U.S. Fish & Wildlife Service

Northern Snakehead (*Channa argus*)
Ecological Risk Screening Summary

U.S. Fish and Wildlife Service, January 2024
Revised, July 2024
Web Version, 8/9/2024

Organism Type: Fish
Overall Risk Assessment Category: High

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1 Native Range and Status in the United States

Native Range

From Whedbee (2017):

"*Channa argus,* commonly known as northern snakehead, is native to river drainages to the Pacific in east Asia, from Heilong (Amur) River basin, Ussuri River basin, and Lake Khanka on the Russian-Chineses [sic] border south to the upper reaches of the Yangtze River in China."

From Fuller et al. (2024):

"China, Russia and Korea (Courtenay and Williams 2004). More specifically, the northern snakehead is found in the lower Amur River basin, including the Ussuri River basin and Khanka Lake; the Sungari River in Manchuria; and, [sic] the Tungushka River at Khaborovsk, Russia. It is native to all but the northeastern regions of Korea, as well as the rivers of China, southward and southwestward to the upper tributaries of the Yangtze River basin in northeastern Yunnan Province (Courtenay and Williams 2004)."

Status in the United States

From Fuller et al. (2024):

"*Channa argus* is established in Delaware, Virginia, Maryland, Pennsylvania, New York, New Jersey, and Arkansas but is not established in California, Florida, Illinois, Massachusetts, and North Carolina where a few individual fish have been collected. However, the northern snakehead was eradicated from the Crofton pond in Maryland where it was oritinally [sic] established. The species is well established in the Potomac River and several of its tributaries in Virginia and Maryland (Starnes et al. 2011). Although young fish were found, the status of the Philadelphia population is uncertain. Officials believe fish may have gotten into the lower Schuylkill River and Delaware River in Pennsylvania and see no practical means to eradicate them. In March 2009, the population in Little Piney Creek drainage received an eradication attempt with the application of rotenone to more 700 km of creeks, ditches, and backwaters. However, more snakeheads have been found since this effort (L. Holt, pers.comm.). The population in Catlin Creek, New York was also treated with rotenone."

From Roop et al. (2020):

"On October 4th, 2019, an angler caught and released a single northern snakehead (*Channa argus*) in a private pond in Gwinnett County, Georgia, USA. Pictures of the specimen were reported to the Georgia Department of Natural Resources, Wildlife Resources Division, Fisheries Management Section (DNR), and subsequent investigations by the DNR including electrofishing and rotenone surveys resulted in the capture and removal of 34 individuals from the area. Genetic analyses of fin clips from 33 specimens indicated the population consisted of a combination of juveniles from a breeding pair of captured adults and other unsampled adults."

Qin (2023) lists *Channa argus* as introduced and present in the following states: Delaware, District of Columbia, Maryland, Massachusetts, Mississippi, Missouri, New Jersey, New York, Pennsylvania, and Virginia.

A juvenile *Channa argus* was collected at Mingo National Wildlife Refuge in southeastern Missouri on June 12, 2024 (Edward Sterling, U.S. Fish and Wildlife Service, Columbia Fish and Wildlife Conservation Office, personal communication, 2024).

From Fuller et al. (2024):

"A specimen collected from Lake Wylie, North Carolina, in 2009 was originally identified as *Channa argus*, but later genetic work combined with a closer morphological analysis determined the specimen to be *Channa maculata* (NCSM 53258 [specimen number]; W. Starnes, personal communication)."

Regulations

Many U.S. States have regulations for the family Channidae, genus *Channa*, species *Channa argus*, or variations of the common name. While effort was made to find all applicable regulations, this list may not be comprehensive.

Fish in the family Channidae are listed as prohibited in the following U.S. States: Alabama (ADCNR 2022), Arkansas (AGFC 2022), Delaware (Delaware DNREC 2022), Florida (FFWCC 2022), Georgia (State of Georgia 2023), Hawaii (HDOA 2019), Kansas (KDWP 2023), Louisiana (Louisiana Revised Statutes 2022), Michigan (Michigan Compiled Laws 2022), North Carolina (North Carolina DEQ 2022), North Dakota (North Dakota Game and Fish Department 2023), New Hampshire (NHFG 2022), New Mexico (NMDGF 2023), Oregon (ODFW 2022), Rhode Island (Rhode Island DEM 2022), South Carolina (South Carolina Code of Laws 2022), Tennessee (TWRA 2022), Texas (TPDW 2022), Utah (Utah DWR 2023), Washington (Revised Code of Washington 2022), Wisconsin (Wisconsin DNR 2022) and Wyoming (WGFD 2022).

Fish in the family Channidae are listed as restricted in the following states: Arizona (Arizona Game and Fish Commission 2022) and California (CDFW 2021).

Channa argus has been prohibited in New York (New York DEC 2022) and Minnesota (Minnesota DNR 2022).

All species in family Channidae (genera include *Aenigmachanna*, *Channa*, *Parachanna*) were officially listed as injurious wildlife species by the U.S. Fish and Wildlife Service in 2002 under 18 U.S.C. 42 Lacey Act (USFWS 2024a).

Means of Introductions within the United States

From Qin (2023):

"*Channa argus* was likely introduced to the United States by people who bought live specimens from fish markets or pet shops and later released them, as unwanted pets, into lakes, rivers or ponds."

"There were cases of the species being cultured in Arkansas in 2001-2002, after an aquaculturalist had been approached by a live-food fish importer […]."

From Fuller et al. (2024):

"According to the Northern Snakehead Working Group (NSWG) of the U.S. Fish and Wildlife Service, northern snakehead likely arrived in U.S. waters by importation for the live food fish market (NSWG 2006). Unauthorized intentional release from this trade, as was the case in the founding individuals of the Crofton pond population in Maryland, continues to be the major mechanism for introduction (Courtenay and Williams 2004). The northern snakehead has become widely popular in ethnic markets and restaurants over the last two decades, such that this species comprised the greatest volume and weight of all live snakehead species imported into the U.S. until 2001 (Courtenay and Williams 2004, NSWG 2006)"

"Historical imports to the U.S. have come from a wide range of source populations, including Nigeria, Thailand, Indonesia, China, and Korea (NSWG 2006). Orrell and Weigt (2005) found seven unique mitochondrial DNA haplotypes, none of which were shared, among the five U.S. populations they surveyed, indicating separate introduction events and source populations for each. Such high genetic diversity among introduced populations can promote their establishment and spread (Lee 2002, Sanders 2010)."

Remarks

This ERSS was previously published in September 2017. Revisions were completed to incorporate new information and conform to updated standards.

From Zhao et al. (2021):

"The northern snakehead (*C. argus*), the blotched snakehead (*C. maculata*) and their hybrids (both cross and reciprocal cross) are main cultured stocks. […] The hybrid (*C. maculata* ♀ × *C. argus* ♂) were cultured mainly in the southern China, because of feeding on compound diets, and faster growth, but poor cold resistance. The reciprocal cross of the hybrid (*C. argus* ♀ × *C. maculata* ♂) have obvious heterosis and additionally acquired good cold resistance from its maternal parent, which are expected to replace the northern snakehead culture (Ou et al., 2018)."

From Stinson (2018):

"The use of chemical control is found to be effective, but has many collateral effects on the ecosystem (Simberloff et al. 2005, Lazur et al. 2006). One chemical that is considered for the control of the northern snakehead is rotenone, and is expected to be used for eradication efforts (Lazur et al. 2006). It has been found that a rotenone concentration of 0.075 mg/L is strong enough to kill all northern snakehead in an enclosed area after 24 hours (Lazur et al. 2006). Along with the complete eradication of northern snakehead, this concentration can also kill other species, including the largemouth bass (Lazur et al. 2006). When used in a small pond, the complete mortality of reintroduced fish continued for several days after the treatment (Lazur et al. 2006). While the use of rotenone as a chemical control would cause a complete eradication of the northern snakehead, this eradication would include any coexisting native fish species (Simberloff et al. 2005, Lazur et al. 2006)."

