Smallmouth Buffalo (*Ictiobus bubalus*)
Ecological Risk Screening Summary

U.S. Fish and Wildlife Service, April 2023
Revised, May 2023
Web Version, 3/20/2024

Organism Type: Fish
Overall Risk Assessment Category: Uncertain

Photo: Paul W Ribitzki. Licensed under CC BY-NC 4.0. Available: https://www.inaturalist.org/observations/103722333 (April 2023).

1 Native Range and Status in the United States

Native Range

From NatureServe (2023):

"Range includes the lower Great Lakes, Red River (Hudson Bay), and Mississippi River basins from Pennsylvania and Michigan to Montana and south to Gulf [of Mexico]; Gulf Slope drainages from Mobile Bay, Alabama, to Rio Grande, Texas and New Mexico; also in Mexico; […]"

From Fuller and Hopper (2023a):

“Lake Michigan drainage […]”

From NatureServe and Soto-Galera (2019):

“[…] as far south along Mexico and Usumacinta basin as Guatemala (E. Soto Galera, pers comms 2018). […] westward into Río Bravo basin (including Río Conchos); southward in eastern México, into Río Usumacinta basin, northern Guatemala, Chiapas, Chihuahua, Coahuila, San Luís Potosí, Tabasco, Tamaulipas, Veracruz. (Miller, et al., 2005).”

Status in the United States

From Fuller and Hopper (2023a):

“Native Range: Lake Michigan drainage and Mississippi River basin from Pennsylvania and Michigan to Montana and south to Gulf of Mexico; Gulf Slope drainages from Mobile Bay, Alabama, to Rio Grande, Texas, and New Mexico. […] (Page and Burr 1991).”

“Status: Unknown in most sites in Arizona. Established in Apache Lake, Arizona, and in North and South Carolina. Extirpated in California. Unknown in Wisconsin; still present in the 1960s (Becker 1983). Native to portions of the Great Lakes basin but considered nonindigenous in other locations.”

According to Fuller and Hopper (2023a), nonindigenous occurrences of *Ictiobus bubalus* have been reported in the following States. Range of observation years, watersheds, and population status (one or more watersheds) where reported in parentheses.

- Arizona (1918-2017; Lower Colorado Region, Lower Salt, Moenkopi Wash, Upper Salt; established)
- California (1979; California Region; extirpated)
- New York (2014; Lake Erie; unknown)
- North Carolina (1986-2017; Lower Pee Dee, Nolichucky, Rocky, Upper Catawba, Upper French Broad, Upper Neuse (failed), Upper Pee Dee, Upper Yadkin; established)
- Ohio (1984-2017; Cedar-Portage, Chautauqua-Conneaut, Lake Erie; established)
- Oklahoma (1962-2003; Deep Fork, Lower Beaver, Lower Canadian, Lower Canadian-Deer, Lower Canadian-Walnut, Lower Cimarron-Eagle Chief, Lower North Canadian, Middle North Canadian; established)
- South Carolina (1986-2009; Carolina Coastal-Sampit, Lower Broad, Lower Catawba, Lower Pee Dee, Santee, Upper Broad, Upper Catawba, Wateree; established)
- Texas (1959-2017; Cibolo-Red Light, Denton, East Galveston Bay, Hubbard, Lower West Fork Trinity, Terlingua, Upper West Fork Trinity; established)
- Wisconsin (1965; Flambeau, Ontonagon; established)

Figure 1. Non-native collection records (red circles) and native range (orange shading) for *Ictiobus bubalus* in the contiguous United States. Map adapted from Fuller and Hopper (2023a).

No live individuals of *Ictiobus bubalus* were found for sale online in the United States, but there are occasional references to aquaculture production of the species. For example, Mischke et al. (2006) report that, as of the early 2000s, "[…] at least one commercial catfish producer in Mississippi currently cultures smallmouth buffalo for sale."

Regulations

Ictiobus bubalus is listed as an approved commercial aquaculture species in Arkansas and requires appropriate permits for importing, trading within the state, and use for commercial aquaculture purposes (Arkansas Game and Fish Commission 2022).

Ictiobus bubalus is listed as a species that requires a permit to import, possess, or sell in Virginia (Virginia Department of Wildlife Resources 2022).

All species in the *Ictiobus* genus are classified as restricted in the State of California (California Department of Fish and Wildlife 2021).

While every effort has been made to list all applicable State laws and regulations pertaining to this species, this list may not be comprehensive.

Means of Introductions within the United States

From Fuller and Hopper (2023a):

"Accidental introduction in Arizona in 1918 with bigmouth buffalo *I. cyprinellus* (Minckley 1973; Rinne 1994); unknown means in California, and South Carolina. Likely stocked in North

Carolina (Leach 1921, 1923). Stocked in Wisconsin during fish rescue operations from the Mississippi River in the 1930s (Becker 1983)."

Remarks

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

From Fuller and Hopper (2023a):

"In the early 1900s all three species of buffalofishes were stocked; *I. bubalus*, *I. cyprinellus*, and *I. velifer* (Leach 1921, 1923). However, when the stockings were reported they were lumped together as "buffalofish" and it is not possible to determine which species were planted. Stocking of buffalofishes occurred outside their native ranges in Lake Erie in Ohio, the Pee Dee and Catawba drainages in North Carolina, and in unknown locations in Massachusetts (Leach 1921, 1923)."

