U.S. Fish & Wildlife Service

Blotched Snakehead (*Channa maculata*)
Ecological Risk Screening Summary

U.S. Fish and Wildlife Service, December 2023
Revised, February 2025
Web Version, 7/2/2025

Organism Type: Fish
Overall Risk Assessment Category: Uncertain

Photo: Tse Chung Yi. Licensed under CC BY-NC 4.0. Available: https://www.inaturalist.org/observations/27687337 (February 2025).

1 Native Range and Status in the United States

Native Range

From Huckstorf (2021):

"This species is native to southern China and northern Viet Nam (Fricke et al. 2018, Rüber et al. 2019). It is known from Pacific coastal drainages in south-eastern China (e.g., Yangtze River, Minjiang River, Hangjiang River, Pearl River, Nanjiujiang), Viet Nam (northern Provinces to Quang Binh Province in Central Viet Nam), and Taiwan (Masuda et al. 1984, Kottelat 2001)."

Status in the United States

From Nico et al. (2025):

"Established in Hawaii. The species has been established on Oahu, Hawaii since before 1900 (Brock 1960; Maciolek 1984; Devick 1991a). Cobb (1902) and Jordan and Evermann (1902, 1905) reported that the species was fairly common in irrigation ditches and freshwater ponds in the Honolulu area. Maciolek (1984) noted that it was found in unspecified standing waters (e.g., reservoirs) on Oahu and reported it as actively spreading. Devick (1991a, b) listed the dominant habitat of this species in Oahu to be reservoirs or ponds. Failed in Massachusetts and North Carolina, as there are only single reports of one or few individuals from these states."

"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* ([…] W. Starnes, personal communication)."

From Courtenay and Williams (2004):

"An angler reported having caught two blotched snakeheads, *Channa maculata*, from a bridge over the Charles River in Boston in late July 2002 (Karsten Hartel, personal commun., 2002). We confirmed that two live snakeheads purchased in an ethnic market in Boston in October 2001 by Karsten Hartel were *C. maculata*, thus proving local availability of this species at that time."

Regulations

All species of the family Channidae were officially listed as injurious wildlife species by the U.S. Fish and Wildlife Service in 2002 under 18 U.S.C. 42(a)(1) prohibiting importation into or transportation between the continental United States, the District of Columbia, Hawaii, the Commonwealth of Puerto Rico, or any territory or possession of the United States (USFWS 2002).

Channa maculata is regulated at the genus level (*Channa*) in Connecticut (Connecticut DEEP 2020), Idaho (IDDA 2022), Kentucky (KDFWR 2022), Ohio (ODNR 2022), Wyoming (WGFD 2022), Missouri (MDC 2023), Montana (Montana FWP 2023), New Jersey (NJFW 2022), North Dakota (NDGF 2023), Oklahoma (ODWC 2023), Oregon (ODFW 2022), Nevada (Nevada Board of Wildlife Commissioners 2022), Virginia (Virginia DWR 2022), and Washington (WDFW 2022). It is regulated at the family level (Channidae) in 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 (except *Channa striata*; HDOA 2019), Illinois (Illinois DNR 2015), Kansas (KDWP 2023), Louisiana (Louisiana Revised Statutes 2022), Michigan (Michigan Complied Laws 2022), Mississippi (MDAC 2022), New Hampshire (NHFG 2022), New Mexico (NMDGF 2023), North Carolina (North Carolina DEQ 2022), Oregon (ODFW 2022), Rhode Island (Rhode Island DEM 2022), South Carolina (South Carolina Code of Laws 2022), Tennessee (TWRA 2022), Texas (TDPW 2022), Utah (Utah DWR 2023), Wisconsin (Wisconsin

DNR 2022). Please refer back to state agency regulatory documents for details on the regulations, including restrictions on activities involving this species. While effort was made to find all applicable regulations, this list may not be comprehensive. Notably, it does not include regulations that do not explicitly name this species or its genus or family, for example, when omitted from a list of authorized species with blanket regulation for all unnamed species.

Means of Introductions within the United States

From Nico et al. (2025):

“This species of snakehead was stocked as a food fish in Hawaii. Cobb (1902) stated that the China-fish or "*Ophicephalus*" was brought to Hawaii from China by the Chinese. However, Jordan and Evermann (1905) suggested that the species had been introduced into Hawaii from Borneo. Devick (1991b) indicated it was a deliberate introduction for use as a food fish (he listed the period of introduction as both 1800 and the 19th century). Jordan and Evermann (1902, 1905) reported that "China-fish" (along with goldfish) were generally sold alive to the Chinese [in Hawaii]. Borneo was mentioned as source by Jordan and Evermann (1902).”

“Unknown means in other areas. The most likely mechanism is as a released food fish, as it is common in the food trade and rarely available in the aquarium trade (Courtenay and Williams 2004).”

Remarks

From Courtenay and Williams (2004):

“As of August 2002, it was becoming apparent that many reports of introductions and established populations of *Channa striata* in such places as Hawaii and Madagascar were based on misidentifications of *C. maculata* (Ralf Britz, personal commun., 2002). We have confirmed (October 2002) that the snakehead species recorded from Hawaii since the late 1800s is indeed *C. maculata* and not *C. striata*.”

From Zhao et al. (2021):

“In China, the snakeheads are important freshwater aquatic products, with the total output almost reached to [sic] 0.5 million tons every year since 2012 (China's Ministry of Agriculture, 2012-2020). The northern snakehead (*C. argus*), the blotched snakehead (*C. maculata*) and their hybrids (both cross and reciprocal cross) are main cultured stocks. The northern snakehead is mainly cultured in the northern regions of China, because of its excellent cold resistance. 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). The blotched snakehead now is mainly kept as breeders to produce hybrid stocks.”

