Walking Catfish (*Clarias batrachus*)

Ecological Risk Screening Summary

U.S. Fish and Wildlife Service, January 2024
Revised, September 2024
Web Version, 1/22/2026

Organism Type: Fish
Overall Risk Assessment Category: High

Photo: USGS. Public Domain. Available: https://www.ipmimages.org/browse/detail.cfm?imgnum=5430846 (January 2024).

1 Native Range and Status in the United States

Native Range

From Nico et al. (2024):

"Southeastern Asia including eastern India, Sri Lanka, Bangladesh, Burma [Myanmar], Indonesia, Singapore, and Borneo (Lee et al. 1980 et seq.; Talwar and Jhingran 1992; Kottelat et al. 1993). Laos (Baird et al. 1999)."

From Bonham and Ng (2010):

"*C. batrachus* is indigenous to the inland waters of South-East Asia in the Mekong and Chao Phraya basins, the Malaysian Peninsula, Sumatra, Java and Borneo. It also inhabits the inland

waters of South Asian countries such as Sri Lanka, India, Bangladesh, Pakistan, Nepal, Laos, Vietnam, Singapore, Thailand, Cambodia and Brunei Darussalam."

While the above sources have indicated that *Clarias batrachus* is native to Sri Lanka, researchers in Sri Lanka assert that it is introduced to the country (Silva and Kurukulasuriya 2010). Some sources also indicate a wide native range across southern Asia (Bonham and Ng 2010; Nico et al. 2024), while others report the native range as much more restricted to southeastern Asia (Silva and Kurukulasuriya 2010; Emıroğlu et al. 2020).

Status in the United States

From Nico et al. (2024):

"Established in Florida; failed in California, Connecticut, Georgia, Massachusetts, and Nevada."

"In 1968, this species was confined to three south Florida counties; by 1978, it had spread to 20 counties in the southern half of the peninsula (Courtenay 1979a; Courtenay et al. 1986). Dispersal apparently has occurred by way of the interconnected network of canals along the southeastern coastal region; however, spread was accelerated by overland migration, typically during rainy nights (Loftus and Kushlan 1987). Its ability to use atmospheric oxygen assists in survival in low-oxygen habitats (Loftus 1979). The walking catfish has been established in Everglades National Park and in Big Cypress National Preserve since the mid-1970s (Courtenay 1989). Populations suffer periodic die-offs from cold temperatures and subsequent bacterial infection (Loftus and Kushlan 1987); consequently, northward dispersal is limited (Courtenay 1978, Courtenay and Stauffer 1990). Although all Florida imports were originally albinos, albinos in the wild are now rare and descendants have reverted to the dominant, dark-color phase (dark brown to gray) probably a result of natural selection by predators (Courtenay et al. 1974; Courtenay and Stauffer 1990). Guarding of free-swimming young may enhance survivorship over that of native species with less advanced (or no) parental care (Taylor et al. 1984)."

From Bonham and Ng (2010):

"*C. batrachus* has been introduced into countries such as Guam […]"

Regulations

All species in the family Clariidae were officially listed as injurious wildlife species by the U.S. Fish and Wildlife Service in 1970 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 2022).

Claria batrachus is regulated in Colorado (CPW 2023), Delaware (DNREC 2022), Florida (FFWCC 2022), Kansas (KDWP 2023), Montana (Montana FWP 2023), New Hampshire (NHFG 2022), New Mexico (NMDGF 2023), and New York (New York DEC 2022). All species in the genus *Clarias* are regulated in Alabama (ADCNR 2022), California (CDFW 2021), Connecticut (Connecticut DEEP 2020), Kentucky (KDFWR 2022), and Nevada (Nevada Board of Wildlife Commissioners 2022). All species in the family Clariidae are

regulated in Arizona (Arizona Game and Fish Commission 2022), Hawaii (HDOA 2019), Idaho (IDDA 2022), Illinois (Illinois DNR 2015), Louisiana (Louisiana Revised Statutes 2022), Mississippi (MDAC 2022), Missouri (MDC 2023), Oklahoma (ODWC 2023), Oregon (ODFW 2022), South Carolina (South Carolina Code of Laws 2022), Texas (TPDW 2022), Utah (Utah DWR 2023), Virginia (Virginia DWR 2022), and Washington (WDFW 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. (2024):

"The walking catfish was imported to Florida, reportedly from Thailand, in the early 1960s for the aquarium trade (Courtenay et al. 1986). The first introductions apparently occurred in the mid-1960s when adult fish imported as brood stock escaped, either from a fish farm in northeastern Broward County or from a truck transporting brood fish between Dade and Broward counties (Courtenay and Miley 1975; Courtenay 1979a; Courtenay and Hensley 1979a; Courtenay et al. 1986). Additional introductions in Florida, supposedly purposeful releases, were made by fish farmers in the Tampa Bay area, Hillsborough County in late 1967 or early 1968, after the state banned the importation and possession of walking catfish (Courtenay and Stauffer 1990). Aquarium releases likely are responsible for introductions in other states (Courtenay and Hensley 1979a; Courtenay and Stauffer 1990; Hartel 1992). Dill and Cordone (1997) reported that this species has been sold by tropical fish dealers in California for some time."

Remarks

This ERSS was previously published in June 2018. Revisions were completed to incorporate new information and conform to updated standards.

From Schofield and Loftus (2015):

"Walking catfish in Florida have consistently been called *Clarias batrachus* since their introduction into Florida in the 1960s. However, Ng and Kottelat (2008) reported hidden diversity within usage of this name (i.e., the name has been applied to at least four species), placing the identity of Florida populations into question. At this time, it is unclear whether the name *C. batrachus* has been incorrectly applied to Florida *Clarias*, and whether more than one species is present in the State."

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 Siluriformes
Family Clariidae
Genus *Clarias*
Species *Clarias batrachus* (Linnaeus, 1758)

According to Fricke et al. (2024) *Clarias batrachus* (Linnaeus, 1758) is the current valid name for this species. *Clarias batrachus* was originally described as *Silurus batrachus* Linnaeus 1758.