From Fuller and Hopper (2023a):

"Common hybridization among buffalo species has caused difficulty in identifying individual species (Dahline 2014)."

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 Ostariophysi
Order Cypriniformes
Superfamily Cobitoidea
Family Catostomidae
Subfamily Ictiobinae
Genus *Ictiobus*
Species *Ictiobus bubalus* (Rafinesque, 1818)

According to Fricke et al. (2023), *Ictiobus bubalus* is the current valid name for this species.

Size, Weight, and Age Range

From Froese and Pauly (2024):

"Max length: 112 cm TL [total length] male/unsexed; [IGFA 2001]; common length: 58.5 cm TL male/unsexed; [Hugg 1996]; max. published weight: 37.3 kg [IGFA 2001]; max. reported age: 15 years [Hugg 1996]"

Environment

From NatureServe (2023):

"Habitat includes pools, oxbow lakes, and deeper waters of large rivers; sometimes backwaters and mouths of smaller rivers; reservoirs and lakes. This species prefers clean to moderately turbid, deep, warm waters (Sublette et al. 1990). In Texas, habitats with abundant aquatic vegetation and silt bottoms were most productive (see Sublette et al. 1990)."

From Fuller and Hopper (2023a):

"The Smallmouth Buffalo is known to be found in faster flowing waters […] observed to prefer deeper water and […] exhibits a preference for fine substrates (Becker 1983)."

From NatureServe and Soto-Galera (2019):

"In Mexico, its habitat seems to be limited to the middle and upper portions of the basins where it is distributed, where temperate temperatures and high concentrations of dissolved oxygen occur (Soto-Galera et al. 2011)."

Climate

From Froese and Pauly (2023):

"Temperate; […]; 5°N - 26°N"

Distribution Outside the United States

Native

A portion of the species' native range occurs within the United States, see Native Range in Section 1.

From NatureServe and Soto-Galera (2019):

"[…] as far south along Mexico and Usumacinta basin as Guatemala (E. Soto Galera, pers comms 2018). […] westward into Río Bravo basin (including Río Conchos); southward in eastern México, into Río Usumacinta basin, northern Guatemala, Chiapas, Chihuahua, Coahuila, San Luís Potosí, Tabasco, Tamaulipas, Veracruz. (Miller, et al., 2005)."

Introduced
From Vassiley and Pehlivanov (2005):

"In Bulgaria it was introduced from Russia in 1977 (Karapetkova, Žhivkov, 1995) together with other Buffalos for fish-farming. Now it occurs in Kardzhali and Ovcharitsa dams (South-East Bulgaria)."

According to Kamilov and Urchinov (1995), *Ictiobus bubalus* were stocked in pond fish farms in Uzbekistan.

From EIFAC (1982):

"Romania has been the recipient of 15 non-native fishes since the last century [Bacalbasa-Dobrovici 1982]. Those of foreign origin include […] smallmouth buffalo (*Ictiobus bubalus*), largemouth buffalo (*I. cyprinellus*), black buffalo, (*I. niger*) […] all three buffalo […] are established."

According to FAO (2023), *Ictiobus bubalus* are stocked in Hungary for aquaculture purposes. Froese and Pauly (2024) report that this population is maintained by continuous restocking.

Means of Introduction Outside the United States

According to Vassiley and Pehlivanov (2005), Kamilov and Urchinov (1995), Welcomme (1988), and FAO (2023), *Ictiobus bubalus* were introduced through stocking for fish-farming and aquaculture purposes.

Short Description

From Fuller and Hopper (2023a):

"The body of Smallmouth Buffalo (*Ictiobus bubalus*) is deep and highly compressed. Fins are slate brown in color, the back bronze or slate olive, and sides bronze. Colors lighten with age. The snout is blunt with a small, ventral horizontal mouth. […] The dorsal fin of Smallmouth Buffalo is sickle shaped […]."

Biology

From NatureServe (2023):

"Spawns in spring and summer, the date depending on locality. Eggs hatch in 1-2 weeks. Sexually mature in one to several years, at younger age in south than in north (Becker 1983)."

"Spawning occurs in quiet pools, backwaters, flooded marshes, and meadows. Eggs sink and adhere to objects."

"Feeds opportunistically on benthic organisms, animal and plant (Becker 1983). Major foods of young include cladocerans, copepods, and algae; adults eats various insects, crustaceans,

mollusks, other invertebrates, algae, and plant material. Feeds primarily in shallow shoreline areas in reservoirs. (Sublette et al. 1990)."

From Froese and Pauly (2024):

"Feeds on shellfish and algae, by grinding with the bony plates in its throat [Frimodt 1995]."

From Fuller and Hopper (2023a):

"The Smallmouth Buffalo begins spawning in April to early June at temperatures of 15.6-18.3°C (Becker 1983). 18,000-500,000 adhesive eggs per female are randomly disturbed over any substrate. Smallmouth Buffalo have a possible preference for spawning over submerged vegetation (Etnier and Starnes 1993). Spawning has been observed to be the most successful in years when water levels rise during the spring to flood marshes or low-lying meadows (Becker 1983)."

"The diet of *Ictiobus bubalus* under one year old is composed of copepods and cladocerans. Other food sources for young include algae, duckweed, protozoans, rotifers, insect larvae, and insect eggs. When mature, *Ictiobus bubalus* is an opportunistic feeder, feeding on organisms that are most abundant. The primary source of food depends on where the species is found (Becker 1983)."