"Mechanical control of the northern snakehead through fishing has been in effect since its discovery in the Potomac River (Odenkirk and Owens 2007, Iwanowicz et al. 2013). Fishermen are told to report and kill any northern snakehead caught (Odenkirk and Owens 2007, Iwanowicz et al. 2013). Identifying northern snakehead nests could expand the target of mechanical control from adults to their eggs (Gascho Landis and Lapointe 2010). Recently, the nest of a pair of northern snakeheads had been discovered (Gascho Landis and Lapointe 2010). The nest consisted of floating vegetation in areas with a minimal current flow (Gascho Landis and Lapointe 2010). The floating vegetation acts to camouflage the nest, but using the known characteristics of the nests, an active search and eradication program may provide an effective method to reduce the population (Simberloff et al. 2005, Gascho Landis and Lapointe 2010). By targeting the nests, individuals would be removed from the ecosystem before becoming highly mobile and reproductively active (Simberloff et al. 2005, Gascho Landis and Lapointe 2010)."

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 Acanthopterygii
                  Order Perciformes
                    Suborder Channoidei
                      Family Channidae
                        Genus *Channa*
                          Species *Channa argus* (Cantor, 1842)

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

From Fuller et al. (2024):

"Synonyms and Other Names: Amur snakehead, eastern snakehead, ocellated snakehead, snakehead, *Ophicephalus argus* Cantor, 1842; *Ophiocephalus argus kimurai* Shih, 1936; *Ophicephalus argus warpachowskii* Berg, 1909; *Ophicephalus pekinensis* Basilewsky, 1855. Courtenay and Williams (2004) provide a larger list, including names used in other languages."

The following synonyms of *Channa argus* from Fricke et al. (2024) were used to search for information for this report: *Ophicephalus argus*, *Channa argus kimurai*, *Ophicephalus warpachowskii*, *Ophiocephalus pekinensis.*

Size, Weight, and Age Range

From Froese and Pauly (2020):

"Max length : 100.0 cm TL [total length] male/unsexed; [Novikov et al. 2002]; max. published weight: 8.0 kg [Novikov et al. 2002]"

From Qin (2023):

"The northern snakehead is a long-lived fish, with one specimen recorded as attaining 8 years of age […]."

From Whedbee (2017):

“Fully mature northern snakeheads range from 44 cm to 72 cm. However, in some locations northern snakeheads have been found to grow up to 150 cm and weigh nearly 8 kg. Females tend to be smaller than males, and have a shorter dorsal fin along with smaller snout and upper jaw.”

Environment

From Whedbee (2017):

“This is the most cold-tolerant species in the family Channidae, it can survive under ice, in [water] temperatures from 0 - 30 degrees Celsius, and possibly higher. Snakeheads are air-breathers, so can persist in waters with very low oxygen levels. Northern snakeheads also are capable of survival in nearly every freshwater habitat system due to their ability to air breathe. Recent observations of the introduced population in the Potomac River in North America indicate tolerance of up to 15-18 ppt salinity. The main habitat preference of the northern snakehead is shallow waters typically less than 2.5m. However, the species has been understood to cross deep waters in order to reach spawning areas. (Courtenay and Williams, 2004; Lapointe et al. 2013)”

Climate

From Froese and Pauly (2020):

“Subtropical; 4°C - 22°C [Baensch and Riehl 1985; assumed to be recommended aquarium temperature]; 54°N - 25°N, 111°E - 141°E”

From Fuller et al. (2024):

“While its optimum maximum air temperature range is 5-16°C (Herborg et al. 2007), the northern snakehead has a wider latitudinal range and temperature tolerance (0 to >30°C, including frost days) than other snakehead species (Dukravets and Machulin 1978, in Courtenay and Williams 2004; Okada 1960).”

Distribution Outside the United States

Native

From Whedbee (2017):

“*Channa argus*, commonly known as northern snakehead, is native to river drainages to the Pacific in east Asia, from Heilong (Amur) River basin, Ussuri River basin, and Lake Khanka on the Russian-Chineses [sic] border south to the upper reaches of the Yangtze River in China.”

From Fuller et al. (2024):

“China, Russia and Korea (Courtenay and Williams 2004). More specifically, the northern snakehead is found in the lower Amur River basin, including the Ussuri River basin and Khanka

Lake; the Sungari River in Manchuria; and, [sic] the Tungushka River at Khaborovsk, Russia. It is native to all but the northeastern regions of Korea, as well as the rivers of China, southward and southwestward to the upper tributaries of the Yangtze River basin in northeastern Yunnan Province (Courtenay and Williams 2004)."

Introduced

From Berdiakhmetkyzy et al. (2021):

"The Amur snakehead *Channa argus* (Cantor, 1842) was unintentionally introduced into the Aral Sea basin [central Asia] in early 1960-1963."

From Qin (2023):

"In Japan, the species was unintentionally introduced from Korea in the early 20th century and has become successfully established in many waters of central and southern Japan including Hokkaido, Honshu, Kyushu, and Shikoku (Okada, 1960; Nakamura, 1963; Uyeno and Akai, 1984; Courtenay and Williams, 2004)."

Qin (2023) lists *Channa argus* as introduced and present in the following regions: Japan, Kazakhstan, Turkmenistan, Uzbekistan, Germany, Russia, and Ukraine.

Bakhtiyar et al. (2004) lists *Channa argus* as an accidental acclimatized commercial species in Uzbekistan.

Means of Introduction Outside the United States

From Fuller et al. (2024):

"Potential pathway of introduction: Unauthorized intentional release from aquariums or live food markets"

"Recognized as a highly injurious species, [northern snakehead] has been subsequently banned in Ontario. Nevertheless, cases of northern snakehead for sale in areas where possession is illegal are not uncommon (NSWG 2006). Accidental release during transport of live fish is possible, but its probability is unknown (Mendoza-Alfaro et al. 2009)."

From GISD (2009):

"Some introductions are believed to be the result of intentional release of aquarium fish as they are very expensive to feed and soon outgrow their aquaria (Courtenay & Williams 2004). Many introductions of the northern snakehead are believed to be the result of intentional release of fish obtained from the live food trade (Courtenay & Williams 2004)."

From Qin (2023):

"The initial introduction of the species to the Soviet Union was unintentional and was as a result of contamination in stocking phytophagous cyprinids (grass carp, *Ctenopharyngodon idella*, and silver carp, *Hypophthalmichthys molitrix*), destined for aquaculture in ponds adjacent to the Syr Dar'ya River. Snakeheads escaped from the ponds in 1964 and soon became established in the Syr Dar'ya (Amanov, 1974)."

Short Description

From GISD (2009):

"The body of snakeheads is torpedo-shaped, which tapers towards the tail. They have a single, long dorsal fin, a long anal fin, and a small head with a large mouth (Cudmore & Mandrak 2006). Northern snakeheads are cylindrical fish that can grow up to 85 centimeters in length (Okada 1960, in Courtenay and Williams, 2004) however, in Russia there have been reports of captured specimens reaching 1.5 meters total length (Courtenay and Williams 2004). As the name implies, the scaled head of the fish looks like a snake; they have a large mouth with sharp teeth, a truncated, not rounded tail and are easily identified by dark irregular blotches along their sides (Sea Grant Pennsylvania 2007) on a background of golden tan to pale brown. This fish is capable of darkening its background colors to the point of almost obscuring the blotches. There is a dark stripe from just behind the eye to the upper edge of the operculum with another dark stripe below from behind the orbit extending to the lower quadrant of the operculum. Coloration of juveniles is virtually the same as in adults, a characteristic atypical for many snakehead species."