Size, Weight, and Age Range

From Froese and Pauly (2024a):

"Max length : 47.0 cm TL [total length] male/unsexed; [IGFA 2001]; common length : 26.3 cm TL male/unsexed; [Hugg 1996]; max. published weight: 1.2 kg [IGFA 2001]"

From Nico et al. (2024):

"**Size:** 61 cm in native range; rarely"

Environment

From Bonham and Ng (2010):

"*C. batrachus* inhabits lowland streams, swamps, ponds ditches, rice paddies, rivers, flooded areas, canals and stagnant water (Froese and Pauly, 2009)."

Bonham and Ng (2010) state that the optimal water parameters for adult *C. batrachus* are pH levels between 6 and 9 and water temperature at 25°C.

From Froese and Pauly (2024a):

“Freshwater; brackish; demersal; potamodromous [Riede 2004]; depth range 1 - ? m [Herre 1924]. […] 10°C - 28°C [Baensch and Riehl 1985; assumed to be the recommended aquarium temperature]”

From Shafland and Pestrak (1982):

“Lower lethal temperatures identified here for […] *Clarias batrachus* [9.8°C] closely approximate those reported previously. […] Pardue (1970) reported lower lethal temperatures for *C. batrachus* from 9.4-12.8°C, depending on thermal history.”

Climate

From Froese and Pauly (2024a):

“Tropical; […] 29°N - 7°S”

Distribution Outside the United States

Native

From Nico et al. (2024):

“Southeastern Asia including eastern India, Sri Lanka, Bangladesh, Burma, Indonesia, Singapore, and Borneo (Lee et al. 1980 et seq.; Talwar and Jhingran 1992; Kottelat et al. 1993). Laos (Baird et al. 1999).”

From Bonham and Ng (2010):

“*C. batrachus* is indigenous to the inland waters of South-East Asia in the Mekong and Chao Phraya basins, the Malaysian Peninsula, Sumatra, Java and Borneo. It also inhabits the inland waters of South Asian countries such as Sri Lanka, India, Bangladesh, Pakistan, Nepal, Laos, Vietnam, Singapore, Thailand, Cambodia and Brunei Darussalam.”

While the above sources have indicated that *Clarias batrachus* is native to Sri Lanka, researchers in Sri Lanka assert that it is introduced to the country (Silva and Kurukulasuriya 2010; see below). Some sources also indicate a wide native range across southern Asia (Bonham and Ng 2010; Nico et al. 2024), while others report the native range as much more restricted to southeastern Asia (Silva and Kurukulasuriya 2010; Emıroğlu et al. 2020).

Introduced

From Global Invasive Species Database (2024):

“Introduced into Hong Kong from Thailand […]”

From Emıroğlu et al. (2020):

“Our findings confirmed the presence of *C. batrachus* in a region with extraordinarily high biodiversity, including the first evidence to indicate the successful establishment of this species in Turkey.”

“Successful establishment of *C. batrachus* in the study area became apparent after examining 28 individuals of which 11 were females, 10 were males, and seven were juveniles. Length and weight of this sample varied from 42.5 to 323.0 mm TL and from 7.0 to 209.9 g, respectively, with values for seven juveniles ranging 42.5–129.0 mm TL and 7.0–15.8 g, respectively […]. Four of the females >185 mm TL had ripening eggs […].”

From Nunkoo et al. (2015):

“The above findings constitute the first report of *C. batrachus* from the wild in Mauritius. *Clarias batrachus* has today established feral populations in Papua New Guinea, Japan, […] Philippines, Taiwan and Sulawesi [Indonesia] (FishBase 2014).”

From Zięba et al. (2010):

“Of particular note with introductions of warmwater species in the UK is the Church Street Canal, St-Helens, Lancashire (Lever 1977), as this location sustained […] a walking catfish *Clarias batrachus* (Linnaeus, 1758), until the nearby power station ceased operations and the canal waters returned to ambient temperatures (Lever 1996). Of these, the walking catfish has recently been found again in open waters […]. A dead, partially decomposed specimen of the Genus *Clarias* […] was discovered by an angler along the River Thames at Woolwich, South-East London […] in March 2009. Using general morphological characteristics and an observed series of lateral white spots (Robins 2008), the specimen was identified as *C. batrachus*. Unlike the specimen found in the Church Street Canal in 1963, which was sustained by the heated waters from a power station, the Thames specimen was found dead, presumably having succumbed to thermal intolerance.”

Silva and Kurukulasuriya (2010) list *Clarias batrachus* as introduced and established in Sri Lanka.

Means of Introduction Outside the United States

From Global Invasive Species Database (2024):

“Introduced into Hong Kong from Thailand for aquaculture, (FishBase, 2003).”

From Bonham and Ng (2010):

“*C. batrachus* has been introduced […] either for the aquaculture or for the ornamental fish trade.”

From Emıroğlu et al. (2020):

“The individuals with calicomorph [coloring] pattern […] in this study supported our molecular data that *C. batrachus* was introduced as a result of the release of aquarium fish, […]”

Short Description

From Global Invasive Species Database (2024):

“*Clarias batrachus* has a broad, flat head and an elongate body which tapers toward the tail. It is readily recognizable as a catfish with four pairs of barbels whiskers and fleshy, papillated lips. The teeth are villiform, occurring in patches on the jaw and palate. Its eyes are small. The dorsal fin is continuous and extends along the back two-thirds of the length of the body but there is no dorsal spine. The dorsal, caudal, and anal fins together form a near-continuous margin; the caudal fin is rounded and not eel-like though it is occasionally fused with the other fins. Its pectoral spines are large and robust and finely serrate along the margins with which it walks accompanied by a back and forth flexion. Their coloration is olive to dark brown or purple to black above, blue green on the sides and white below, with white specks on their rear side.”

From Bonham and Ng (2010):

“*C. batrachus* is similar in size and appearance to *C. macrocephalus* but can be distinguished from the latter species by the shape of the occipital process in the head portion. The occipital process is round-shaped in *C. macrocephalus* but pointed in *C. batrachus*. Unlike *C. macrocephalus, C. batrachus* does not have large numbers of small white spots along the sides of its body (Teugels et al., 1999). *C. batrachus* lacks an adipose fin. […] The mouth is wide and has four pairs of well-developed barbels, with the maxillary barbels reaching to the middle or base of the pectoral fin (Talwar and Jhingran, 1991).”

