and central Asia, and South Africa. In the United States, both triploid and diploid Grass Carp have been stocked or introduced in areas where evidence of natural reproduction has been documented including throughout the Mississippi River, western Lake Erie, and Colorado River drainages. Negative impacts associated with *C. idella* introductions are well documented in scientific literature and include the species' ability to alter trophic structures, removal of aquatic vegetation, degradation of habitat, and spread of pathogens. The climate matching analysis for the contiguous United States indicates establishment concern for this species. High climate match was found throughout the Mississippi River drainage and within the Appalachian Range, Great Lakes, Southeast, Northern Plains, Southern Plains, and portions of the Intermountain West. The Certainty of Assessment for this ERSS is classified as High due to the abundant information available regarding the distribution, biology, and impacts of introductions documented in peer-reviewed literature. The Overall Risk Assessment Category for *C. Idella* in the contiguous United States is High.

Assessment Elements

- **History of Invasiveness (see Section 4): High**
- **Establishment Concern (see Section 7): Yes**
- **Certainty of Assessment (see Section 8): High**
- **Remarks, Important additional information: Host of at least 30 diseases/parasites, including the WOAH-reportable spring viraemia of carp virus (SVCV).**
- **Overall Risk Assessment Category: High**

10 Literature Cited

Note: The following references were accessed for this ERSS. References cited within quoted text but not accessed are included below in section 11.

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Appendix

Summary of Future Climate Matching Analysis

Future climate projections represent two Shared Socioeconomic Pathways (SSP) developed by the Intergovernmental Panel on Climate Change (IPCC 2021): SSP5, in which emissions triple by the end of the century; and SSP3, in which emissions double by the end of the century. Future climate matches were based on source locations reported by Stanley (1976) and GBIF Secretariat (2023).

Under the future climate scenarios (figure A1), on average, high climate match for *Ctenopharyngodon idella* was projected to occur in the Appalachian Range, Colorado Plateau, Great Basin, Great Lakes, Mid-Atlantic, Northeast, Northern Plains, Southeast, and Southern Atlantic Coast regions of the contiguous United States. Areas of high match decreased in extent and contracted mostly northward with time and from SSP3 to SSP5. Areas of low climate match were projected to occur in the Northern Pacific Coast region as well as the Cascade-Sierra Mountains. Areas of medium-low match developed in the southwest deserts and southern Texas, mainly in the 2085 scenarios. The Climate 6 scores for the individual future scenario models (figure A2) ranged from a low of 0.786 (model: UKESM1-0-LL, SSP5, 2085) to a high of 0.943 (model: GFDL-ESM4, SSP3, 2055). All future scenario Climate 6 scores were above the Establishment Concern threshold, indicating that Yes, there is establishment concern for this species under future scenarios. The Climate 6 score for the current climate match (0.942, figure 4) falls within the range of scores for future projections. The time step and climate scenario with the most change relative to current conditions was SSP5, 2085, the most extreme climate change scenario. Under one or more time step and climate scenarios, small areas within the Colorado Plateau, Great Basin, Northeast, and Western Mountains saw a moderate increase in the climate match relative to current conditions. No large increases were observed regardless of time step and climate scenarios. Under one or more time step and climate scenarios, areas within the Central Plains saw a large decrease in the climate match relative to current conditions. Additionally, areas within the Appalachian Range, California, Colorado Plateau, Great Basin, Great Lakes, Gulf Coast, Mid-Atlantic, Southeast, Southern Atlantic Coast, Southern Florida, Southwest, and Western Mountains saw a moderate decrease in the climate match relative to current conditions. Areas of large and moderate decrease were much larger in size under the 2085 scenarios when compared to the 2055 scenarios. Additional, very small areas of large or moderate change may be visible on the maps (figure A3).