"Gular part of head without patch of scales; head somewhat depressed anteriorly; interorbital area flat; eye above middle of upper jaw; mouth large, reaching far beyond eye; villiform teeth present in bands with some large canine-like teeth on lower jaw and palatines; lateral line scales 60 to 67; eight scale rows above lateral line to dorsal fin origin; 12 to 13 scale rows below lateral line to anal fin origin; dorsal fin elongated, with 49 to 50 rays; anal fin with 31 to 32 rays; origin of pelvic fin beneath fourth dorsal fin ray; pectorals extending beyond base of pelvic fins (Courtenay & Williams 2004)."

From Fuller et al. (2024):

"It has a somewhat flattened head with eyes located in a dorsolateral position on the anterior part of the head; anterior nostrils are present and tubular; dorsal and anal fins are elongated, and all fins are supported only by rays (Courtenay and Williams 2004)."

"Snakeheads (family Channidae) are morphologically similar to the North American native Bowfin (*Amia calva*), and the two are often misidentified. […] Snakeheads can be distinguished from Bowfin by the position of pelvic fins (directly behind pectoral fins in snakeheads, farther back on body in Bowfin) and the size of the anal fin (elongate and similar in size to dorsal fin in snakeheads, short and much smaller than dorsal fin in Bowfin). Additionally, Bowfin can be identified by the presence of a bony plate between the lower jaws (gular plate) and a distinctive method of swimming through undulation of the dorsal fin. The Northern Snakehead is also very similar to the Burbot (*Lota lota*), another North American native fish species."

From Qin (2023):

“The pelvic fins originate below the fourth dorsal ray and the pectoral fins extend beyond the base of the pelvic fins (Courtenay and Williams, 2004). […] The body fins are yellow. The dorsal, anal and caudal fins are spotted in black (Amanov, 1974). […] Sexing of this fish by external morphology is difficult and can only be accurately done in sexually mature individuals.”

“A key characteristic of northern snakeheads is their distinctive colour patterns, which vary according to specific habitat attributes and can change with the background colour of habitats.”

Biology

From Fuller et al. (2024):

“In its native range, reproductive maturity is typically reached when fish are 2-3 years old (Dukravets and Machulin 1978), but may occur only after one year of growth in some introduced populations (USACE 2011). In the U.S., northern snakehead spawning has been observed to start by the end of April, peak in June, and continue through August (Gascho [Landis] et al. 2011). Adult females build circular floating nests from clipped aquatic plants and release their pelagic, nonadhesive, buoyant eggs on top (Gascho Landis and Lapointe 2010). Each spawn can consist of 1300-1500 bright orange-yellow eggs (about 1.8 mm diameter), with up to five spawns occurring within a year. Northern snakehead fecundity can range from 22,000-51,000 in its native range (Amur River basin; Nikol'skiy 1956) to 28,600-115,000 in an introduced population (Syr Dar'ya basin, Turkmenistan/Uzbekistan; Dukravets and Machulin 1978). Both parents guard the nest of eggs from predation and continue to guard the hatched fry for several additional weeks (Courtenay and Williams 2004, Gascho Landis and Lapointe 2010). Depending on water temperature, eggs may hatch in fewer than three days (28 hours at 31°C, 45 hours at 25°C, and 120 hours at 18°C; Gascho Landis and Lapointe 2010). Larvae experience rapid growth after their first two weeks, though overall individual growth rate in North American populations appears to be less than that in both native and introduced Asian populations (Gascho Landis et al. 2011).”

“Fry initially feed on zooplankton, before moving on to a diet of small insects and crustaceans (e.g., cladocerans, copepods, small chironimid larvae). Juveniles may feed on small fish, including goldfish (*Carassius* spp.) and roach (*Rutilis* spp.; Courtenay and Williams 2004). As an adult, the northern snakehead is a voracious feeder (Okada 1960), and its diet may include fish up to 33 percent of its body length (Courtenay and Williams 2004). Adult prey items include loach (*Cobitis* spp.), bream (*Abramis* spp.), carp (*Cyprinus carpio*), perch (*Perca fluviatilis*), zander (*Sander* spp.), grass carp (*Ctenopharyngodon idella*), various catfishes, cray fish, dragonfly larvae, beetles, and frogs.”

“Although the northern snakehead can survive up to four days out of the water, overland migration is only possible for juveniles (Courtenay and Williams 2004). The rounded body of the adult northern snakehead is not as conducive to overland migration as observed in more horizontally flattened snakehead species.”

From Qin (2023):

“The species can breathe air and survive for up to 4 days out of water, and can survive for longer periods of time when burrowed in the mud; […]. These features are adaptive to the seasonal drying of shallow bodies of water in the native habitat, and contribute to the ability of the species to survive and disperse in the introduced range.”

“Larger prey items often include loach, bream, carp and perch; other food items include crayfish, dragonfly larvae, beetles and frogs (Courtenay and Williams, 2004). Gut content analysis of northern snakeheads (n=219) from the Potomac River in the USA (2004-2006) indicated 17 different food items, including 15 fish species. Primary prey items consisted mainly of banded killifish (*Fundulus diaphanus*); however, white perch (*Morone americana*), bluegill (*Lepomis macrochirus*) and pumpkinseed sunfish (*Lepomis gibbosus*) were also commonly consumed (Odenkirk and Owens, 2007). Goldfish (*Carassius auratus*), gizzard shad (*Dorosoma petenense*), American eel (*Anguilla rostrata*), yellow perch (*Perca flavescens*), largemouth bass (*Micropterus salmoides*), spottail shiner (*Notropis hudsonius*), eastern silvery minnow (*Hybognathus regius*), mummichog (*Fundulus heteroclitus*), channel catfish (*Ictalurus punctatus*), green sunfish (*Lepomis cyanellus*), tessellated darter (*Etheostoma olmstedi*), frogs and crayfish were also consumed at low levels (Odenkirk and Owens, 2006; Northern Snakehead Working Group, 2007).”

From Stinson (2018):

“The northern snakehead has demonstrated a high ability to disperse long distances (Lapointe et al. 2013). Dispersal occurs during the pre-spawn months, April to June, most likely due to the snakehead’s desire to find a habitat or a mate (Lapointe et al. 2013). Nearly a third of the snakeheads in an observed population had dispersed up to 39km from their primary habitat (Lapointe et al. 2013). Dispersal was only restricted by physical barriers, occurred across unsuitable habitats, and tended to be in the direction of lower salinity, despite the ability to live in higher salinity habitats (Lapointe et al. 2013). Once dispersed or introduced to a new environment, the species has a high ability to colonize and increase in population size (Odenkirk and Owens 2007, Lapointe et al. 2013). Within the Potomac River, the catch rate of the northern snakehead increased by 950% across the span of a year (Odenkirk and Owens 2007).”

From GISD (2009):

“It is reported that actively feeding adults make grunting noises \"like pigs\" (Nina Bogutskaya Pers. Comm. 2002, in Courtenay & Williams 2004). Soin (1960, in Courtenay & Williams 2004) noted clicking sounds produced by the northern snakehead in ponds in northeastern China as the fish rose to the surface to breathe air. The northern snakehead, because of its torpedo-shaped body, has limited ability to move onto land except as young, and only during flood conditions (Courtenay and Williams 2004).”