“The body of the normal coloured variety is greyish to olive in colour with a whitish underside. Other varieties include albino with a white body and reddish eyes, and a pink variety with normal coloured eyes (Axelrod et al., 1971). Various multi-coloured varieties are becoming more common in the tropical fish aquarium trade.”

Biology

From Global Invasive Species Database (2024):

“*Clarias batrachus* feeds on insect larvae, earthworms, shells, shrimps, small fish, aquatic plants and debris.”

“In southeast Asia, spawning period is during the rainy season, when rivers rise and fish are able to excavate nests in submerged mud banks and dikes of flooded rice fields (FishBase, 2003).”

“*Clarias batrachus* engages in mass spawning migrations in late spring and early summer. Inundated rice paddy fields have been reported as favored spawning grounds over its native range. The pair manifests the 'spawning embrace' which is widely observed in other catfish species. Mating occurs repeatedly for as long as 20 hours. The pair gently nudge each other in

the genital region and flick their dorsal fins; male wraps his body around the female, then the female releases a stream of hundreds to thousands of adhesive eggs into the nest or on submerged vegetation. Males guard the nests and embryos hatch in about 30 hours. Both parents guard fry for about three days, when they develop barbles visible to the naked eye and swim freely (GSMFC, 2006; FishBase, 2009, Ros, [2004]).”

From Bonham and Ng (2010):

“Choudhary et al. (1990) reported that *Clarias batrachus* is a euryphasic, omnivorous bottom feeder, with juveniles being predominantly insectivorous and adults being omnivorous with a higher preference towards animal food. *C. batrachus* is a voracious feeder throughout the year in the wild and can swallow prey whole. *C. batrachus* can lay buried in moist mud for prolonged periods of time and remains dormant during cold dry months until the rainy season (Courtenay et al., 1974).”

From Froese and Pauly (2024a):

“Facultative air-breathing [Müller et al. 2022]; Adults inhabit lowland streams [Vidthayanon 2002], swamps, ponds, ditches, rice paddies, and pools left in low spots after rivers have been in flood [Herre 1924, Vidthayanon 2002]. Usually confined to stagnant, muddy water [Rahman 1989]. Found in medium to large-sized rivers, flooded fields and stagnant water bodies including sluggish flowing canals [Taki 1978]. Undertake lateral migrations from the Mekong mainstream, or other permanent water bodies, to flooded areas during the flood season and returns to the permanent water bodies at the onset of the dry season [Sokheng et al. 1999]. Can live out of water for quite sometime and move short distances over land [Talwar and Jhingran 1991]. Can walk and leave the water to migrate to other water bodies using its auxiliary breathing organs”

Human Uses

From Froese and Pauly (2024a):

“Fisheries: commercial; aquaculture: commercial; aquarium: commercial”

From Global Invasive Species Database (2024):

“An important food fish that is marketed live, fresh and frozen. (FishBase, 2003)”

Diseases

No information was found associating *Clarias batrachus* with any diseases listed by the World Health Organisation for Animal Health (2024).

According to Bonham and Ng (2010), *Clarias batrachus* can be a host to the following parasites and pathogens: *Aeromonas hydrophila* (causative agent of Aeromonas infection in fish), *Bovienia serialis*, *Chilodonella* sp. (causative agent of chilodonellosis), *Dactylogyrus* sp., *Edwardsiella ictaluri* (causative agent of enteric septicaemia of catfish), fungal diseases of catfish, *Gyrodactylus* sp., *Lytocestus* sp., *Pallisentis* sp., *Procamallanus* sp., and *Trichodina* sp.

According to Poelen et al. (2014), *Clarias batrachus* can be a host to the following additional parasites and pathogens: *Acanthogyrus tilapiae*, *Anacornuatus postbifidus, Aploparaksis* sp.*, Ascaridia alatae, Bilobulata georgievi, Bovienia indica, Bovienia nagpurensis, Bovienia raipurensis, Bovienia serialis, Bychowskyella tchangi, Camallanides lucknowensis, Camallanus anabantis*. *Capingentoides srivastavai, Centrorhynchus betharidae, Cleaveius durdanae, Clinostomoides brieni, Clinostomum complanatum, Dactylogyrus vastator, Djombangia penetrans, Furconema viviparous, Gauhatiana batrachii, Gnathostoma spinigerum, Gyrodactylus fernandoi, Haplodidentus indicus, Haplorchis yokogawai, Hysterothylacium yaradensis, Lucknowia fossilisi, Lucknowia microcephala, Lytocestoides ajanthii, Lytocestus filiformis, Lytocestus fossilisi, Lytocestus indicus, Masenia dayali, Masenia gwaliorensis, Moravekia chotanagpurensis, Neolytocestus vitellodiscontinutus, Opecoelus minimus, Orientocreadium batrachoides, Pallisentis gaboes, Phyllodistomum folium, Posthodiplostomum grayii, Posthodiplostomum minimum, Procamallanus mysti, Procamallanus planoratus, Procamallanus spiculogubernaculus, Prosorhynchus clarias, Pseudocaryophyllaeus ritai, Pseudocaryophyllaeus tenuicollis, Pycnadena bariliusi, Quadriacanthus gyrocirrus, Quadriacanthus kobiensis,* Roundworm, and *Spinitectus batrachus.*

In addition to the pathogens and parasites listed above, Froese and Pauly (2024b) report *Clarias batrachus* as a host to the following: *Acanthocephalus parallelcementglandatus, Allocreadium handiai, Allocreadium nagendrai, Allocreadium raipurense, Astiotrema reniferum, Clinostomum brieni, Clinostomoides rai, Clinostomum dasi, Clinostomum ophicephali, Diplostomulum batrachi, Diplostomulum tulsipurensis, Masenia proteropora, Orientocreadium clariae, Gauhatiana batrachii, Hamatopeduncularia batrachi, Lytocestus alii, Lytocestus longicollis, Lytocestus paithanensis, Lytocestus sahayi, Masenia collata, Neascus shahjahanpurensis, Opegaster minima, Orientocreadium lucknowensis, Orientocreadium mahendrai, Orientocreadium pseudobagri, Orientocreadium vermai, Phyllodistomum batrachii, Phyllodistomum guptai, Procamallanus (Procamallanus) clarius, Satyapalia vinodae*, and *Tetracotyle fotedari*.