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From ITIS (2023):

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 maculata* (Lacepède, 1801)

According to Fricke et al. (2023), *Channa maculata* (Lacepède, 1801) is the current valid name for this species.

The following synonyms of *Channa maculata* from Nico et al. (2025) were used to search for information for this report: *Ophiocephalus guntheri, Ophiocephalus marmoratus*, *Ophiocephalus tadianus*.

Size, Weight, and Age Range

From Courtenay and Williams (2004):

"Lifespan—No specific information appears in literature. […] Most larger snakeheads are reported to reach sexual maturity within 2 years, after which growth slows but fecundity increases with increasing size."

"To 33 cm (Okada, 1960) but reaches a length of more than 1 m when fully mature (William S. Devick, personal commun. to Paul L. Shafland, 2002)."

Environment

From Froese and Pauly (2023):

"Freshwater; benthopelagic."

From Courtenay and Williams (2004):

“Streams, lakes, ponds and ditches in southern China; prefers shallow waters with vegetation (Okada, 1960; Hay and Hodgkiss, 1981).”

“Snakeheads are either obligate or facultative airbreathers. Therefore, survival in hypoxic waters is not problematic to these fishes.”

Climate

From Courtenay and Williams (2004):

“Native range is subtropical to warm temperate. Nevertheless, Okada (1960) reported that in Japan, this species tolerated ‘seven days in 7 °C air temperature out of water.’”

“[…] its temperature tolerance indicates a species that could live in subtropical to temperate areas […].”

Distribution Outside the United States

Native

From Huckstorf (2021):

“This species is native to southern China and northern Viet Nam (Fricke et al. 2018, Rüber et al. 2019). It is known from Pacific coastal drainages in south-eastern China (e.g., Yangtze River, Minjiang River, Hangjiang River, Pearl River, Nanjiujiang), Viet Nam (northern Provinces to Quang Binh Province in Central Viet Nam), and Taiwan (Masuda et al. 1984, Kottelat 2001).”

Introduced

From Huckstorf (2021):

“This fish was introduced into the following countries: Madagascar from China in 1976-1978 (Courtenay et al. 2004, Fricke et al. 2018), Japan from Taiwan in 1906 (Masuda et al. 1984, Welcomme 1988); and Hawaii from China in the 1800s or 1900s (Maciolek 1984, Welcomme 1988, Yamamoto and Tagawa 2000, Courtenay et al. 2004).”

From Courtenay and Williams (2004):

“Introduced and established [in] the Philippines (Okada, 1960; Liang and others, 1962; Hay and Hodgkiss, 1981; Uyeno and Akai, 1984)”

From Scott et al. (2013):

“In June 2012 a single non-native snakehead fish was captured by local officials in a small pond within an urban park in Burnaby, British Columbia. This single snakehead fish garnered significant attention in the local and national media. DNA analysis determined it to be a blotched snakehead (*Channa maculata*) or possibly a hybrid; […].”

"[…] this introduction [British Columbia] was quickly detected and did not result in an invasive population, […]."

Means of Introduction Outside the United States

From Courtenay and Williams (2004):

"Introduced and established as a food resource in Taiwan; Nara, Hyôgo, Hiroshima, Mie, and Shiga prefectures, Japan; and the Philippines (Okada, 1960; Liang and others, 1962; Hay and Hodgkiss, 1981; Uyeno and Akai, 1984)."

"*Channa maculata* was introduced into Madagascar about 1978 by former President Didier Ratsiraka who had seen snakeheads at an aquaculture facility during an earlier visit to North Vietnam. […] The shipment was divided equally, one group stocked into ponds at the presidential summer residence near Antananarivo, adjacent to the headwaters of the Betsiboka River. The remaining fish were stocked into ponds at Ratsiraka's home near Vatomandry on the east coast. Subsequent floods from monsoons washed snakeheads out of ponds in both localities and into adjacent natural waters."

From Scott et al. (2013):

"Since only one individual was discovered [in British Columbia], it seems unlikely this was an attempt to seed a population for harvest, but perhaps it may have been a ceremonial or a hobbyist release after the fish became too large (Severinghaus and Chi 1999)."

Short Description

From Courtenay and Williams (2004):

"No patch of scales on gular region. Head profile slightly depressed. Dorsal rays 40-46; anal rays 26-30. Lateral line scales 41-60 with lateral line continuous; transverse scales below lateral line 11; 9 scale rows between posterior rim of orbit to upper edge of operculum. Color pattern similar to that of *Channa argus*; dark stripe from tip of snout through orbit extending to almost above anterior base of pectoral fin; second dark stripe from posteroventral corner of orbit to posteroventral edge of operculum; sides of body with two rows of large, dark blotches extending posteriorly to anterior caudal peduncle; blotches in the form of two bar-like markings on caudal peduncle; dark markings toward mid-dorsal part of back extending up onto proximal part of dorsal fin."

Biology

From Courtenay and Williams (2004):

"Those snakeheads with more rounded bodies (for example, […] *C. maculata*) have very limited ability to move on land except as young, and only when some water is present, as under mild flooded conditions."

"Snakeheads are either obligate or facultative airbreathers. Therefore, survival in hypoxic waters is not problematic to these fishes. When prevented from access to the surface, adult snakeheads of many species will drown due to lack of oxygen (Day, 1868; Lee and Ng, 1991)."