Human Uses

From Whedbee (2017):

"In their native range, northern snakeheads are raised in commercial aquaculture for food. It is the most important snakehead species in China, and an estimated 500 tons are produced yearly, for food, in Korea. It is also stocked in many of its native ranges in order to be cultured as a sport fish. Also, in Europe and Japan, northern snakeheads are valued as pets and aquarium owners purchase them for this reason. (Courtenay and Williams, 2004)"

From GISD (2020):

"Snakeheads have long been favored food fishes in India and many parts of Asia, particularly southeastern Asia (Lee and Ng 1991, in Courtenay & Williams 2004). Some are utilised as luxury specialty foods, available alive in aquaria for customer selection at upscale restaurants in larger cities such as Calcutta, Bangkok, Singapore, Hong Kong and other major locales. They also provide easily caught food for poorer people (Wee 1982, in Courtenay & Williams 2004). *C. argus* is the most cultured snakehead in China and the most available snakehead in North American live-food markets. *C. argus* has a modest importance in aquarium fish trade in Japan, Europe and to a lesser extent, the USA (Courtenay & Williams 2004)."

Diseases

***Channa argus* has been documented as susceptible to epizootic ulcerative syndrome, a disease listed by the World Organisation for Animal Health (2024).**

Poelen et al. (2024) lists the following as parasites of *Channa argus: Aeromonas schubertii, Aeromonas veronii*, *Aspidogaster limacoides, Asymphylodora japonica, Azygia anguillae, Azygia hwangtsiyui, Camallanus cotti, Carassotrema koreanum, Clavinema fujimotoi, Clonorchis sinensis, Diplostomum, Eudiplozoon nipponicum, Gnathostoma hispidum, Gnathostoma spinigerum, Gyrodactylus ophiocephali*, hybrid snakehead virus, *Nocardia seriolae, Pallisentis celatus, Pallisentis chongqingensis, Pallisentis umbellatus, Paraproteocephalus parasiluri, Philometra fujimotoi, Pingus sinensis, Polyonchobothrium, Santee-Cooper ranavirus, Senga ophiocephalina, and Spirocamallanus fulvidraconis*

From Whedbee (2017):

"Like most fish, northern snakeheads are also affected by several parasites, including myxozoans, tapeworms (including *Cysticercus, Gryporhynchus cheilancristrotus*), trematodes such as *Clinostomum complanatum* and *Posthodiplostomum*, and acanthocephalans including *Paracanthocephalus cutus*. (Courtenay and Williams, 2004; Landis and Lapointe, 2010; Nguyen, et al., 2012)."

From Stinson (2018):

"Strains of the largemouth bass virus (LMBV) have been found in northern snakehead adults (Iwanowicz et al. 2013)."

Threat to Humans

From Qin (2023):

"They have even been known to bite humans who got too close to a guarded nest."

From Froese and Pauly (2024):

"Potential pest [US Fish and Wildlife Service 2002]"

3 Impacts of Introductions

From Qin (2023):

"Impact on Biodiversity
The northern snakehead is a voracious, apex predator with few, if any, natural enemies. […] Snakeheads are able to negatively impact native populations at all life stages, from egg predation to consumption of adult fish. Additionally, cascading effects at all trophic levels promote monoculture of snakeheads in non-native waterbodies. Northern snakehead are able to tolerate habitats with extremely low dissolved oxygen content which provides a competitive advantage over native species such as pike (*Esox* sp.) or bass (*Micropterus* sp.) (Sea Grant Pennsylvania, 2012)."

"*Channa argus* is also a vector for disease and parasites, a number of which have been documented as affecting native species. Parasites include *Mysosoma acuta* [*Myxobolus acutus*?], (also affects crucian carp), *Henneguya zschokkei* (also affects salmonids), *Cysticercus gryporhynchuscheilancristrotus* (also affects cyprinids, perches), *Clinostomum complanatum* (also affects perches) and *Paracanthocephalus cutus* [*Acanthocephalus curtus*], (also affects cyprinids, escocids, sleepers and bagrid catfish) (Courtenay and Williams, 2004). Northern snakehead are also known to be susceptible to epizootic ulcerative syndrome (EUS), a disease with a number of known pathogens (Cudmore and Mandrak, 2006), although in Canada (the location of Cudmore and Mandrak's study), only a single cyprinid genus (*Cyprinus*) is known to be affected by EUS. In another study, *C. argus* in the Chesapeake Bay watershed (USA) were found to harbour the Largemouth Bass virus (Iwanowicz et al., 2013)."

From Rohrback et al. (2023):

"Fish-community surveys of 2005 and 2008 indicated that densities of *Anguilla rostrata* (Lesueur) (American Eel) and *Fundulus diaphanus* (Lesueur) (Banded Killifish) decreased significantly in shoreline samples […]. Additionally, stomach contents of Northern Snakehead showed feeding on American Eel, *Lepomis macrochirus* Rafinesque (Bluegill), *Lepomis gibbosus* (L.) (Pumpkinseed), Banded Killifish, and *Micropterus salmoides* (Lacepède) (Largemouth Bass), suggesting impacts to these fish populations […]. Out of 122 Northern Snakehead stomachs, 10 contained identifiable food items. Centrarchid fishes comprised of Bluegill, Pumpkinseed, and Largemouth Bass were found in 60% of stomachs with identifiable items. American Eel were found in 20%, and Banded Killifish were found in 10%. A small turtle was also discovered in 1 stomach."

From Newhard and Love (2019):

"Northern Snakehead is an invasive species initially discovered in the Potomac River in 2004, but has since spread to most major river systems of the Chesapeake Bay. In 2012, Northern Snakehead was first reported from the Blackwater River drainage on the eastern shore of Maryland. Fish community surveys were conducted in Blackwater River and Little Blackwater River in 2006 and 2007, before the establishment of Northern Snakehead there. Because of minimal habitat changes owed to protection by Blackwater National Wildlife Refuge, this dataset enabled us to document changes in the fish community that could be attributed to the establishment of Northern Snakehead. We replicated the 2006 and 2007 surveys (pre-Snakehead) over a year from 2018-2019 (post-Snakehead). Over all sampling periods we caught 35 species (32 fish species and 3 invertebrate species) totaling over 50,000 individuals. Of 21 species that were captured both pre- and post-Snakehead, 17 declined in relative abundance with percent reductions ranging from 30%-97%. We found that five of six sites had significantly different fish communities when comparing pre-Snakehead and post-Snakehead surveys. The main difference in fish communities was a reduction in overall biomass of most fish. Species dominance during the post-Snakehead period was significantly higher for both Blackwater and Little Blackwater River. Pre-Snakehead surveys were more evenly distributed and dominated by White Perch, Black Crappie, and Brown Bullhead, while post-Snakehead surveys were less even and dominated by Common Carp and Gizzard Shad. This study is the first to document major shifts in a fish community following establishment of Northern Snakehead."

"We found significant changes in aquatic community structure for fish and invertebrate fauna in the Blackwater River drainage since the introduction and establishment of Northern Snakehead. These changes were evidenced by both significant differences in ranked abundance and relative abundance for multiple species, with differences leading to measurable differences in fundamental attributes of species diversity. These differences can be explained by the introduction of a top predator (Northern Snakehead) and the installation of a water control structure and fresher water. Major reductions occurred for the overall abundance of several fish species after Northern Snakehead was introduced and became abundant. There was also a reduction in abundance of dominant species, and a shift in the dominant species that make up the fish community. Surveys completed in 2006 and 2007, before Northern Snakehead were known to inhabit waters on the eastern shore of Maryland, were dominated by an abundance of White Perch, Brown Bullhead, and a few sunfish species (F. Centrarchidae). Additional species, such as Banded Killifish, had been frequently caught before snakeheads were introduced, but were not observed in 2018 and 2019, suggesting a much reduced relative abundance and/or distribution."