Threat to Humans

From Froese and Pauly (2024a):

“Potential pest”

3 Impacts of Introductions

From Bonham and Ng (2010):

“Its ability to ‘walk’ over land aided by its pectoral fins, combined with high fecundity and voracious feeding habits have led to this species becoming both a threat to native fish species and an invader of fish farms.”

“In the 1970s, this exotic catfish species expanded to more than 25% of the freshwater area of Florida (Courtenay, 1978) and is considered as one of the most invasive and harmful non-indigenous species in the Gulf of Mexico [Gulf of America] ecosystem. […] Courtenay and

Miley (1975) reported that in small wetland pools during the dry season, *C. batrachus* can quickly become the dominant species due to its air-breathing abilities."

"In the Philippines, the exotic *C. batrachus* has displaced many of the native catfish species including the indigenous *Clarias macrocephalus* in irrigation canals, lakes and rivers (Juliano et al., 1989). In Taiwan, the faster growth of the introduced *C. batrachus* has led to the diminished importance of the local *Clarias fuscus* as a cultured species (Liao and Lia, 1989). In both these countries, despite the obvious economic benefits from aquaculture of an introduced species, the demand for the local indigenous catfish species is still higher and commands a better market value."

From Global Invasive Species Database (2024):

"*Clarias batrachus* in South Florida are known to invade commercial aquaculture facilities, often consuming vast numbers of the stocks of fishes (Robins, undated). The impacts from this opportunist feeder are probably most pronounced in small, isolated wetland ponds where walking catfish quickly consume or outcompete other resident populations to become the dominant species in the pond. Resident centrarchids (freshwater sunfish) and native catfish species appear particularly susceptible to impacts from this invader (Masterson, 2007). *C. batrachus* can also negatively impact native amphibian populations by preying on tadpoles. The ability of walking catfish to exploit isolated, ephemeral water bodies allows them to access tadpole prey stocks that other fish cannot reach (Masterson, 2007)."

From Nico et al. (2024):

"In Florida, walking catfish are known to have invaded aquaculture farms, entering ponds where these predators prey on fish stocks. In response, fish farmers have had to erect protective fences to protect ponds (Courtenay and Stauffer 1990). Loftus (1988) reported heavy predation on native fishes in remnant pools during seasonal drying of wetlands. Baber and Babbitt (2003) examined predation impacts on tadpole assemblages in temporary wetlands in south-central Florida, and found that native fishes (e.g., eastern mosquitofish *Gambusia holbrooki*, golden topminnow *Fundulus chrysotus*, flagfish *Jordanella floridae*) had larger impacts and higher predation rates on tadpoles than *C. batrachus*."

From Silva and Kurukulasuriya (2010):

"*Clarias batrachus*, which is another predator, has also contributed to the direct exploitation of native species [in Sri Lanka] (Weerawardane and Dissanayake, 2005)."

All species in the family Clariidae were officially listed as injurious wildlife species by the U.S. Fish and Wildlife Service in 1970 (USFWS 2022). *Claria batrachus* is also regulated by name in 8 U.S. States, as part of genus *Clarias* in 5 States, and as part of family Clariidae in 14 States. See section 1.

4 History of Invasiveness

The History of Invasiveness for *Clarias batrachus* is classified as High. *C. batrachus* has been introduced and become established outside of its native range. In the United States, it has become established in Florida and has been recorded, but failed to become established, in California, Connecticut, Georgia, Guam, Massachusetts, and Nevada. Established nonnative populations can also be found in southern Asia outside of its native range and in thermally regulated waters in Turkey. *C. batrachus* are present in trade pathways, as they are used for food, aquaculture stock, and in the aquarium and pet trade. They are reported to invade and prey heavily on stock in aquaculture systems, leading to economic losses. In the Philippines, *C. batrachus* has displaced native catfish species.

5 Global Distribution

Figure 1. Reported global distribution of *Clarias batrachus*. Map from GBIF Secretariat (2023). Observations are reported from the United States, India, China, Taiwan, Philippines, Indonesia, Papua New Guinea, Nepal, Bangladesh, Laos, Vietnam, Singapore, Thailand, Cambodia, Brunei Darussalam, and Myanmar. Observations in northern China and in the United States outside of Florida do not represent established populations and were not used in the climate matching analysis.

Geographic distribution of *Clarias batrachus* in Sri Lanka was given in Silva and Kurukulasuriya (2010).

The location of an established population in Pınarbaşı Stream, part of the Sakarya River drainage, Turkey was given in Emıroğlu et al. (2020). This waterway is fed by hot springs (Emıroğlu et al. 2016) and was not used in the climate matching analysis as the climate matching program cannot account for thermally regulated waters (USFWS 2024).

Clarias batrachus is established in Japan (Nunkoo et al. 2015) but no georeferenced observations representing the population were available to use in the climate matching analysis. There were

also no georeferenced observations available to represent portions of the described native range in Pakistan (Bonham and Ng 2010).