"Reported to feed on crustaceans, large insects, frogs, and fishes (Okada, 1960; Hay and Hodgkiss, 1981); described as a "fierce predatory fish" that "hides among rocks or aquatic plants until its prey approaches, then it quickly attacks, kills, and swallows its victim" (Hay and Hodgkiss, 1981)."

From Courtney et al. (2004):

"A resident of Madagascar reported observing juvenile *C. maculata* slithering onto land, allowing themselves to become covered with ants, then returning to the water where the ants floated at the surface, to be devoured by the young snakeheads."

From Huckstorf (2021):

"This species exhibits distinct pairing during breeding in shallow freshwater areas amid plants (Breder and Rosen 1966). It is oviparous. The reproduction season in May to October depends on each region. At this time, they live in as couple [sic], nesting near pond dikes, rice farms, and rivers. They usually remove all aquatic plants to make a nest 0.4 - 0.6 m^2 large to spawn. Eggs float on the water surface and stick to each other. Male and female stay around the nest to protect and nurse juveniles until juveniles can search for food and escape from the enemy by themselves."

Human Uses

From Courtenay and Williams (2004):

"*Channa maculata* is the second most important snakehead cultured in China (Fang Fang, personal commun., 2002), and its culture appears to be concentrated primarily in Guangdong Province, where it is native. […] it is considered to be the most important species economically in India (Bhatt, 1970), and is being cultured there and in Thailand, Java (Hofstede and others, 1953); Vietnam (Pantulu, 1976; Bard, 1991); the Philippines (Conlu, 1986; Guerrero, 2000); Sri Lanka (Kilambi, 1986); Pakistan (Talwar and Jhingran, 1992); Malaysia (Ali, 1999); and Cambodia (Balzer and others, 2002)."

Diseases

***Channa maculata* has been documented as susceptible to Epizootic Ulcerative Syndrome (EUS), a disease listed by the World Organisation for Animal Health (2025).**

From Li et al. (2019):

"The Organization International Des Epizooties (OIE) [World Organisation for Animal Health] has confirmed that EUS is a seasonal epidemic caused by infection of the oomycete *Aphanomyces invadans* or *Aphanomyces piscicida*, and is listed among those diseases that must be notified (OIE, 2013; Iberahim, Trusch & West, 2018)."

"Specimens of hybrid snakehead [*Channa maculata*♀ × *Channa argus*♂] with and without EUS infection were collected on April 12, 2016, from the pond of a hybrid snakehead aquaculture farm […] located in Junan Town, Foshan City, southern China. The hybrid snakeheads were naturally infected by *Aphanomyces* sp. and approximately 70% of individuals in the sampling pond were infected."

From Chinabut (1998):

"[…] red spot disease (RSD) in Australia (Callinan et al., 1995) and mycotic granulomatosis (MG) in Japan (Miyazaki and Egusa, 1972) correspond to EUS."

"The disease called mycotic granulomatosis was first found […] in various regions in Japan in 1971 (Miyazaki and Egusa, 1973a). Wild species such as formosan snakehead *Channa maculata*, […] were also affected by the disease at this time (Miyazaki and Egusa, 1973b, c). Later, the causative agent of mycotic granulomtosis was identified as *Aphanomyces piscicida* sp. nov. by Hatai (1980)."

Poelen et al. (2014) list the following as additional parasites of *Channa maculata*: *Neocamallanus ophicephali, Gyrodactylus maculati, Gyrodactylus maculatus, Spinitectus gigi, Pingus sinensis, Azygia hwangtsiyui, Isoparorchis hypselobagri, Clonorchis sinensis, Pallisentis vietnamensis, Gnathostoma hispidum, Gnathostoma spinigerum, Procamallanus ophiocephali, Neoparacamallanus ophicephali,* and *Pallisentis nagpurensis.*

Threat to Humans

From Froese and Pauly (2023):

"Harmless"

3 Impacts of Introductions

The following sources discuss possible, probable, and suggested impacts of introduction of *Channa maculata*. However, there is limited concrete evidence to support that *C. maculata* has had the reported impacts.

From Benstead et al. (2003):

"Far worse for the future of Madagascar's native freshwater fishes than any of these species, however, was the introduction of the Asian snakehead (*Channa maculata*) in 1978 (Raminosoa 1987). This voracious predator has since dispersed throughout Madagascar. […] The spread of this taxon has been extremely rapid because of its tolerance of poor water quality, extreme fecundity, and efficient biparental custodial care of its eggs and fry. A suprabranchial organ used for breathing air allows the Asian snakehead to survive and disperse through water with very low oxygen content (Ishimatsu and Itazawa 1981). This predator is present in most of Madagascar's large lakes and is responsible for the rapid decline in abundance of a number of native species."

From Jones et al. (2007):

"In Vohiparara [Madagascar], a village to the west of Ranomafana National Park, predation of young crayfish by the introduced fish *Channa maculata* (Asian snakehead or fibata), was given as a reason for this species' decline. We confirmed the presence of *C. maculata* in this area (photographs identified by Paul Loiselle) and that *C. maculata* do feed on crayfish (we found crayfish carapaces in the stomach of a captured *C. maculata*). Informants from all other areas (with the exception of Vohibato in Iazoara commune where *C. maculata* is present but not considered a threat to crayfish) told us that this fish was not yet found in their waterways."