"Species dominance significantly differed between survey periods. Comparison of the fish community before Northern Snakehead were present showed high abundances (>1,000 individuals) of several species captured within a year, indicating a more even assemblage of fishes. However, surveys conducted after Northern Snakehead introduction showed that fewer species had high abundances (Common Carp, Gizzard Shad, and White Perch) along with much lower catches of some previously abundant species, such as Brown Bullhead, Black Crappie, and Bluegill."

From Saylor et al. (2012):

"Diet overlap was biologically significant between northern snakehead and largemouth bass. Fishes (mainly fundulids) were prevalent in largemouth bass and northern snakehead diets. The main difference between the species was the greater importance of crayfish in largemouth bass diet. Both species prefer littoral habitats with abundant vegetation and structure (Warren 2009; Lapointe et al. 2010), thereby increasing chances of competition. In this case, dietary overlap seemed to highlight the use of abundant forage species by northern snakehead and largemouth bass. Sharing abundant resources may limit competition according to diet; however, if food availability becomes limited, comparable levels of diet similarity may lead to competition (Zaret & Rand 1971; Abrams 1980). […] We cannot infer competition between northern snakehead and largemouth bass because we did not have estimates of prey relative abundance or data suggesting that prey was a limiting resource. […] Additional analyses were robust to various methods of measuring dietary overlap and supported our conclusion that overlap is biologically significant between northern snakehead and largemouth bass."

From Guseva (1990):

"We recorded 11 species of fishes in the food of the snakehead in Lake Togyztore [Uzbekistan]. Nearly half the consumption consisted of valuable food fish species: carp, grass carp, bream."

"It [*Channa argus*] causes considerable losses to the fishing industry in the summer months in Dautkul' Reservoir [Uzbekistan] and Lake Togyztore by feeding on valuable food fish species: carp, bream, zander, and their young."

"The snakehead has become a permanent element of the ecosystem in the lower reaches of the Amu Darya [Uzbekistan]. Conditions conducive to its colonization, reproduction, and increase in abundance have been established in most of the present-day water bodies of the region; these conditions have also been promoted by the decline in competition from indigenous predators that are disappearing under the influence of anthropogenic factors. The snakehead has occupied the ecological niches vacated and has, in part, displaced the native pike and catfish."

Channa argus, or the genus or family to which it belongs, is regulated in the following U.S. States: Alabama (ADCNR 2022), Arizona (Arizona Game and Fish Commission 2022), Arkansas (AGFC 2022), California (CDFW 2021), Delaware (Delaware DNREC 2022), Florida (FFWCC 2022), Georgia (State of Georgia 2023), Hawaii (HDOA 2019), Kansas (KDWP 2023), Louisiana (Louisiana Revised Statutes 2022), Michigan (Michigan Compiled Laws 2022), Minnesota (Minnesota DNR 2022), New York (New York DEC 2022), North Carolina (North Carolina DEQ 2022), North Dakota (North Dakota Game and Fish Department 2023), New Hampshire (NHFG 2022), New Mexico (NMDGF 2023), Oregon (ODFW 2022), Rhode Island (Rhode Island DEM 2022), South Carolina (South Carolina Code of Laws 2022), Tennessee (TWRA 2022), Texas (TPDW 2022), Utah (Utah DWR 2023), Washington (Revised Code of Washington 2022), Wisconsin (Wisconsin DNR 2022) and Wyoming (WGFD 2022).

All species in family Channidae (genera include *Aenigmachanna*, *Channa*, *Parachanna*) were officially listed as injurious wildlife species by the U.S. Fish and Wildlife Service in 2002 under 18 U.S.C. 42 Lacey Act (USFWS 2024a).

4 History of Invasiveness

The History of Invasiveness for *Channa argus* is classified as High. There have been multiple reported introductions resulting in established populations outside of this species' native range. There are well documented negative impacts to native species including changes in abundance and range, native species replacement, and changes in both fish and invertebrate community structure.

5 Global Distribution

Figure 1. Reported global distribution of *Channa argus*. Map from GBIF Secretariat (2023). Observations are reported from Eastern Asia, central Asia and Eastern United States. The points in north-central China and in the U.S. States of Florida, Illinois, Kansas, Texas, and North Carolina do not represent established populations and were not used to select source points for the climate matching analysis.

6 Distribution Within the United States

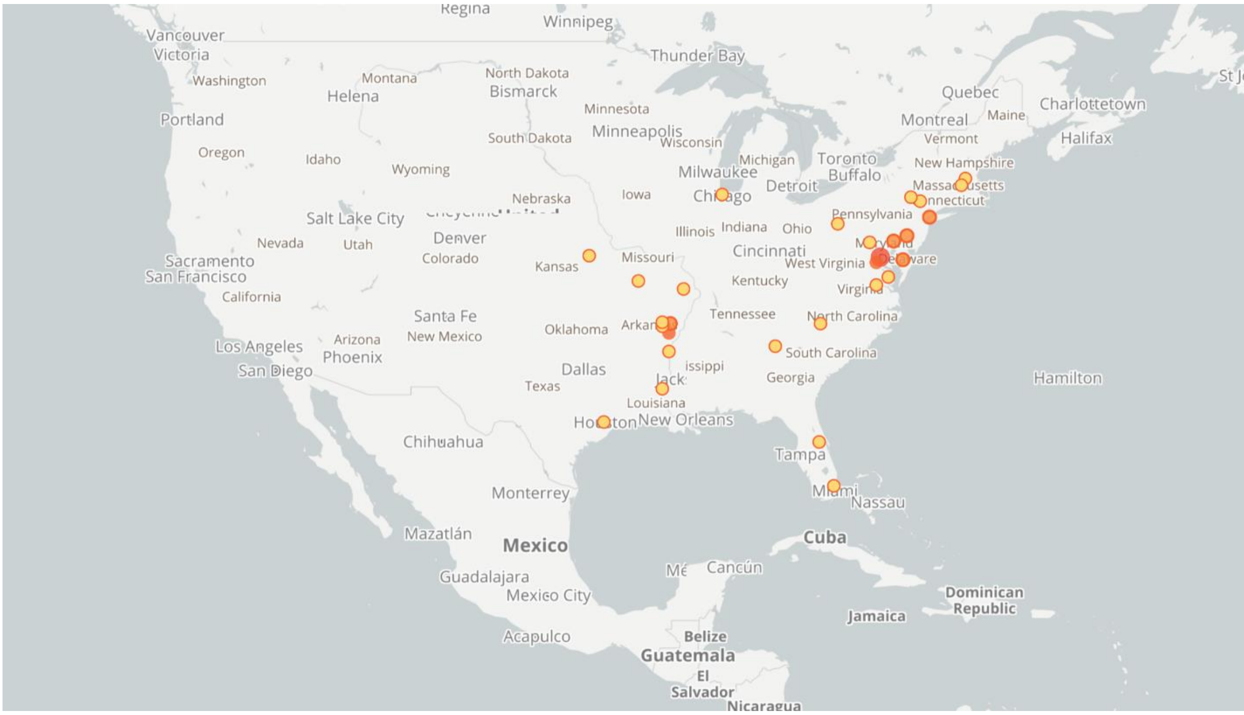

Figure 2. Reported distribution of *Channa argus* in the United States. Map from GBIF-US (2024). The observations in Florida, Texas, Illinois, Louisiana, North Carolina, Kansas, Massachusetts, southwestern Missouri, and western Pennsylvania do not represent established populations and were not used to select source points for the climate matching analysis.