Human Uses

From Froese and Pauly (2024):

"Fisheries: commercial; gamefish: yes"

"Appears to be a good candidate for aquaculture. Marketed fresh and eaten pan-fried, broiled and baked [Frimodt 1995]."

Diseases

***Ictiobus bubalus* can carry spring viraemia of carp virus and viral hemorrhagic septicemia which are listed by the World Organisation of Animal Health (2023).**

According to Poelen et al. (2014), *Ictiobus bubalus* hosts the following parasites or pathogens: *Acanthocephala* sp., *Bialovarium giganteum, Camallanus* sp., *Camallanus ancylodirus, Capingens singularis,* Carp sprivivirus, *Caryophyllaeus* sp., *Cestodaria* sp., *Digenea* sp., *Glaridacris* sp., *Glaridacris confuse, Glaridacris laruei, Lissorchis gullaris, Monobothrium ingens, Nematobothrium* sp., *Nematobothrium texomensis, Neodiscocotyle carpioditis, Neoechinorhynchus strigosus,* Novirhabdovirus piscine, *Pellucidhaptor alahamus, Pellucidhaptor dicerobasis, Pomphorhynchus* sp., *Proteocephalus* sp., *Pseudolytocestus differtus, Triganodistomum ranslucens,* spring viraemia of carp virus, and viral hemorrhagic septicemia virus.

Threat to Humans

From Deeds et al. (2022):

"In the United States, buffalofish (*Ictiobus* spp.) are sporadically associated with sudden onset muscle pain and weakness due to rhabdomyolysis within 24 h of fish consumption (Haff disease). […] In contrast to previous reports that *I. cyprinellus* is the causative species in US cases, data indicate that all three buffalofish species are harvested but *I. bubalus* is most often associated with illness."

3 Impacts of Introductions

Although *Ictiobus bubalus* has been reported as introduced beyond its native range, the impacts of these introductions are uncertain.

From Fuller and Hopper (2023a):

"The impacts of this species are currently unknown, as no studies have been done to determine how it has affected ecosystems in the invaded range. The absence of data does not equate to lack of effects. It does, however, mean that research is required to evaluate effects before conclusions can be made."

This species is regulated in California, Arkansas, and Virginia. More detail about regulations can be found in Section 1.

4 History of Invasiveness

The History of Invasiveness for *Ictiobus bubalus* is classified as Data Deficient. Although established populations of *I. bubalus* have been found outside of its native range, there was no information found regarding actual impacts of introduction. Although *I. bubalus* is sold and used for commercial and sport fish stocking, there were no records found quantifying the duration or number of individuals in live trade.

5 Global Distribution

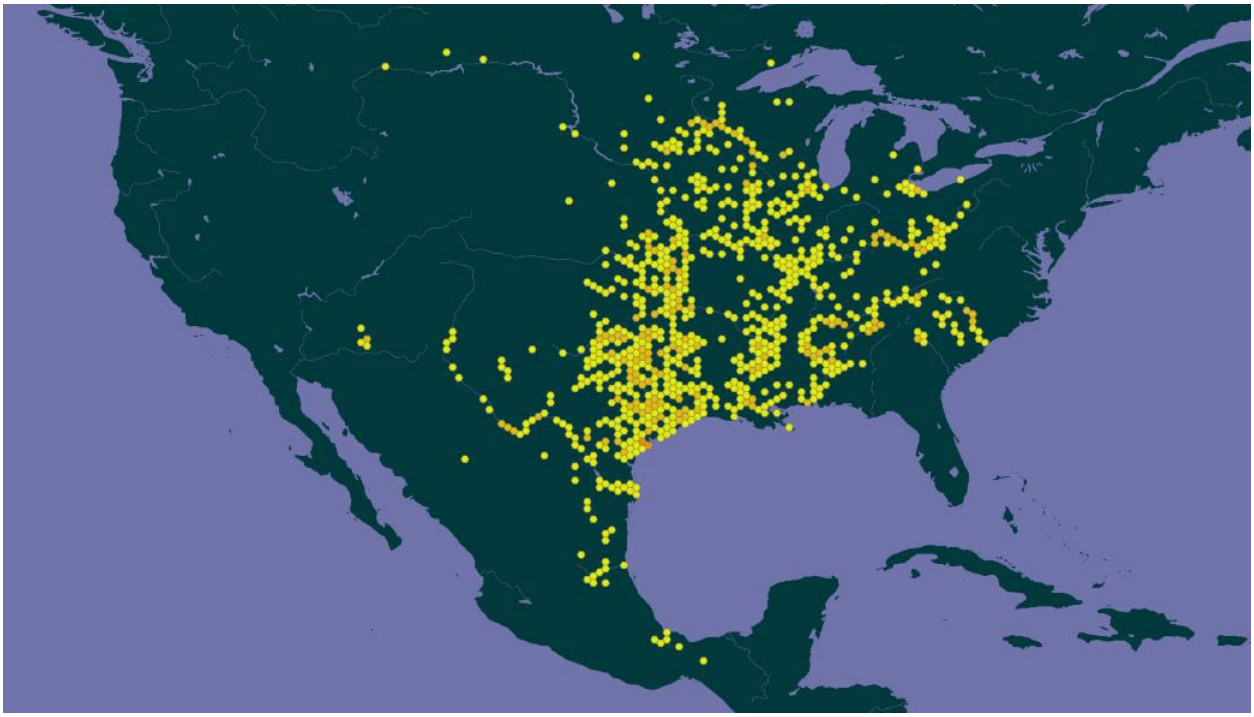

Figure 2. Known global distribution of *Ictiobus bubalus*. Observations were mainly in the Lower Great Lakes and Mississippi River basin, from Pennsylvania to Montana, south to the Gulf slope drainages and Rio Grande basin from New Mexico to Texas and Mexico as well as the Río Usumacinta basin in Mexico. Map from GBIF Secretariat (2022). The points in Michigan and northeast Minnesota were not found to be indicative of established populations and were excluded from the climate matching analysis.