"Villages in Vohiparara blamed the Asian snakehead, *C. maculata* (local name: fibata) for the reduction in *A. betsileoensis* in their area. *Channa maculata* is a predatory fish, introduced to Madagascar in 1978, which is devastating native fish fauna throughout the country (Sparks & Stiassny, 2003). We confirmed the presence of *C. maculata* in the Namorona catchment (the main river draining Ranomafana National Park). Hitherto, the species had not been recorded from this catchment, the only known habitat of an undescribed endemic fish in the genus *Bedotia* (IUCN, 2004). The presence of *C. maculata* may represent a serious, as yet unrecognized threat to Madagascar's crayfish. *Astacoides betsileoensis* is likely to be particularly vulnerable to the threat from *C. maculata* as it is most commonly found in large rivers the habitat apparently preferred by *C. maculata*. Fortunately, most of the study area remains free from *C. maculata*. However, given this species' history of invasion and the fact it is still intentionally introduced to new waterways in Madagascar (P. Loiselle personal communication 2004), this threat may be increasing."

From Kull et al (2014):

"The introduced fish known locally as fibata (snakehead, *Channa maculata*), […], is now found in most lakes around the island [Madagascar] (Masuda et al. 1984, Sparks and Stiassny 2003). At Lake Alaotra, collection of this fish is one of the reasons villagers burn marshlands that are crucial habitat of the gentle lemur (*Hapalemur alaotrensis*) (Copsey et al. 2009). It has been widely suggested that the fish may be responsible for the local extinction of the fish genus *Paratilapia* and the total loss of the Alaotra grebe (*Tachybaptus rufolavatus*), but causality has not been scientifically proven."

From Courtenay and Williams (2004):

"Paul V. Loiselle (personal commun., 2003) […] commented that amphibian populations in Madagascar are probably being negatively affected by the introduced blotched snakehead. Historically, frog tadpoles in the central highlands were preyed upon to some extent by native eels (Anguillidae), but now those same waters contain considerable numbers of *Channa maculata*."

Channa maculata is listed as injurious wildlife by the U.S. Fish and Wildlife Service. Additionally, it is regulated in 37 U.S. States, see section 1.

4 History of Invasiveness

The History of Invasiveness for *Channa maculata* is classified as Data Deficient. *C. maculata* has a well-documented history of establishing populations outside of its native range in several countries. The pathways of its introduction are also known. Despite this, information on negative impacts of introduction of *C. maculata* is largely circumstantial, primarily from observations of local villagers. It is thought to have contributed to declines in native species in Madagascar, possibly including fish, frogs, crayfish, lemurs, and birds, but specific information documenting those declines or causal mechanisms was not found.

5 Global Distribution

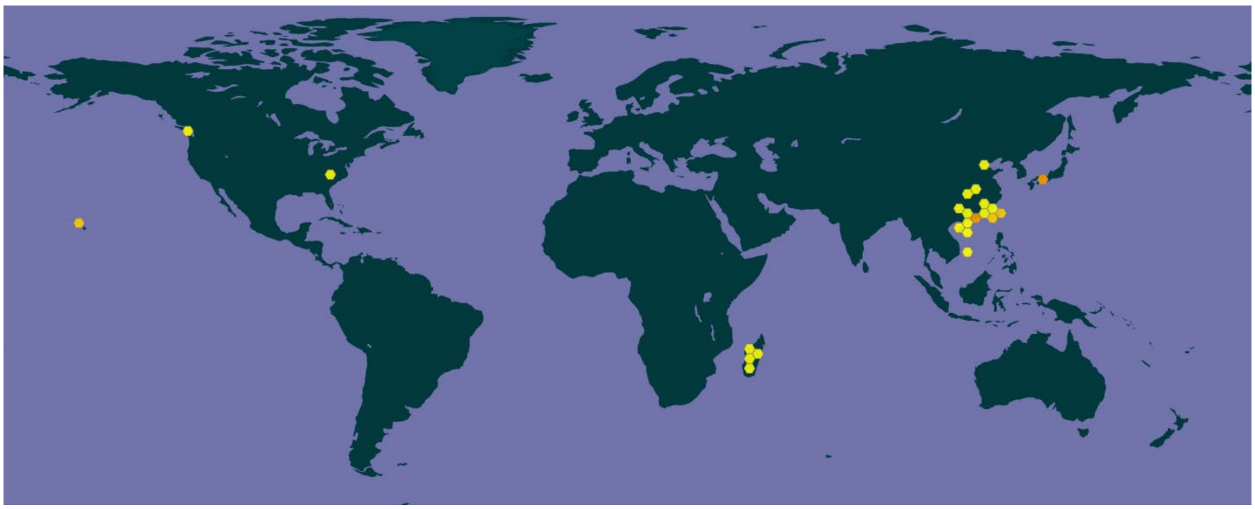

Figure 1. Reported global distribution of *Channa maculata*. Map from GBIF Secretariat (2023). Observations are reported from Southeast Asia, Madagascar, Japan and in North America in British Columbia, Hawaii and North Carolina. The observation in northern China was not used in the climate matching analysis; it is outside the species' described native range and no records of established populations in northern China were found. The points in British Columbia and North Carolina do not represent established populations and were excluded from the climate matching analysis.

6 Distribution Within the United States

Figure 2. Reported distribution of *Channa maculata* in Hawaii. Map from Nico et al. (2025). Observations are reported from the island of Oahu and represent established populations.

Figure 3. Reported distribution of *Channa maculata* in the United States. Map from Nico et al. (2025). Observations are reported from Massachusetts and North Carolina. Neither of these observations represent established populations and therefore they were not included in the climate matching analysis.