6 Distribution Within the United States

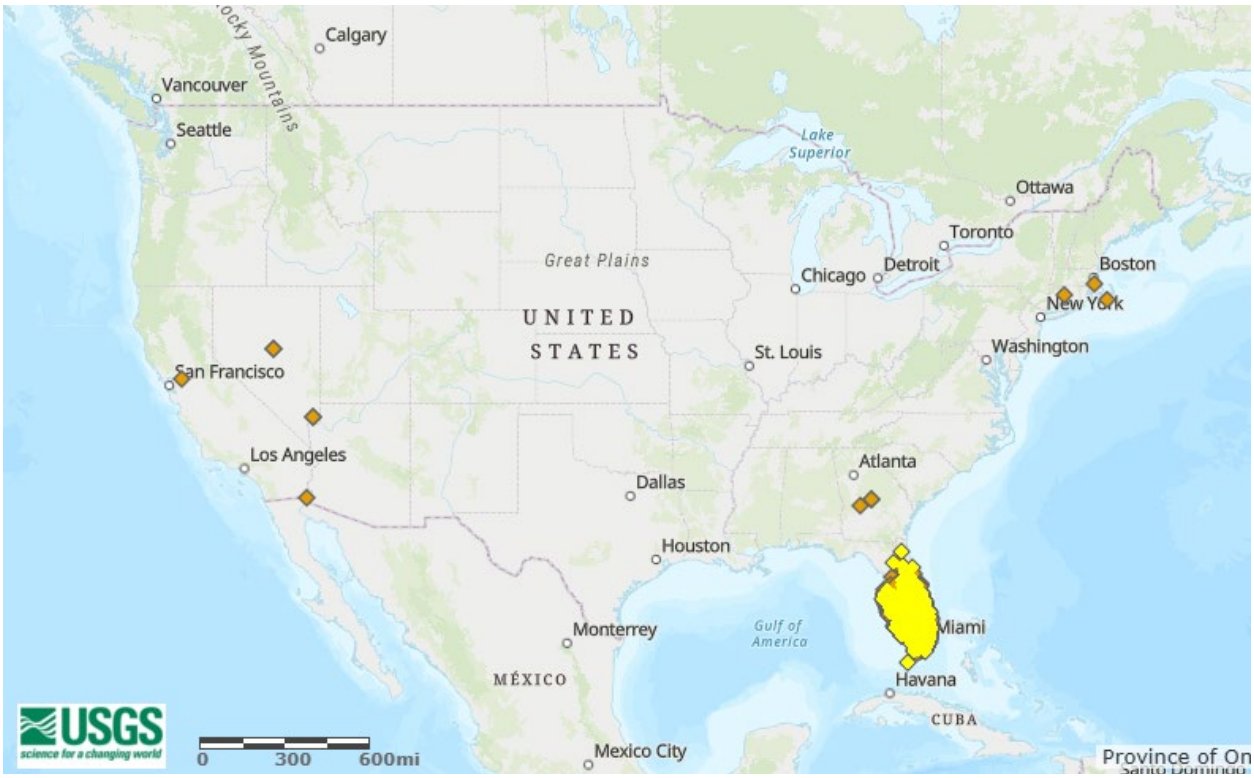

Figure 2. Reported distribution of *Clarias batrachus* in the United States. Map from Nico et al. (2025). Observations are reported from Florida, California, Nevada, Georgia, Massachusetts, and Connecticut. Points indicated with yellow diamonds represent established populations; orange diamonds represent introduction records with failed or unknown status. Only points representing established populations were used in the climate matching analysis.

7 Climate Matching

Summary of Climate Matching Analysis

The climate matching analysis for *Clarias batrachus* to the contiguous United States was high across portions of the Southern Atlantic Coast, in Florida, and in small areas of the Gulf Coast. Central and eastern portions of the United States, as well as southern and central California, had medium climate matches. Areas of low climate match were predicted in portions of the Colorado Plateau, Great Basin, northern Great Lakes, Northeast, Northern Pacific Coast, Northern Plains, and Western Mountains regions. The overall Climate 6 score (Sanders et al. 2023; 16 climate variables; Euclidean distance) for the contiguous United States was 0.068, 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). The climate matching results may underestimate where the species could establish as it has been demonstrated that it can establish in thermally regulated waters which could not be accounted for in this analysis.