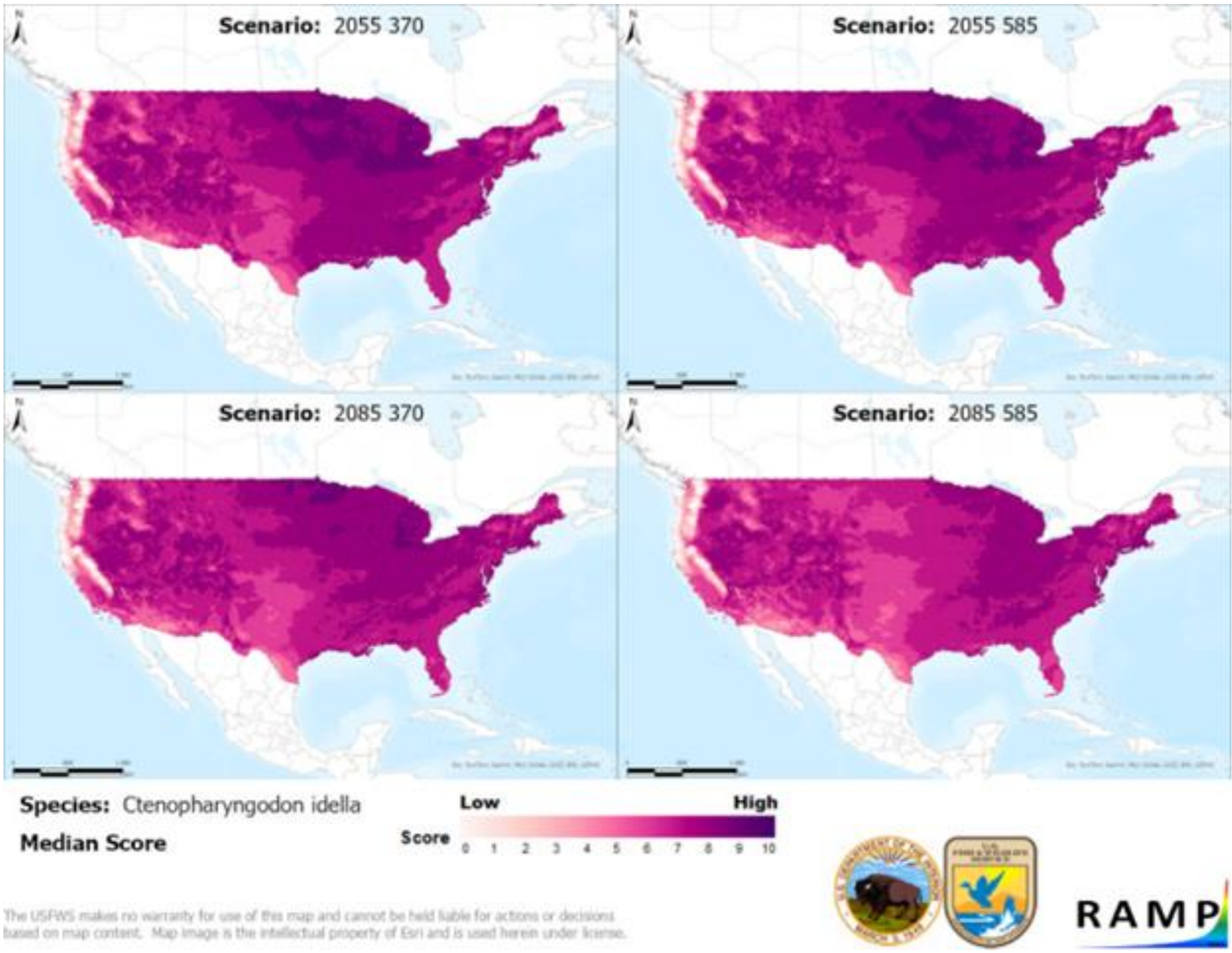

Figure A1. Maps of median RAMP (Sanders et al. 2023) climate matches projected under potential future climate conditions using five global climate models for *Ctenopharyngodon idella* in the contiguous United States. Climate matching is based on source locations reported by Stanley (1976) and GBIF Secretariat (2023). Shared Socioeconomic Pathways (SSPs) used (from left to right): SSP3, SSP5 (IPCC 2021). Time steps: 2055 (top row) and 2085 (bottom row). Climate source data from CHELSA (Karger et al. 2017, 2018); global climate models used: GFDL-ESM4, UKESM1-0-LL, MPI-ESM1-2-HR, IPSL-CM6A-LR, and MRI-ESM2-0. 0/Pale Pink = Lowest match, 10/Dark Purple = Highest match.

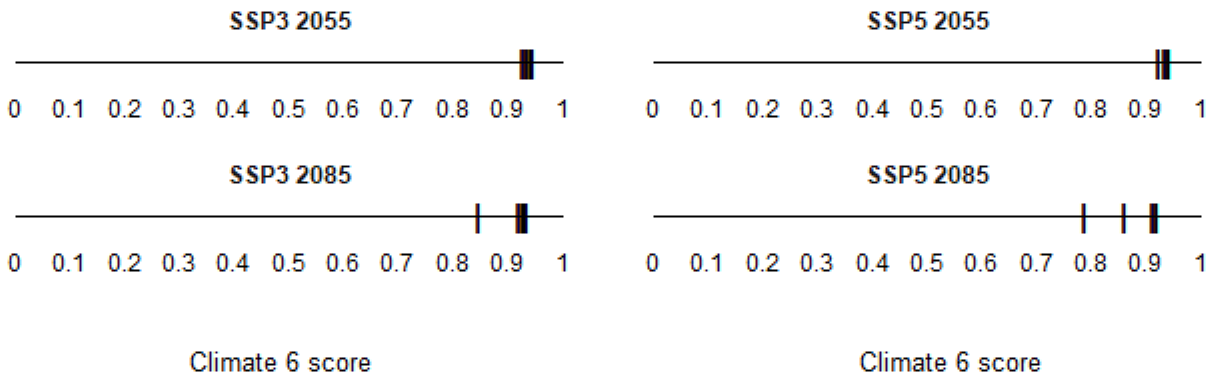

Figure A2. Comparison of projected future Climate 6 scores for *Ctenopharyngodon idella* in the contiguous United States for each of five global climate models under four combinations of Shared Socioeconomic Pathway (SSP) and time step. SSPs used (from left to right): SSP3, SSP5 (Karger et al. 2017, 2018; IPCC 2021). Time steps: 2055 (top row) and 2085 (bottom row). Climate source data from CHELSA (Karger et al. 2017, 2018); global climate models used: GFDL-ESM4, UKESM1-0-LL, MPI-ESM1-2-HR, IPSL-CM6A-LR, and MRI-ESM2-0.