7 Climate Matching

Summary of Climate Matching Analysis

The areas of the contiguous United States that had a high climate match for *Channa argus* included the Northeast, Mid-Atlantic, southern Midwest, Southeast, Great Basin, northern Great Plains, and the Central Valley of California into the Lower Colorado River basin. Areas with a medium climate match included the remainder of the Great Plains, parts of the Southwest, the northern Great Lakes region, the western Gulf Coast, and northern New England. The northern Pacific coast, Sierra Nevada Mountains, and scattered areas of the Rocky Mountains had a low match. The overall Climate 6 score (Sanders et al. 2023; 16 climate variables; Euclidean distance) for the contiguous United States was 0.833, 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).

Projected climate matches in the contiguous United States under future climate scenarios are available for *Channa argus* (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.

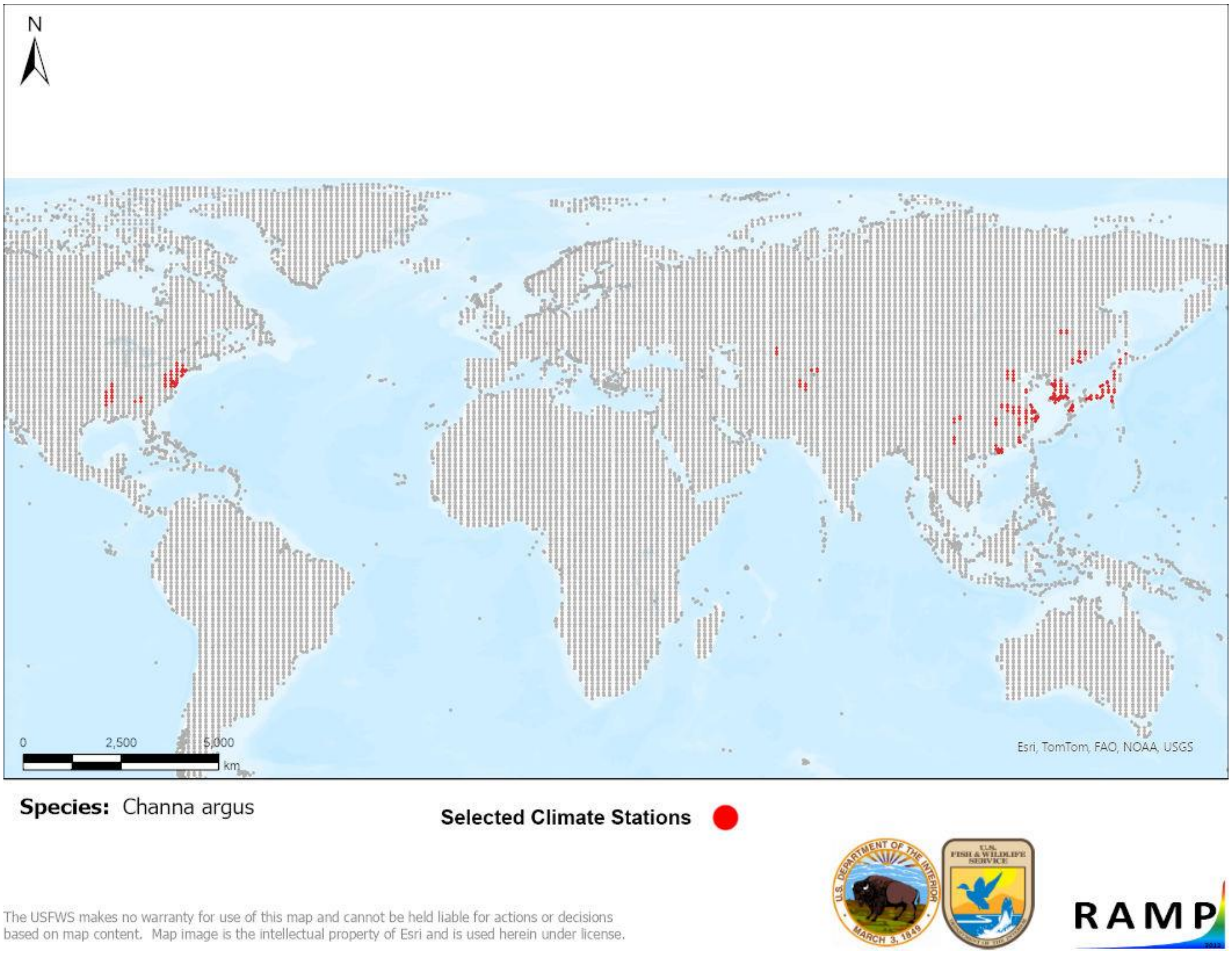

Figure 3. RAMP (Sanders et al. 2023) source map showing weather stations in the world selected as source locations (red; China, Russia, South Korea, Japan, Uzbekistan, Kazakhstan, and the United States) and non-source locations (gray) for *Channa argus* climate matching. Source locations from GBIF Secretariat (2023). Selected source locations are within 100 km of one or more species occurrences, and do not necessarily represent the locations of occurrences themselves.