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

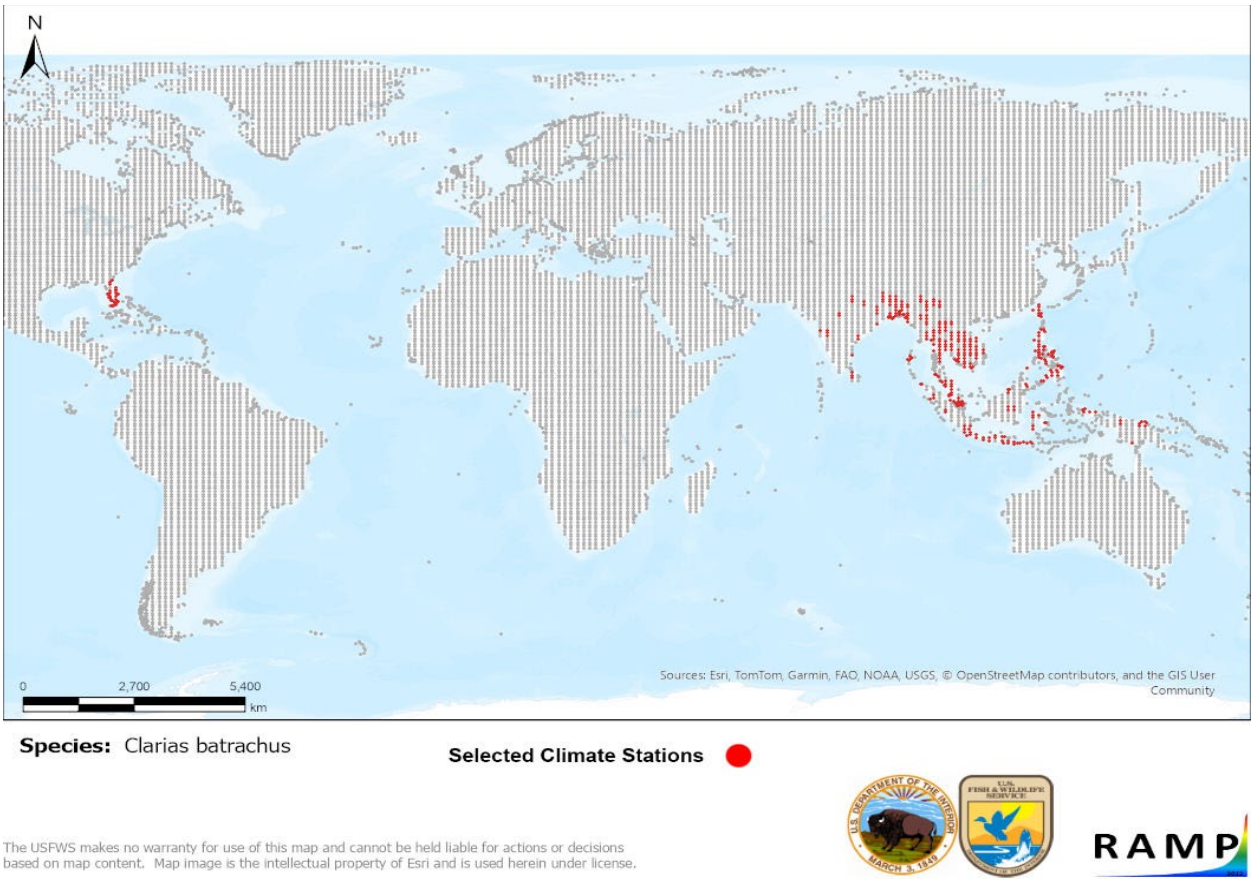

Figure 3. RAMP (Sanders et al. 2023) source map showing weather stations globally selected as source locations (red; Bangladesh, Bhutan, Brunei Darussalam, Cambodia, China, India, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, Nepal, Papua New Guinea, Philippines, Singapore, Sri Lanka, Taiwan, Thailand, United States [Florida], and Vietnam) and non-source locations (gray) for *Clarias batrachus* climate matching. Source locations from Silva and Kurukulasuriya (2010) 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.

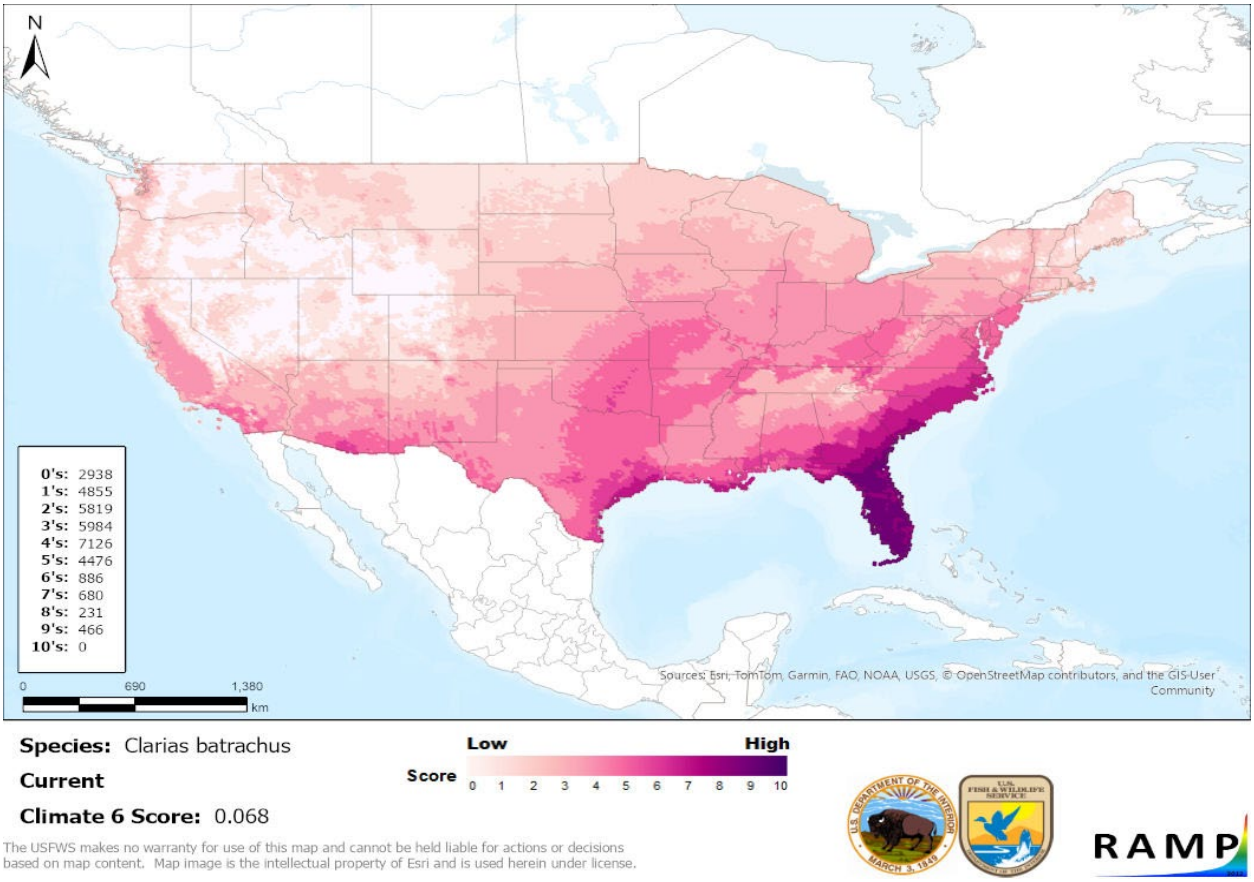

Figure 4. Map of RAMP (Sanders et al. 2023) climate matches for *Clarias batrachus* in the contiguous United States based on source locations reported by Silva and Kurukulasuriya (2010) and GBIF Secretariat (2023). Counts of climate match scores are tabulated on the left. 0/Pale Pink = Lowest match, 10/Dark Purple = Highest match.

8 Certainty of Assessment

The Certainty of Assessment for *Clarias batrachus* is classified as Medium. Information on the biology, ecology, and distribution was available. Records of introduction with establishment outcomes and records of impacts from those introductions were found. The climate matching analysis may underestimate where this species could establish. There was some disagreement on the native range of the species and portions of the species' potential range were not represented in the climate matching analysis. Additionally, the potential for the species to establish in thermally regulated waters was not reflected in the climate matching analysis.