7 Climate Matching

Summary of Climate Matching Analysis

The climate matching analysis for *Channa maculata* to the contiguous United States found areas of high climate match in Florida, coastal Georgia, North Carolina and South Carolina and portions of Oklahoma, Kansas, and Missouri. Areas of medium climate match included the Northeast, Midwest, Great Plains and the South. The West primarily had a low match. The overall Climate 6 score (Sanders et al. 2023; 16 climate variables; Euclidean distance) for the contiguous United States was 0.261, 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 2024).

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

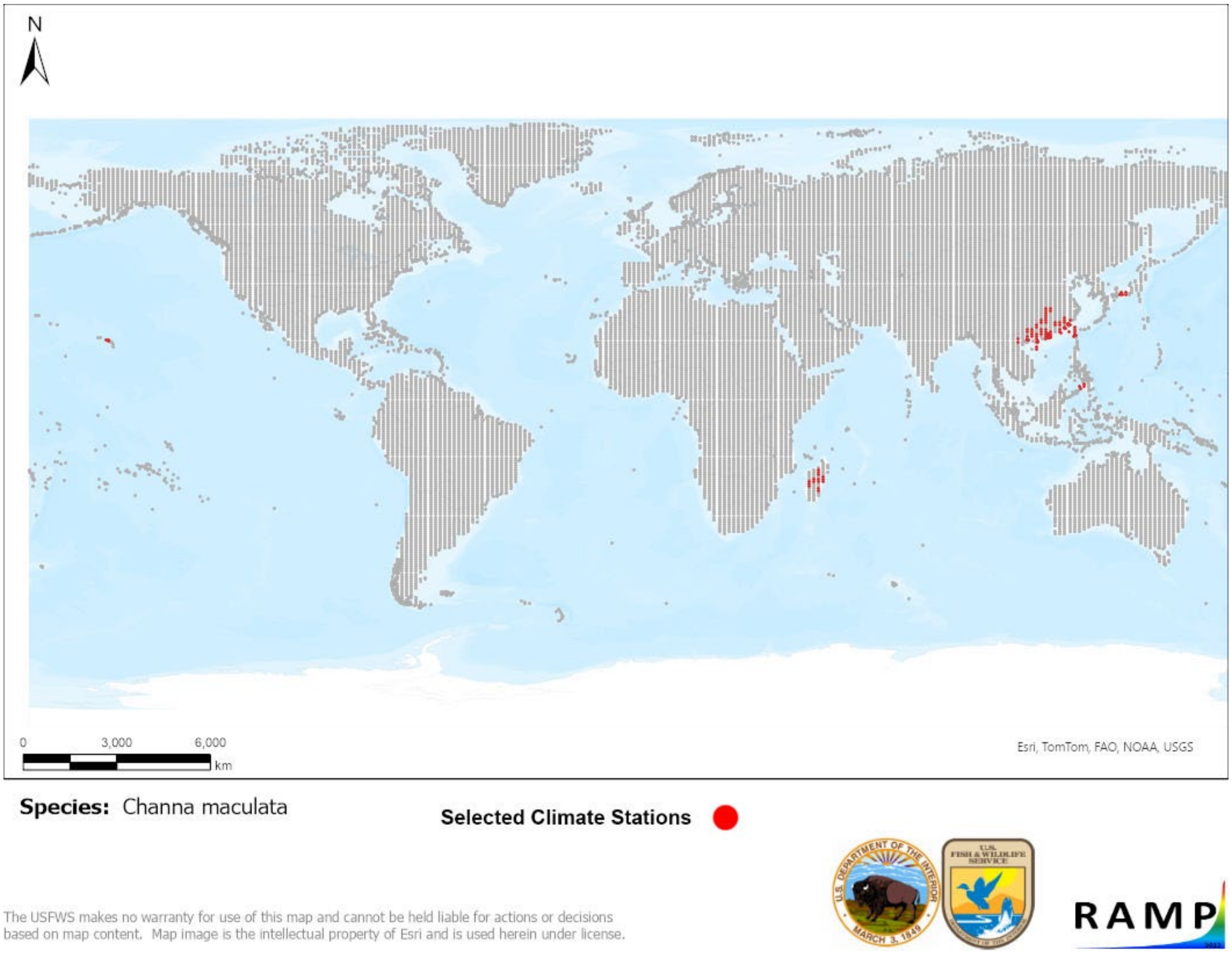

Figure 4. RAMP (Sanders et al. 2023) source map showing weather stations in general geographic area selected as source locations (red; Hawaii, Japan, China, Taiwan, the Philippines, Vietnam, Madagascar) and non-source locations (gray) for *Channa maculata* climate matching. Source locations from GBIF 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.