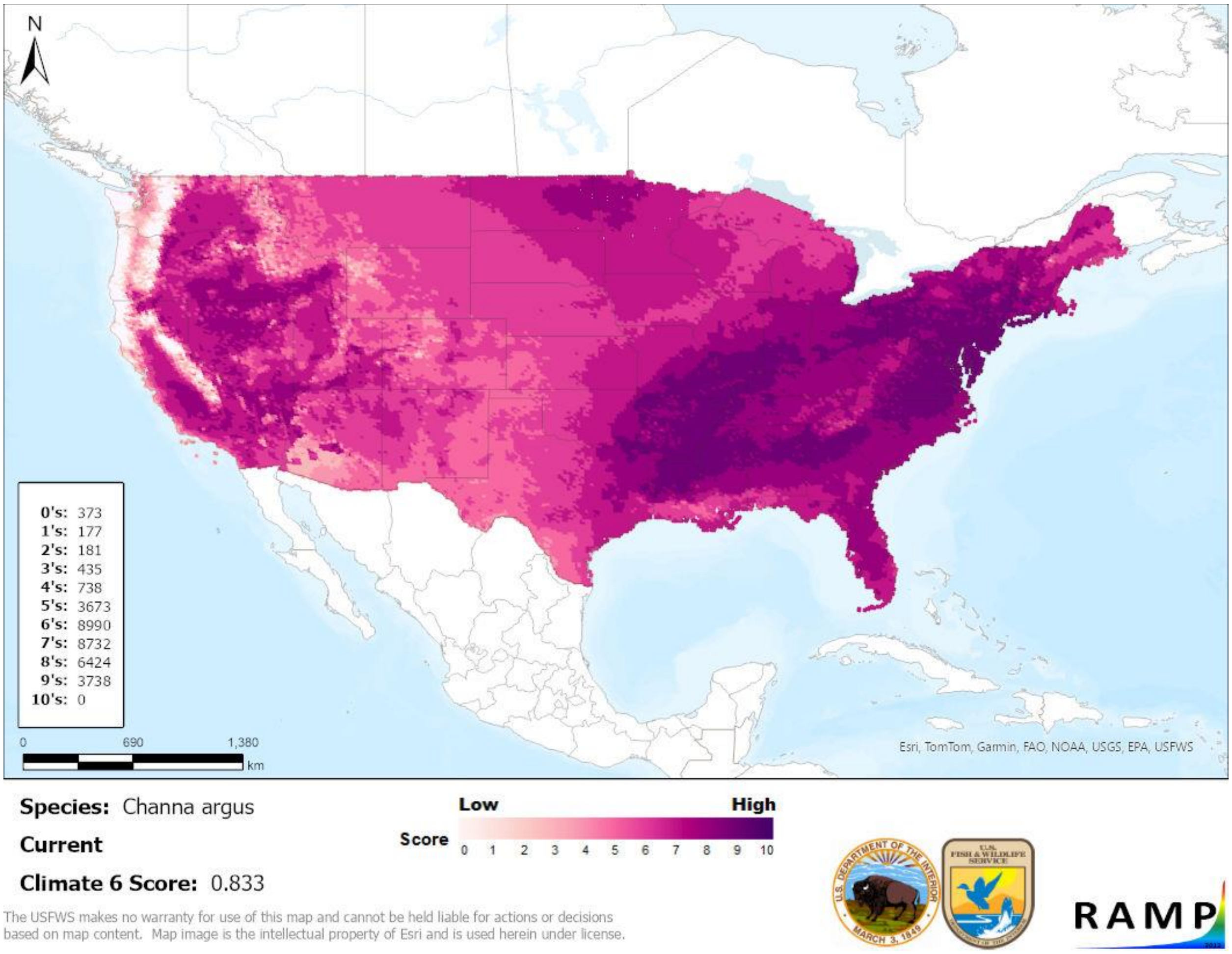

Figure 4. Map of RAMP (Sanders et al. 2023) climate matches for *Channa argus* in the contiguous United States based on source locations reported by GBIF Secretariat (2023). Counts of climate match scores are tabulated on the left. 0/Pale Pink = Lowest match, 10/Dark Purple = Highest match.

8 Certainty of Assessment

There is abundant information about the biology, ecology, and distribution of *Channa argus*. Several detailed, scientifically credible records of documented impacts from *Channa argus* nonnative introductions were found. Other credible sources listed a generalized adverse impact but gave no details. Further information regarding impacts may have been available in languages other than English and was not available to the assessor. The Certainty of Assessment for *Channa argus* is classified as High.

9 Risk Assessment

Summary of Risk to the Contiguous United States

Channa argus, northern snakehead, is a fish native to Eastern Asia. This species is an obligate air breather allowing it to breathe atmospheric oxygen. This allows the northern snakehead to travel over land during periods of heavy rain. *Channa argus* is susceptible to epizootic ulcerative syndrome, a disease listed by the World Organisation for Animal Health. *Channa argus* is one of the most important aquaculture species in its native range. *Channa argus,* and all species in the family Channidae, are listed by the U.S. Fish & Wildlife Service as injurious species. *Channa argus* has been introduced in the United States and Central Asia, most likely via aquarium releases and both intentional and unintentional aquaculture releases. This species is able to outcompete many native species; it is piscivorous and has a similar diet and habitat to the native largemouth bass (*Micropterus nigricans*). Changes to native species abundance and community structure have been observed, as well. The History of Invasiveness for *Channa argus* is classified as High due to multiple established populations outside the native range and documented negative impacts. The climate matching analysis for the contiguous United States indicates establishment concern for this species. Areas that had a high climate match include the Northeast, Midwest, Southeast, Great Basin, northern Great Plains, and the Central Valley of California. This particular species of snakehead is the most cold-tolerant in the family Channidae, allowing it to inhabit more northern areas of the United States. The Certainty of Assessment for this ERSS is classified as High due to the abundant information available on the biology, ecology, distribution, and impacts of introduction of *Channa argus*. The Overall Risk Assessment Category for *Channa argus* 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:** Obligate air breather. Susceptible to epizootic ulcerative syndrome, a disease listed by the World Organisation for Animal Health. Listed by USFWS in 2002 as injurious wildlife.
- **Overall Risk Assessment Category: High**

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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 GBIF Secretariat (2023).

Under the future climate scenarios (figure A1), on average, high climate match for *Channa argus* was projected to occur in the Appalachian Range, Great Basin, Great Lakes, Mid-Atlantic, Northeast, and Southeast regions of the contiguous United States. Areas of low climate match were projected to occur in the Northern Pacific Coast region. The areas of high match contracted and shifted northward between time steps 2055 and 2085 and between SSP3 and SSP5. The Climate 6 scores for the individual future scenario models (figure A2) ranged from a low of 0.500 (model: UKESM1-0-LL, SSP5, 2085) to a high of 0.800 (model: MRI-ESM2-0, 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 (0.833, figure 4) falls above 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 nearly all time step and climate scenarios, areas within the Southwest saw a large increase in the climate match relative to current conditions. The increase in the Southwest was most prominent under the 2055 time step. Additionally, areas within the Colorado Plateau, Great Lakes, Northeast, and Western Mountains saw a moderate increase in the climate match relative to current conditions. Under one or more time step and climate scenarios, areas within the Southeast saw a large decrease in the climate match relative to current conditions. Additionally, areas within the Appalachian Range, California, Colorado Plateau, Great Basin, Gulf Coast, Mid-Atlantic, Northeast, Northern Plains, Southern Atlantic Coast, Southern Florida, Southern Plains, Southwest, and Western Mountains saw a moderate decrease in the climate match relative to current conditions. Additional, very small areas of large or moderate change may be visible on the maps (figure A3). Other than the magnitude of change in climate match in the Southwest being larger at the 2055 time step than at the 2085 time step, the magnitude and extent of change generally increased with time and from SSP3 to SSP5.