No georeferenced occurrences were available for established populations of *I. bubalus* in Bulgaria and Romania.

6 Distribution Within the United States

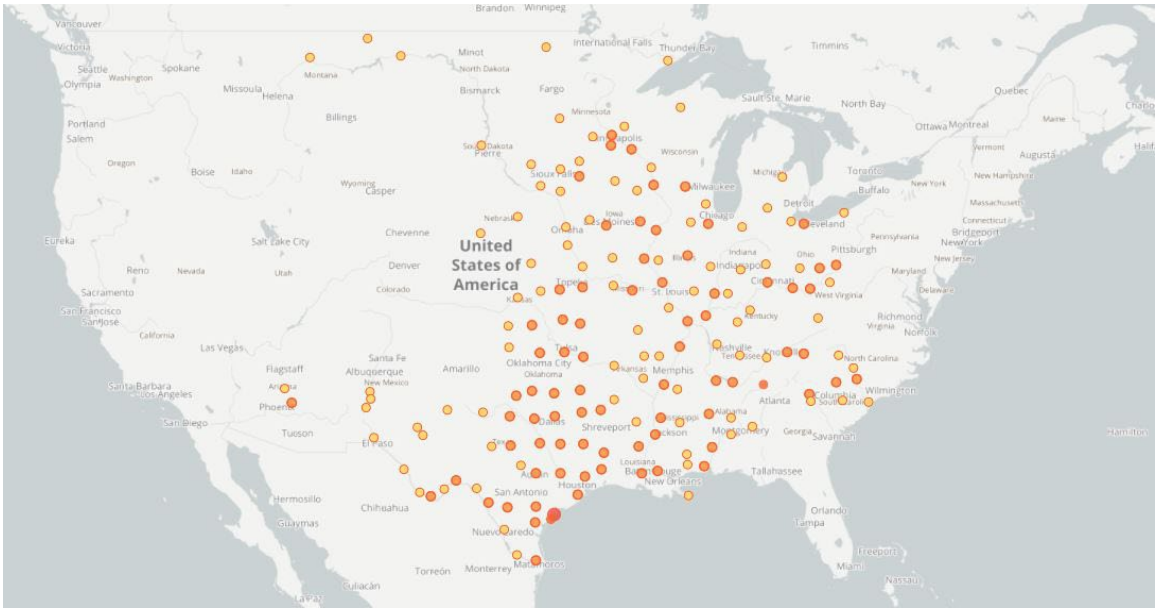

Figure 3. Reported distribution of *Ictiobus bubalus* in the United States. Map from GBIF-US (2023). Observations were mainly in the Lower Great Lakes and Mississippi River basin, from Pennsylvania to Montana, south to the Gulf slope drainages and Rio Grande basin from New Mexico to Texas. Observations were also found in the States of Arizona, North Carolina, and South Carolina. The points in Michigan and northeast Minnesota were not found to be indicative of established populations and were excluded from the climate matching analysis.

7 Climate Matching

Summary of Climate Matching Analysis

The climate match for *Ictiobus bubalus* in the contiguous United States was generally high east of the Rocky Mountains, including regions in and around the Mississippi River and Rio Grande basin, the Great Plains, the Midwest and Great Lakes region, Northeast, Southeast, and the Southwest. Medium matches were found in the Rocky Mountains and low matches were restricted to the coastal Pacific Northwest and Cascade-Sierra Mountains. The overall Climate 6 score (Sanders et al. 2023; 16 climate variables; Euclidean distance) for the contiguous United States was 0.868, indicating that Yes, there is establishment concern for this species outside its native range. 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 *Ictiobus bubalus* (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.