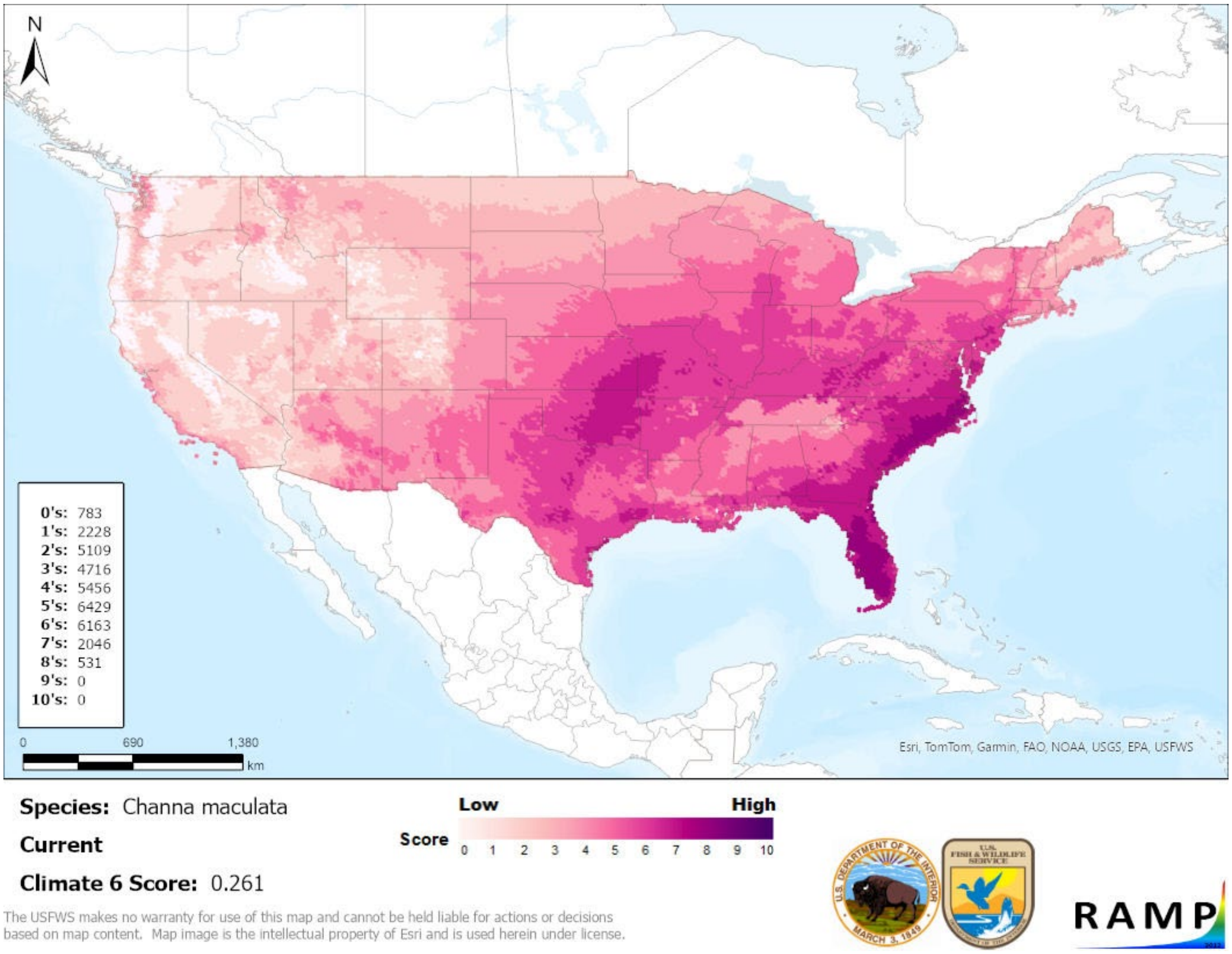

Figure 5. Map of RAMP (Sanders et al. 2023) climate matches for *Channa maculata* in the contiguous United States based on source locations reported by GBIF Secretariat (2023). Counts of climate match scores are tabulated on the left. 0/Pale Pink = Lowest match, 10/Dark Purple = Highest match.

8 Certainty of Assessment

The Certainty of Assessment for *Channa maculata* is classified as Low. Information was available regarding the species' biology and ecology. Although multiple introductions of *C. maculata* outside of its native range have been documented, there is a lack of specific information documenting negative impacts of these introductions. Further information is needed to adequately assess the risk this species poses to the contiguous United States.

9 Risk Assessment

Summary of Risk to the Contiguous United States

Channa maculata, Blotched Snakehead, is a fish that is native to southeastern China, Taiwan, and Vietnam. It is a carnivorous, air-breathing fish adapted to tropical and warm-temperate environments. This species is important in aquaculture in many Asian countries. This is one of the likely mechanisms of introduction of *C. maculata* outside of its native range. *C. maculata* is established in Madagascar, Japan, Hawaii, and the Philippines. *C. maculata* is a highly-regulated species at the State level in the United States and is also Federally listed as injurious wildlife under the Lacey Act. The History of Invasiveness for *Channa maculata* is classified as Data Deficient. Although this species has been reported from outside of its native range and some negative impacts of introduction of this species have been suggested, there is a lack of clear and convincing evidence of negative impacts. The climate matching analysis for the contiguous United States indicates establishment concern for *C. maculata*. In the contiguous United States the climate match was highest in the Southeast, generally medium across the Midwest, and low in the Upper Midwest, West, and Northeast. The Certainty of Assessment for this ERSS is classified as Low due to a lack of information regarding impacts of introduction from which to base an assessment of risk. The Overall Risk Assessment Category for *Channa maculata* in the contiguous United States is Uncertain.

Assessment Elements

- **History of Invasiveness (see Section 4): Data Deficient**
- **Establishment Concern (see Section 7): Yes**
- **Certainty of Assessment (see Section 8): Low**
- **Remarks, Important additional information: Susceptible to Epizootic Ulcerative Syndrome, a disease listed by the World Organisation for Animal Health.**
- **Overall Risk Assessment Category: Uncertain**

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 GBIF Secretariat (2023).