9 Risk Assessment

Summary of Risk to the Contiguous United States

Clarias batrachus, walking catfish, is a fish that is native to southeastern Asia. They inhabit lowland streams, swamps, pond ditches, canals and stagnant water. They are hardy fish that can survive in waters with low oxygen and are facultative air breathers, making them the ideal inhabitants of areas with limited water. *C. batrachus* are an important food source that is marketed, as well as one that is used in aquaculture and aquarium trade. This species has been

introduced through aquaculture and ornamental trade and established nonnative populations in many countries, including the United States. Of note, it has been introduced to and become established in thermally regulated waters in Turkey. *Clarias batrachus* has been documented to invade aquaculture facilities and eat large numbers of stock fish in Florida and have been detrimental to native fish species in Sri Lanka and the Philippines. The History of Invasiveness for *Clarias batrachus* is classified as High. The climate matching analysis for the contiguous United States indicates establishment concern for this species. Florida, where they are established, had high climate match for *C. batrachus*. There are also areas of high climate match along the southern Atlantic and Gulf Coasts. The Certainty of Assessment for this ERSS is classified as Medium due to conflicting information regarding the native range of the species and gaps in representing of the range in the climate matching analysis. General biological and ecological information as well as records of introduction and impact were available. The Overall Risk Assessment Category for *Clarias batrachus* 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): Medium**
- **Remarks, Important additional information: Federally listed as Injurious Wildlife. Can establish in thermally regulated waters.**
- **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 Silva and Kurukulasuriya (2010) and GBIF Secretariat (2023).

Under the future climate scenarios (figure A1), on average, high climate match for *Clarias batrachus* was projected to occur in the Southern Atlantic Coast and Southern Florida regions of the contiguous United States. Areas of low climate match were projected to occur in the Colorado Plateau, Great Basin, Northeast, Northern Pacific Coast, Northern Plains, and Western Mountains regions. The Climate 6 scores for the individual future scenario models (figure A2) ranged from a low of 0.066 (model: GFDL-ESM4, SSP5, 2085) to a high of 0.177 (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 (0.068, 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, areas within the Appalachian Range, California, Colorado Plateau, Great Basin, Great Lakes, Northeast, Northern Pacific Coast, Southern Plains, Southwest, 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 Gulf Coast, 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 changes in climate match from current conditions were more pronounced in time step 2085 than in time step 2055.

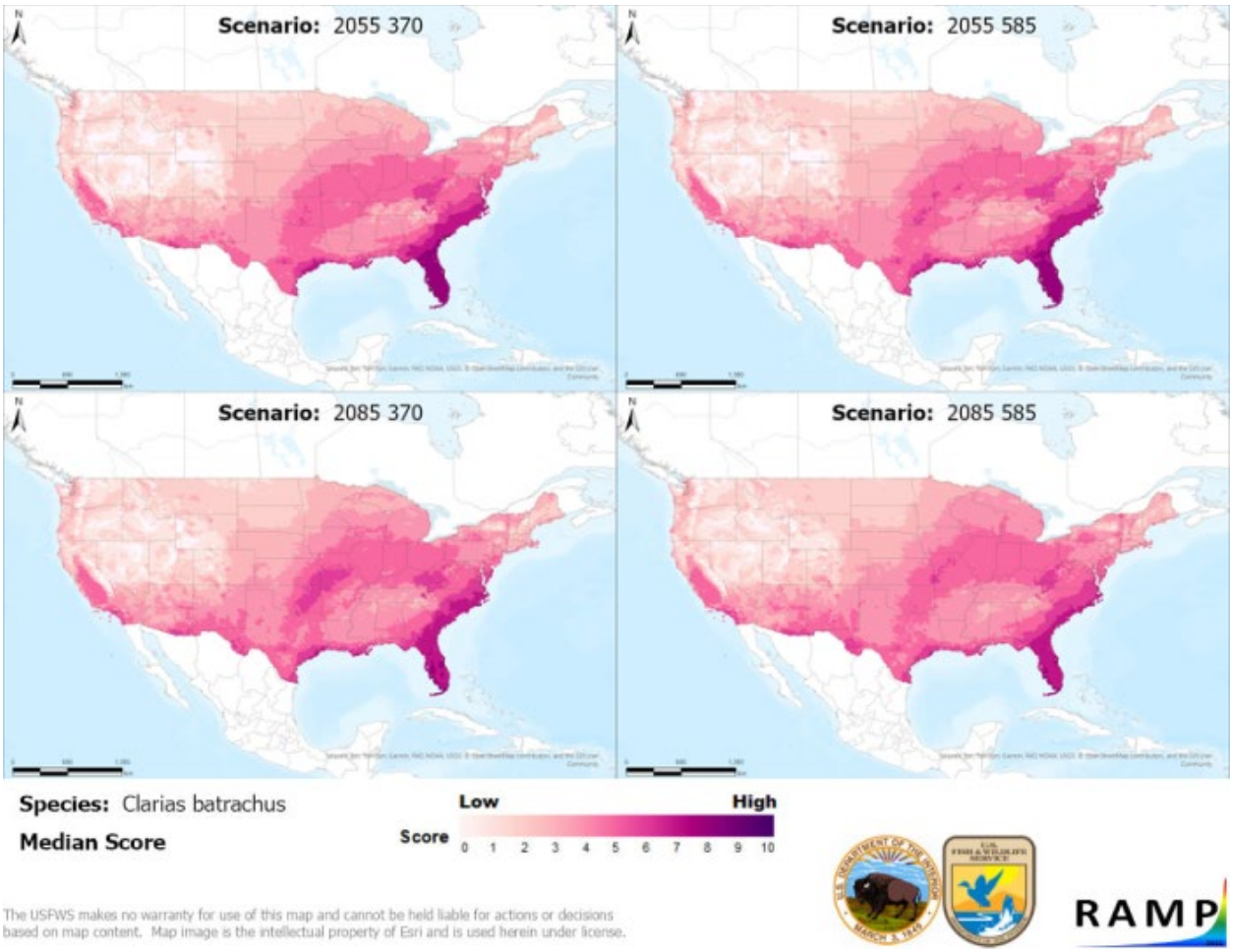

Figure A1. Maps of median RAMP (Sanders et al. 2023) climate matches projected under potential future climate conditions using five global climate models for *Clarias batrachus* in the contiguous United States. Climate matching is based on source locations reported by Silva and Kurukulasuriya (2010) 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.