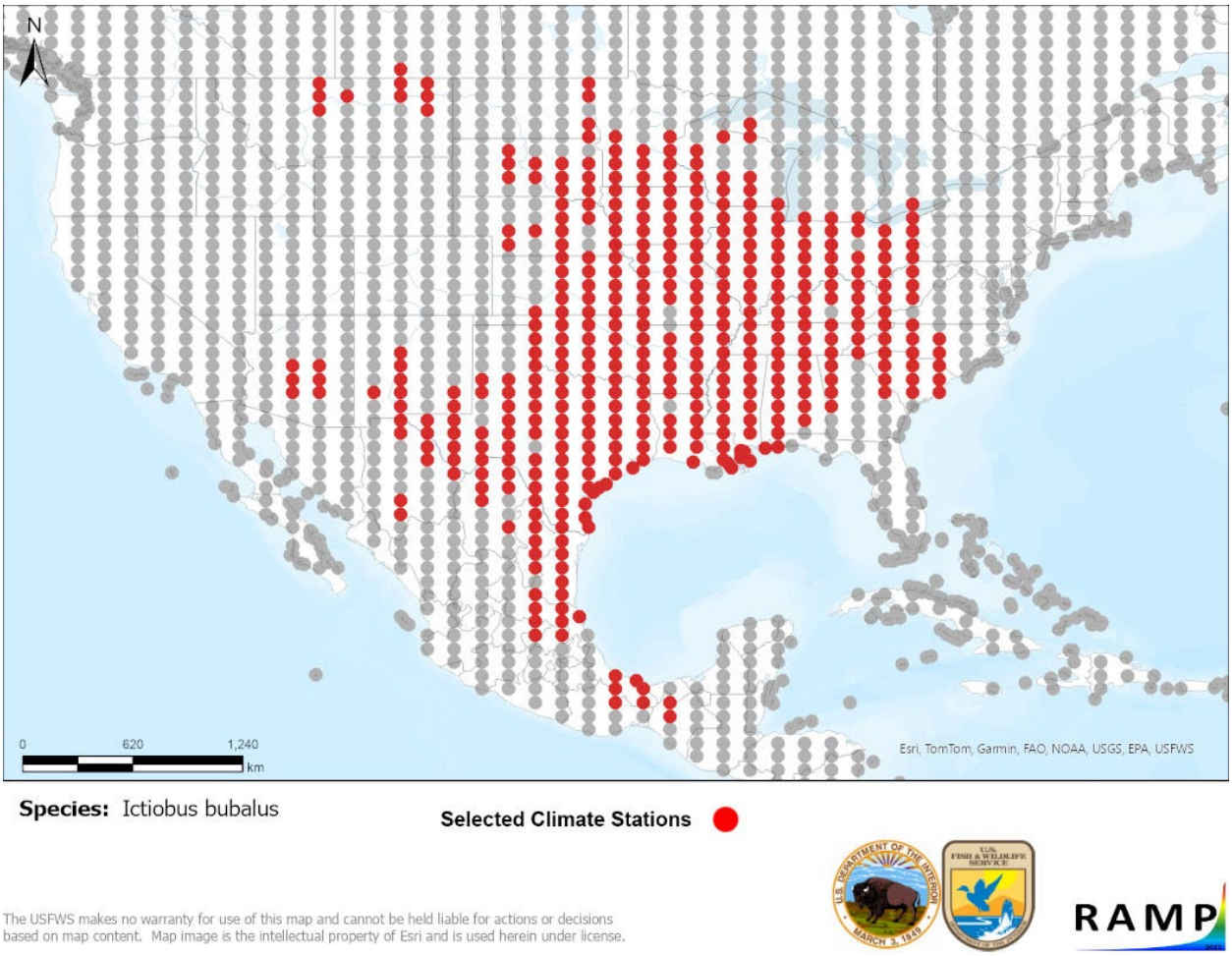

Figure 4. RAMP (Sanders et al. 2023) source map showing weather stations within the United States down to Mexico (red; Alabama, Arizona, Arkansas, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, New Mexico, North Carolina, North Dakota, Ohio, Oklahoma, South Carolina, South Dakota, Tennessee, Texas, Virginia, West Virginia, and Wisconsin, United States; Chiapas, Chihuahua, Coahuila, Guanajuato, Hidalgo, Nuevo León, Oaxaca, Queretaro, San Luis Potosí, Tabasco, Tamaulipas, and Veracruz, Mexico) and non-source locations (gray) for *Ictiobus bubalus* climate matching. Source locations are from GBIF Secretariat (2022). Selected source locations are within 100 km of one or more species occurrences, and do not necessarily represent the locations of occurrences themselves.