Under the future climate scenarios (figure A1), no regions of the contiguous United States were projected to have a High climate match for *Channa maculata*. Areas of low climate match were projected to occur in California, the Great Basin, Northern Pacific Coast, Southwest, and Western Mountains regions. Areas of high climate match diminished slightly in both 2085 scenarios, especially in the Southeast. The Climate 6 scores for the individual future scenario models (figure A2) ranged from a low of 0.178 (model: UKESM1-0-LL, SSP5, 2085) to a high of 0.366 (model: MRI-ESM2-0, SSP5, 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 (0.261, figure 5) 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, areas within the Northeast saw a large increase in the climate match relative to current conditions. Additionally, areas within the Colorado Plateau, Great Lakes, Northern Pacific Coast, Northern Plains, 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 Appalachian Range, Gulf Coast, Mid-Atlantic, Southeast, Southern Atlantic Coast, and Southern Florida saw a moderate decrease in the climate match relative to current conditions. No large decreases were observed regardless of time step and climate scenarios. Additional, very small areas of large or moderate change may be visible on the maps (figure A3). The 2085 climate scenarios had the highest levels of change in climate match relative to current conditions, both positively and negatively. The climate match saw only slight changes in the western United States under both 2055 scenarios.

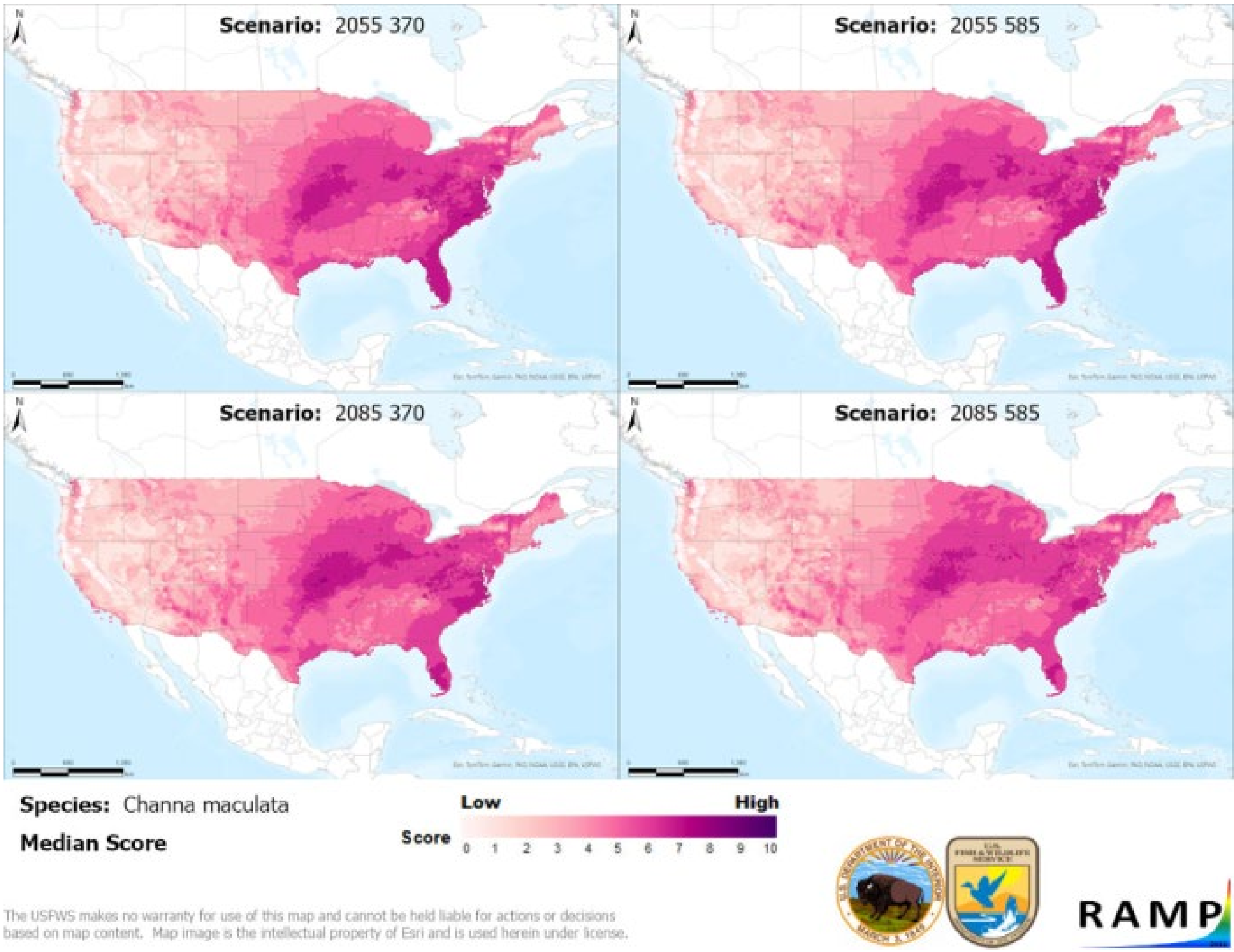

Figure A1. Maps of median RAMP (Sanders et al. 2023) climate matches projected under potential future climate conditions using five global climate models for *Channa maculata* in the contiguous United States. Climate matching is based on source locations reported by GBIF Secretariat (2023). Shared Socioeconomic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