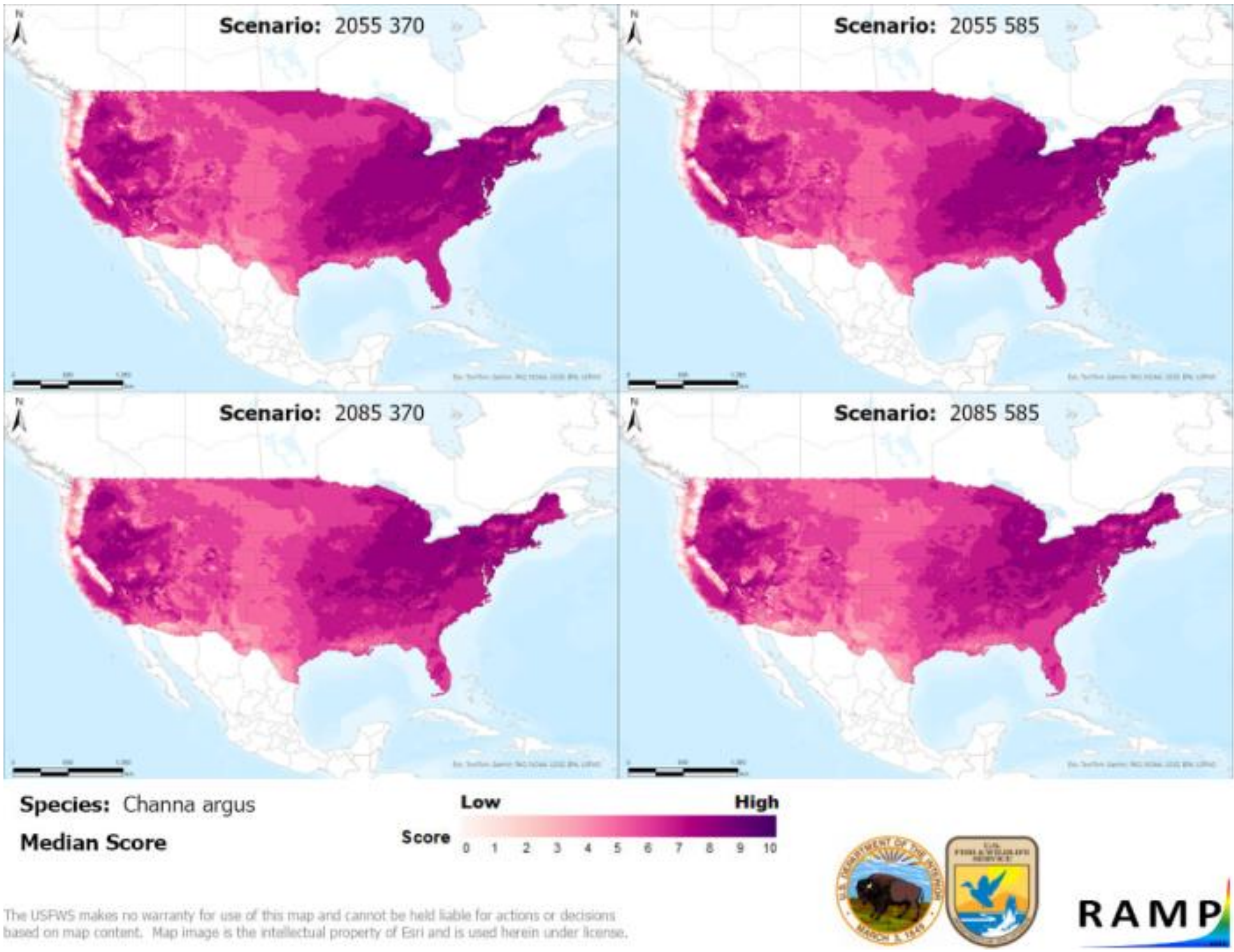

Figure A1. Maps of median RAMP (Sanders et al. 2023) climate matches projected under potential future climate conditions using five global climate models for *Channa argus* in the contiguous United States. Climate matching is based on source locations reported by GBIF Secretariat (2023). Shared Socioeconomic 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.

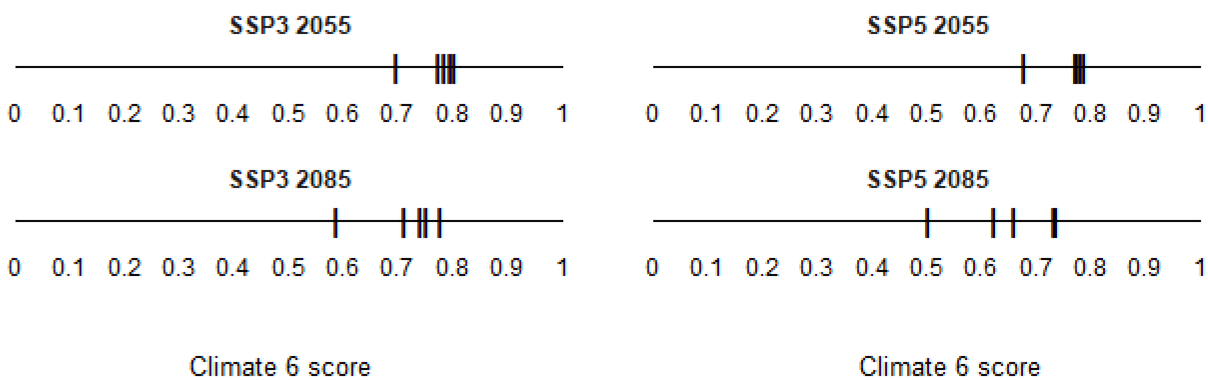

Figure A2. Comparison of projected future Climate 6 scores for *Channa argus* in the contiguous United States for each of five global climate models under four combinations of Shared Socioeconomic Pathway (SSP) and time step. SSPs used (from left to right): SSP3, SSP5 (Karger et al. 2017, 2018; IPCC 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.

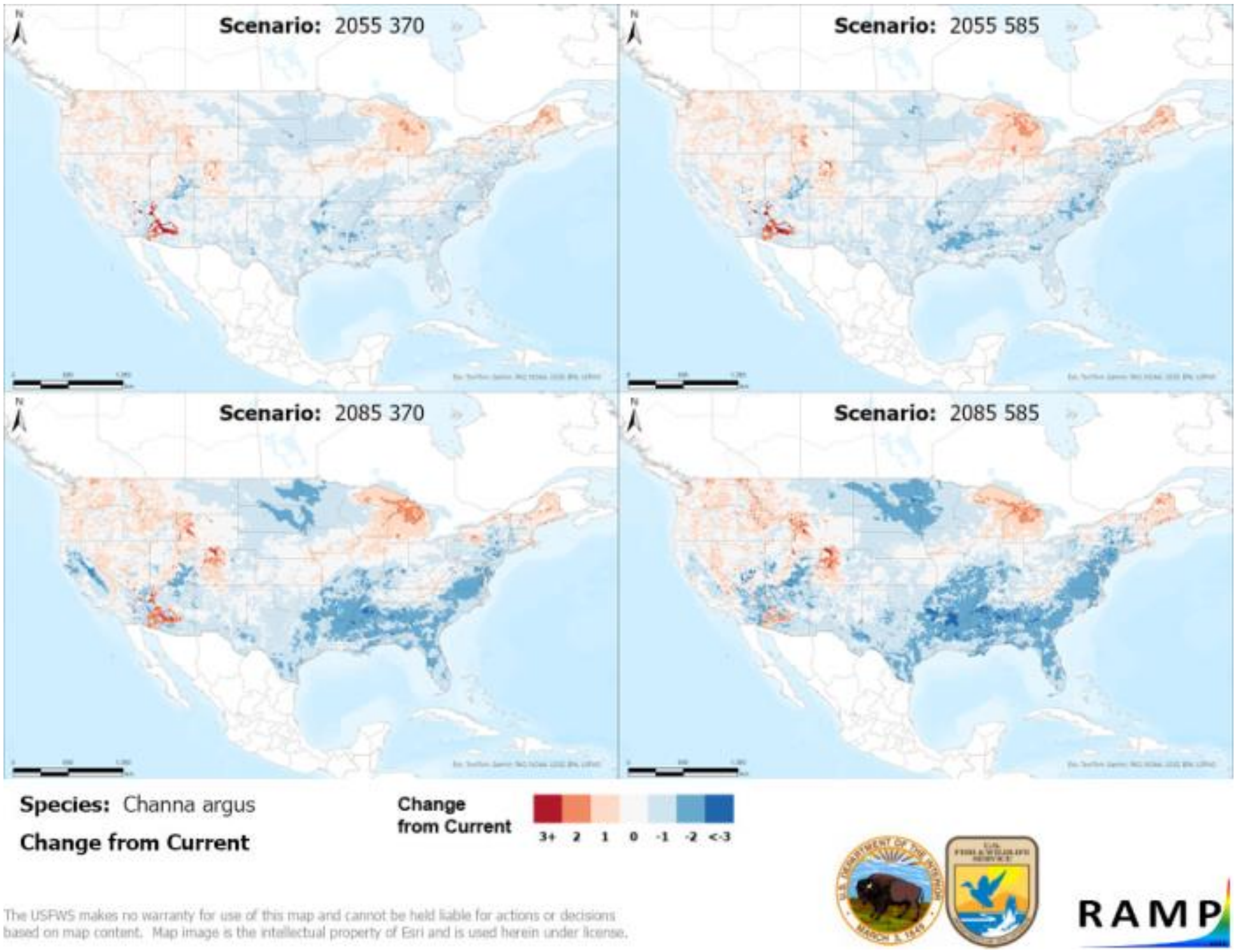

Figure A3. RAMP (Sanders et al. 2023) maps of the contiguous United States showing the difference between the current climate match target point score (figure 4) and the median target point score for future climate scenarios (figure A1) for *Channa argus* based on source locations reported by GBIF Secretariat (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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