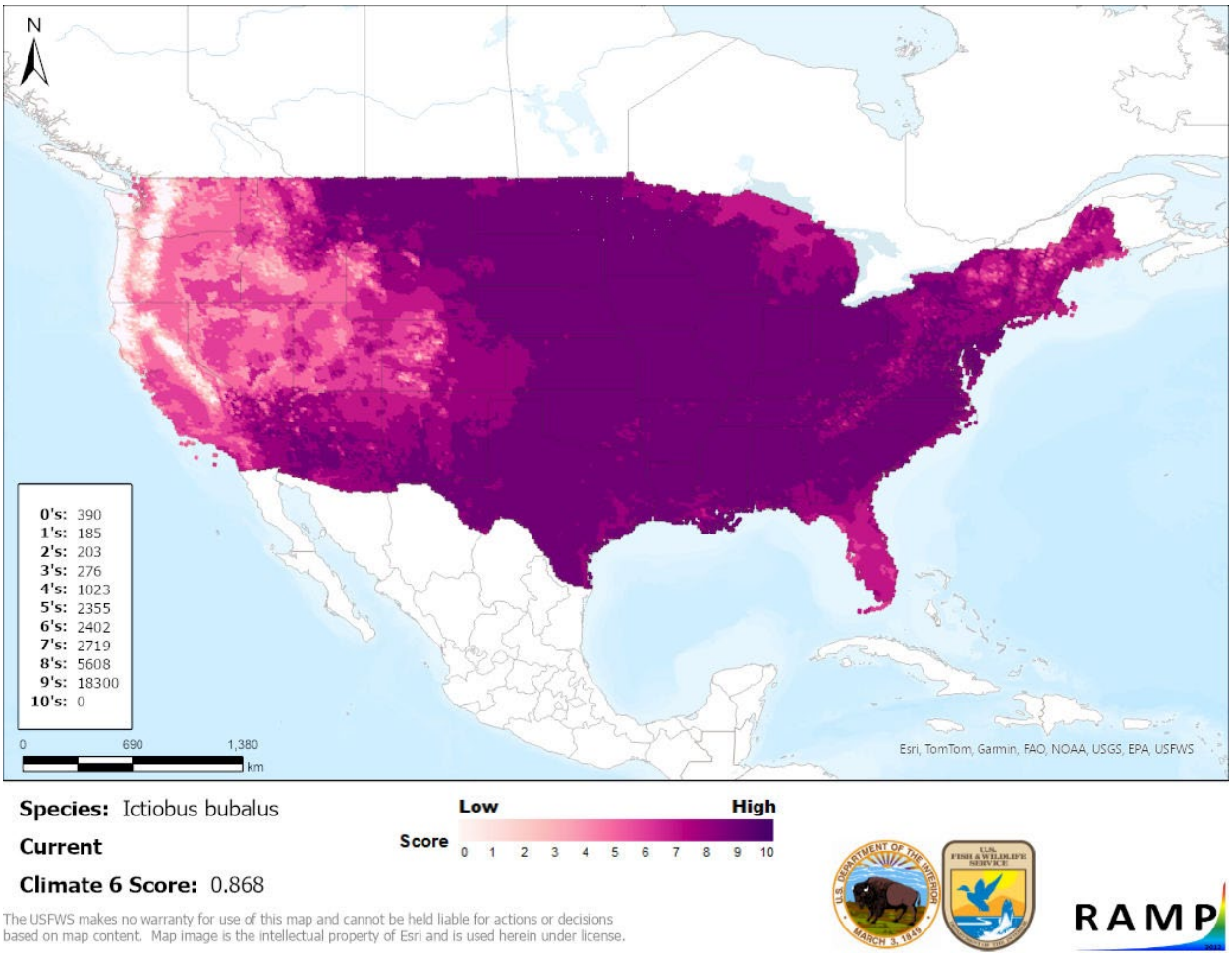

Figure 5. Map of RAMP (Sanders et al. 2023) climate matches for *Ictiobus bubalus* in the contiguous United States based on source locations reported by GBIF Secretariat (2022). Counts of climate match scores are tabulated on the left. 0/Pale Pink = Lowest match, 10/Dark Purple = Highest match.

8 Certainty of Assessment

The Certainty of Assessment for *Ictiobus bubalus* is classified as Low. Information is available on the biology, ecology, and distribution of *I. bubalus*. However, no information is available on actual impacts of introduction and although *I. bubalus* is sold and used for commercial and sport fish stocking, there were no records found quantifying the duration or number of individuals in-trade.

9 Risk Assessment

Summary of Risk to the Contiguous United States

Ictiobus bubalus, Smallmouth Buffalo, is a freshwater fish that is native to the Lower Great Lakes and Mississippi River Basin from Pennsylvania and Michigan to Montana and south to the Gulf slope drainages in southern Mexico. *I. bubalus* is commonly found in lakes, reservoirs, and impoundments as well as fast flowing waters and deeper waters of large rivers. They are stocked for sport and aquaculture purposes but are not common in the aquarium trade. This species is

regulated in three States. *I. bubualus* has been introduced outside of its native range, with some introductions resulting in established populations. The History of Invasiveness is classified as Data Deficient due to the lack of information regarding impacts of introduction. The climate matching analysis for the contiguous United States indicates establishment concern for this species outside its native range. There were areas of high match for most of the central and eastern United States. Areas of low match were found in and west of the Rocky Mountains. The Certainty of Assessment for this ERSS is classified as Low due to lack of information regarding impacts of introduction and trade. The Overall Risk Assessment Category for *Ictiobus bubalus* 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:** Hybridization with other buffalo species can make identification difficult.
- **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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11 Literature Cited in Quoted Material

Note: The following references are cited within quoted text within this ERSS, but were not accessed for its preparation. They are included here to provide the reader with more information.

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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 (2022).

Under the future climate scenarios (figure A1), on average, high climate match for *Ictiobus bubalus* was projected to occur in the Appalachian Range, Colorado Plateau, Great Lakes, Gulf Coast, Mid-Atlantic, Northeast, Northern Plains, Southeast, Southern Atlantic Coast, Southern Plains, and Southwest regions of the contiguous United States. Areas of low climate match were projected to occur in the Northern Pacific Coast region and along the Sierra-Nevada Range. Areas of high match decreased with time and between SSP3 and SSP5. The Climate 6 scores for the individual future scenario models (figure A2) ranged from a low of 0.867 (model: MPI-ESM1-2-HR, SSP3, 2055) to a high of 0.924 (model: UKESM1-0-LL, SSP5, 2085). All future scenario Climate 6 scores were above the Establishment Concern threshold, indicating that Yes, there is establishment concern for this species. The Climate 6 score for the current climate match (0.868, 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 (figure A3). Under one or more time step and climate scenarios, areas within the Colorado Plateau, Great Basin, Northeast, Southwest, and Western Mountains saw a moderate increase in the climate match relative to current conditions. Scattered, small areas of the western United States had a large increase in climate match relative to current conditions at the 2085 time step. Under the most extreme scenario (SSP5, 2085), areas within the Northern Plains saw a large decrease in the climate match relative to current conditions. Additionally, areas within the Appalachian Range, Gulf Coast, Mid-Atlantic, Southeast, Southern Atlantic Coast, Southern Plains, and Southwest saw a moderate decrease in the climate match relative to current conditions. In time step 2055 there were mostly minor changes with moderate changes occurring in 2085 under both SSP3 and SSP5. There was more change under SSP5 relative to current conditions than SSP3.