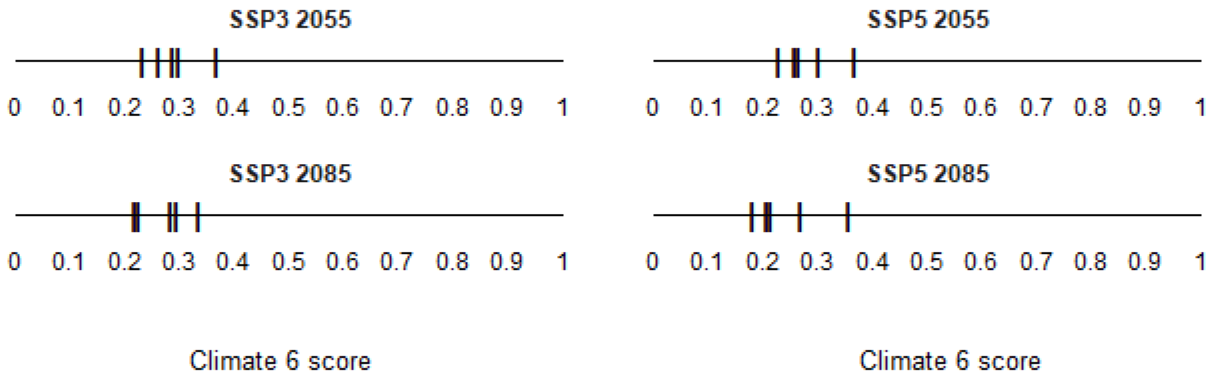

Figure A2. Comparison of projected future Climate 6 scores for *Channa maculata* in the contiguous United States for each of five global climate models under four combinations of Shared Socioeconomic Pathway (SSP) and time step. SSPs used (from left to right): SSP3, SSP5 (Karger et al. 2017, 2018; IPCC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

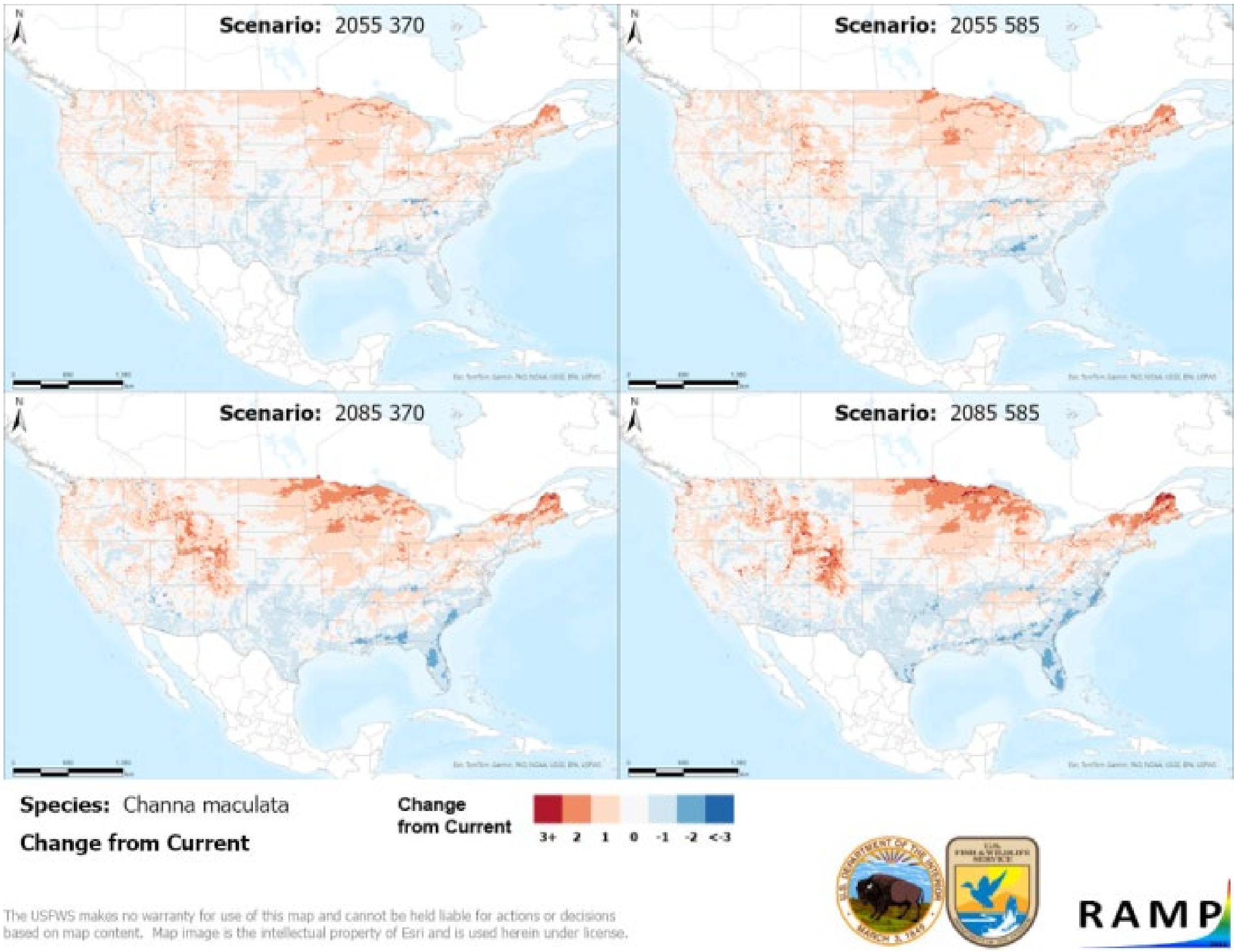

Figure A3. RAMP (Sanders et al. 2023) maps of the contiguous United States showing the difference between the current climate match target point score (figure 5) and the median target point score for future climate scenarios (figure A1) for *Channa maculata* based on source locations reported by GBIF 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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