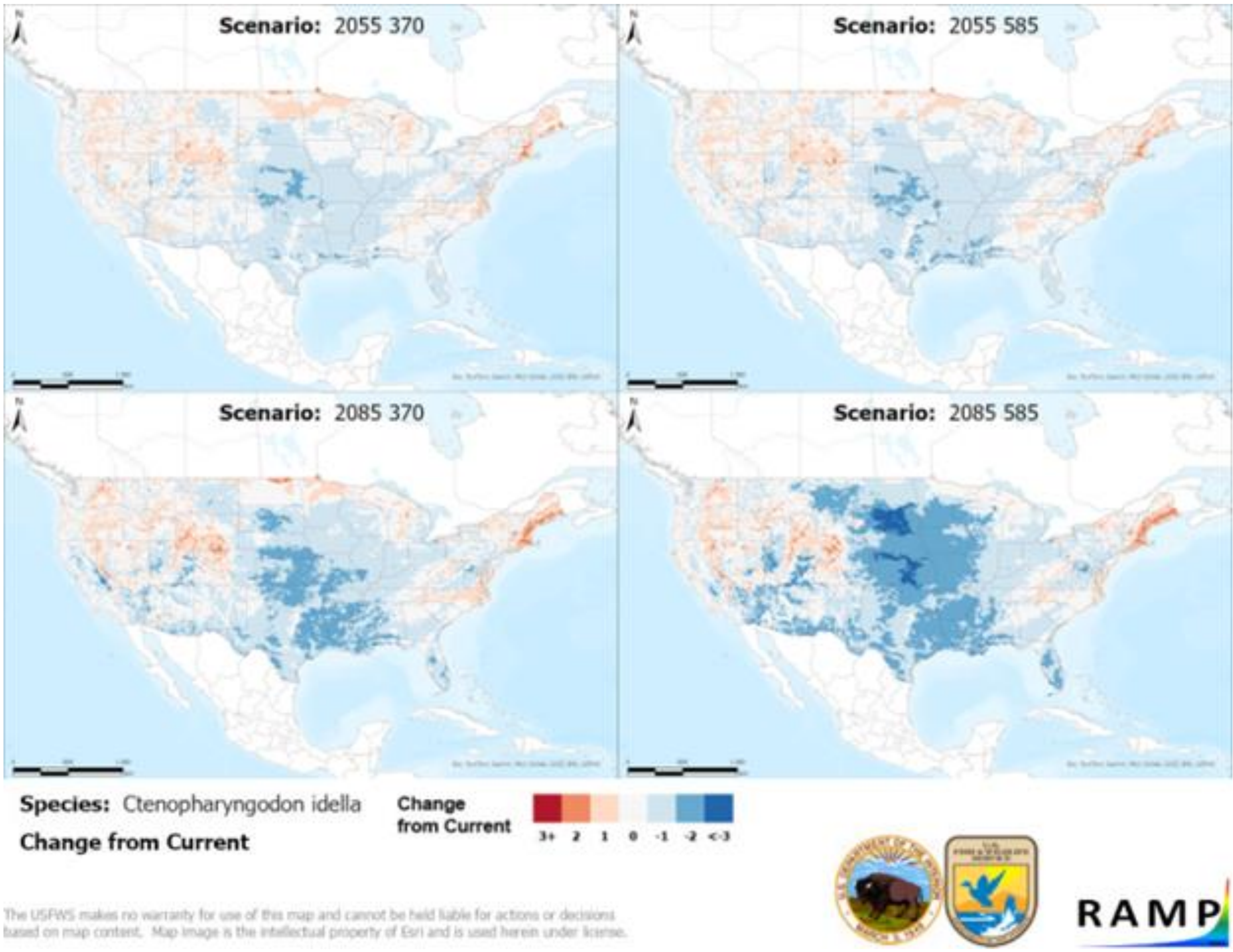

Figure A3. RAMP (Sanders et al. 2023) maps of the contiguous United States showing the difference between the current climate match target point score (figure 4) and the median target point score for future climate scenarios (figure A1) for *Ctenopharyngodon idella* based on source locations reported by Stanley (1976) and GBIF Secretariat (2023). Shared Socioeconomic Pathways (SSPs) used (from left to right): SSP3, SSP5 (IPCC 2021). Time steps: 2055 (top row) and 2085 (bottom row). Climate source data from CHELSA (Karger et al. 2017, 2018); global models used: GFDL-ESM4, UKESM1-0-LL, MPI-ESM1-2-HR, IPSL-CM6A-LR, and MRI-ESM2-0. Shades of blue indicate a lower target point score under future scenarios than under current conditions. Shades of red indicate a higher target point score under future scenarios than under current conditions. Darker shades indicate greater change.

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