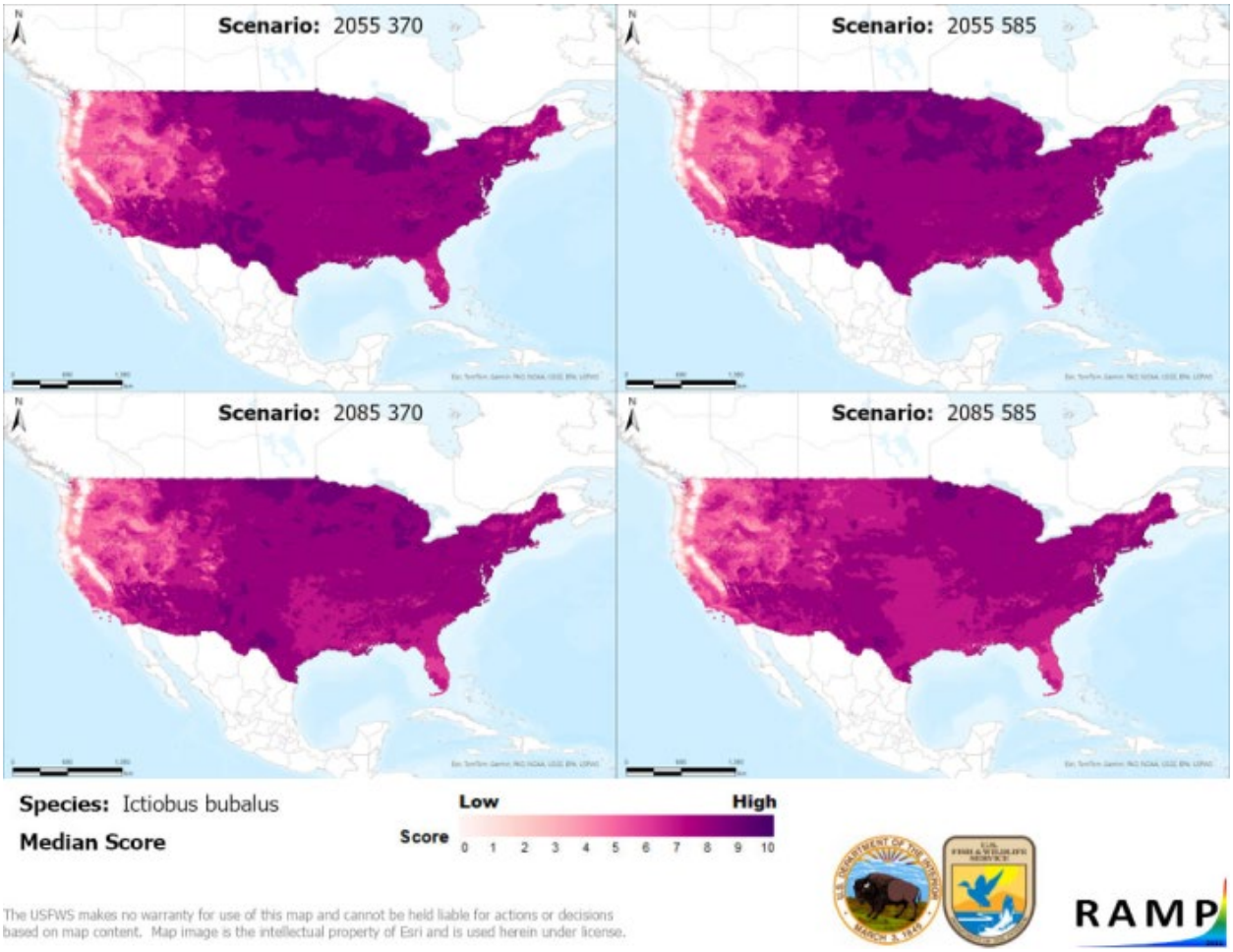

Figure A1. Maps of median RAMP (Sanders et al. 2023) climate matches projected under potential future climate conditions using five global climate models for *Ictiobus bubalus* in the contiguous United States. Climate matching is based on source locations reported by GBIF Secretariat (2022). Shared Socioeconomic 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.