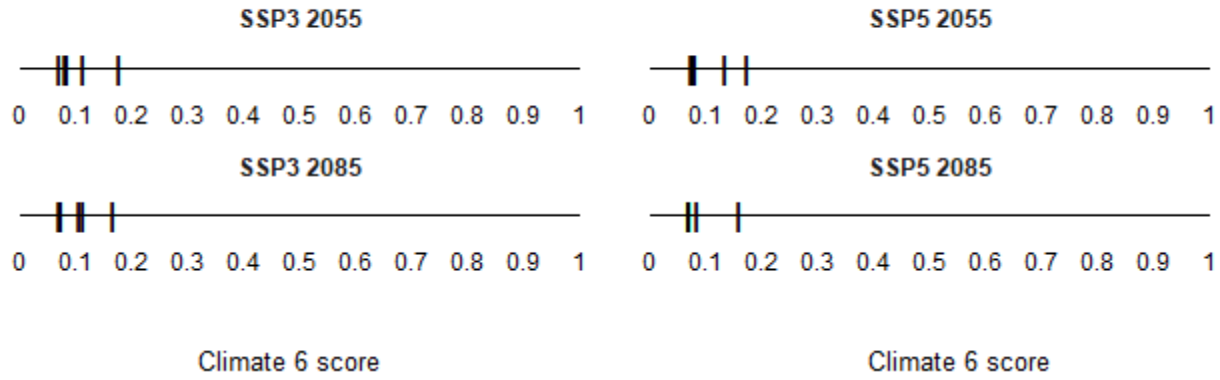

Figure A2. Comparison of projected future Climate 6 scores for *Clarias batrachus* in the contiguous United States for each of five global climate models under four combinations of Shared Socioeconomic Pathway (SSP) and time step. SSPs used (from left to right): SSP3, SSP5 (Karger et al. 2017, 2018;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

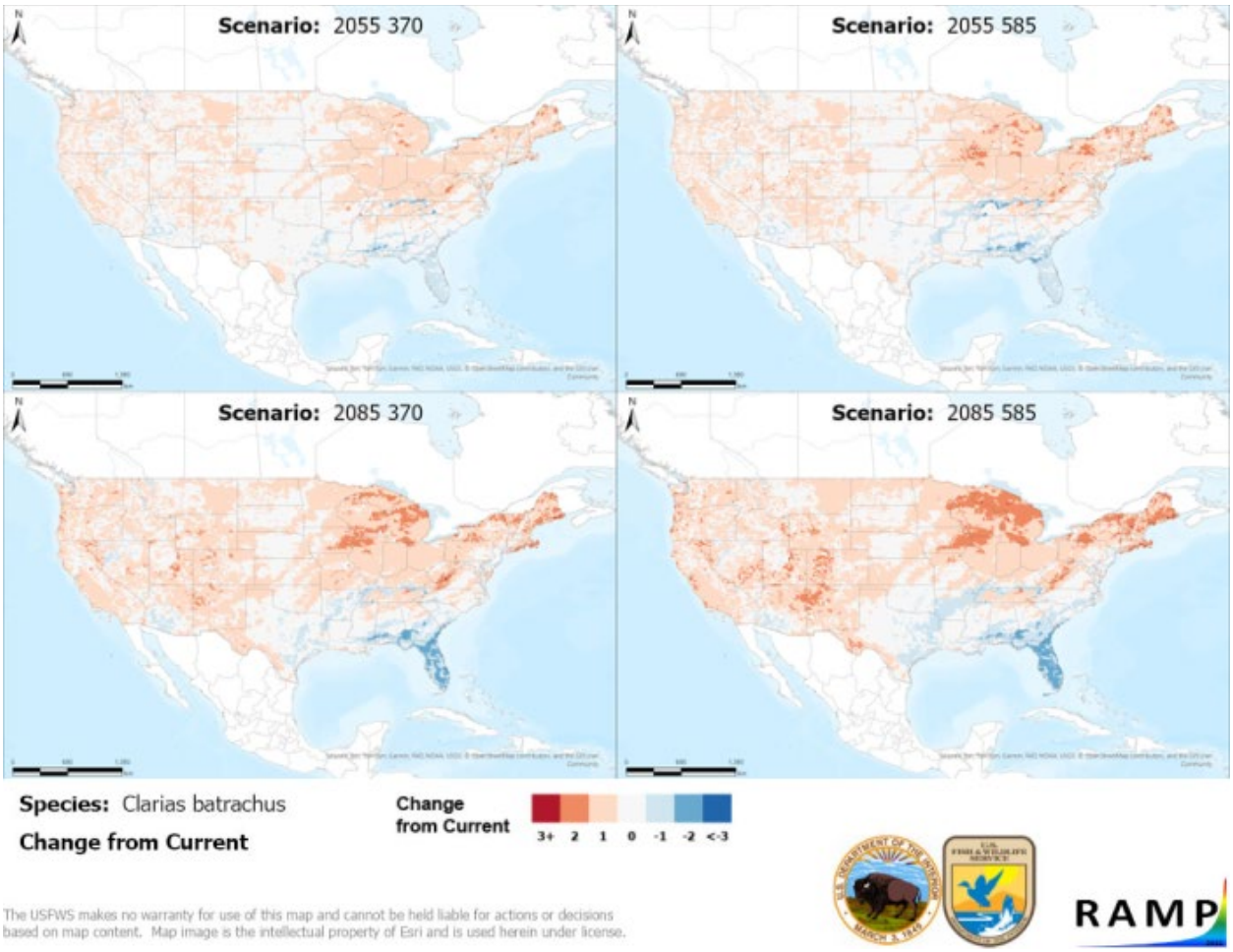

Figure A3. RAMP (Sanders et al. 2023) maps of the contiguous United States showing the difference between the current climate match target point score (figure 4) and the median target point score for future climate scenarios (figure A1) for *Clarias batrachus* based on source locations reported by Silva and Kurukulasuriya (2010) 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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