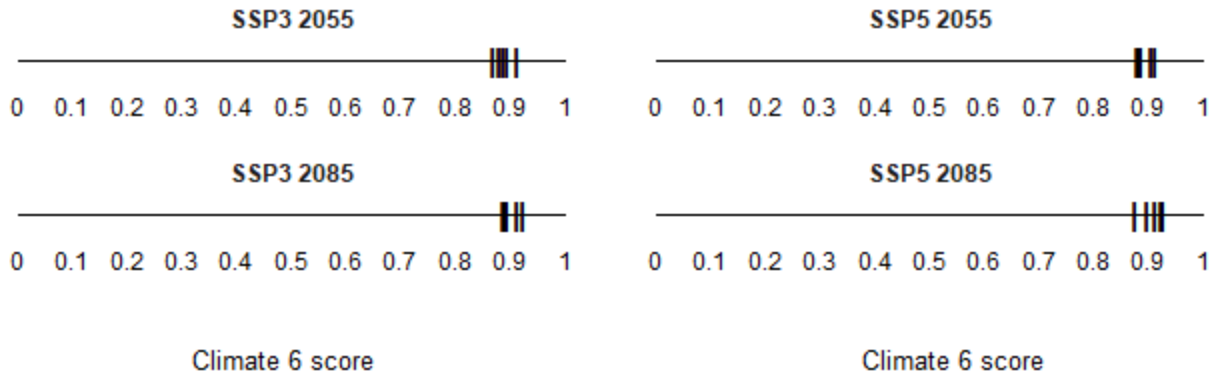

Figure A2. Comparison of projected future Climate 6 scores for *Ictiobus bubalus* in the contiguous United States for each of five global climate models under four combinations of Shared Socioeconomic Pathway (SSP) and time step. SSPs used (from left to right): SSP3, SSP5 (Karger et al. 2017, 2018; IPCC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

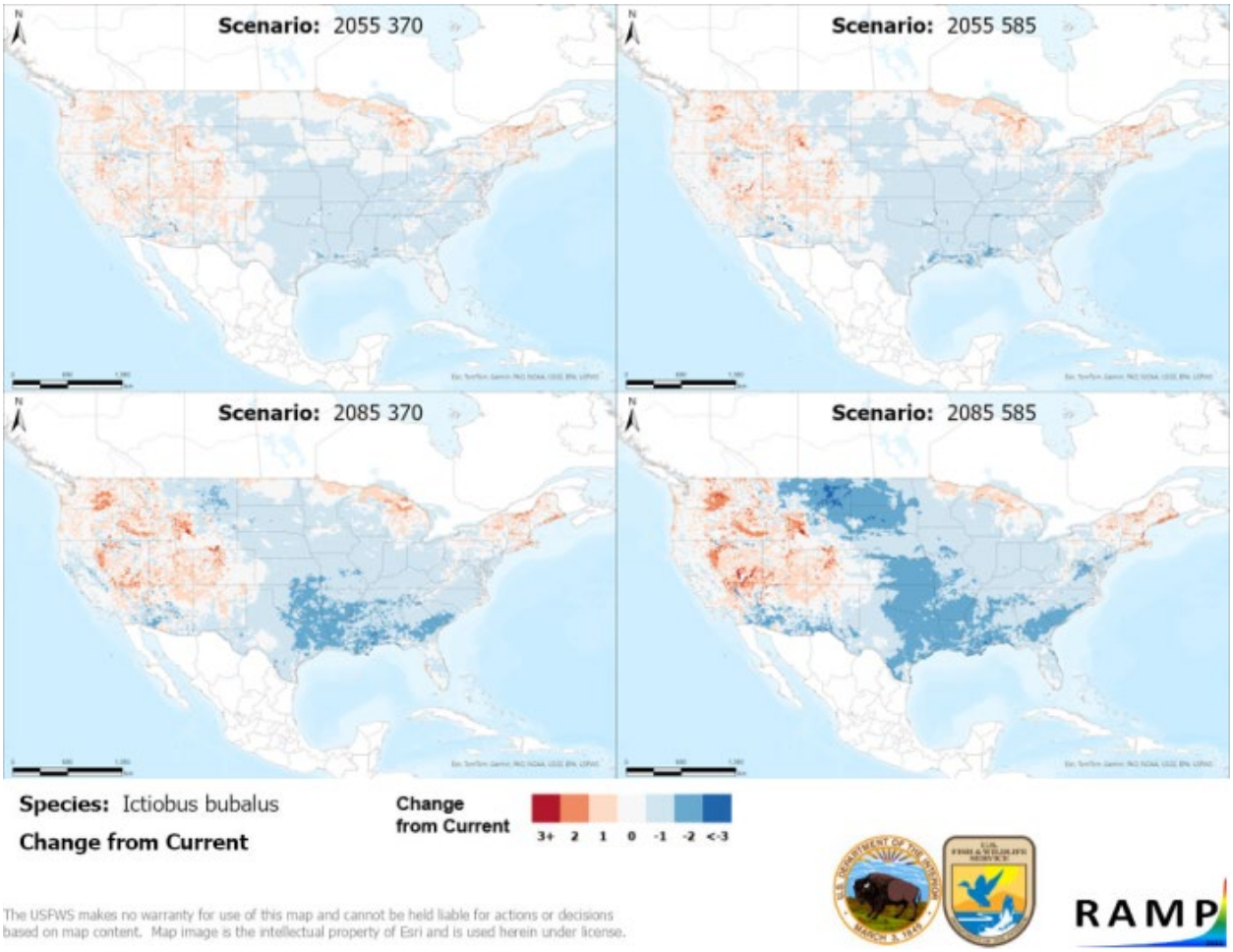

Figure A3. RAMP (Sanders et al. 2023) maps of the contiguous United States showing the difference between the current climate match target point score (figure 4) and the median target point score for future climate scenarios (figure A1) for *Ictiobus bubalus* based on source locations reported by GBIF Secretariat (2022). 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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