

Blackchin Tilapia (*Sarotherodon melanotheron*)

Ecological Risk Screening Summary

U.S. Fish and Wildlife Service, November 2023

Revised, March 2025

Web Version, 2/4/2026

Organism Type: Fish

Overall Risk Assessment Category: High



Photo: J. Tengeres, U.S. Fish and Wildlife Service. Public Domain. Available: <https://nas.er.usgs.gov/queries/FactSheet.aspx?SpeciesID=477> (November 2023).

1 Native Range and Status in the United States

Native Range

From Froese and Pauly (2023):

“Africa: Lagoons and estuaries from Mauritania to Cameroon.”

From Nico and Neilson (2025):

“Tropical Africa. Brackish estuaries and lagoons from Senegal to Zaire (Trewavas 1983).”

From Konaté et al (2022):

“The black-chinned tilapia, *Sarotherodon melanotheron* (Rüppell, 1852) endemic to Africa, occurs naturally in estuaries, lagoons and lower parts of rivers from Senegal to Angola [Kone and Teugels 2003].”

Froese and Pauly (2023) lists the following countries as the native range for *Sarotherodon melanotheron*: Benin, Cameroon, Republic of the Congo, Democratic Republic of the Congo, Cote d’Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mauritania, Nigeria, Senegal, Sierra Leone, and Togo.

Status in the United States

From Nico and Neilson (2025):

“Established in Florida and Hawaii. Evidence indicates it is spreading rapidly in both fresh and salt water around island of Oahu, Hawaii (Devick 1991b), but it does not seem to be expanding its range in Florida.”

From Jennings (1991):

“Originally imported into the United States as an aquarium fish, it is presently established in Florida on the west coast in the Tampa Bay system, Hillsborough County, and on the east coast in the Indian River lagoon system [...], Brevard and Indian River counties.”

No records of live *Sarotherodon melanotheron* in trade in the United States were found.

Regulations

Sarotherodon malenotheron is regulated in Hawaii (Hawaii Department of Land and Natural Resources 2023) and Oregon (ODFW 2022). All species in the genus *Sarotherodon* are regulated in Florida (FFWCC 2022), Minnesota (Minnesota DNR 2022), Nevada (Nevada Board of Wildlife Commissioners 2022), New Mexico (NMDGF 2023), Texas (TPDW 2022), Utah (Utah DWR 2023), and Washington (WDFW 2022). Species with the common name ‘tilapia’ are regulated in Oklahoma (ODWC 2023). 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 and Neilson (2025):

“The probable source of Florida fish was Tampa area fish farms, although release of aquarium fish cannot be ruled out (Springer and Finucane 1963). In the eastern part of Florida, this species apparently was introduced or spread by local anglers to create a commercial fishery (Dial and

Wainright 1983). Blackchin tilapia were imported into Hawaii in 1962 by the Federal Bureau of Commercial Fisheries (now the National Marine Fisheries Service); coastal and lagoon introductions were the result of escapes from a fish station on Oahu, where the species was being tested as a baitfish for tuna, in or about 1965 (Randall 1987; Devick 1991b). The fish was introduced accidentally into Wahiawa Reservoir, Hawaii, in the mid-1970s; these reservoir introductions probably resulted from bait bucket releases (Devick 1991a, b).”

From Jennings (1991):

“Originally imported into the United States as an aquarium fish, [...]”

Remarks

This ERSS was previously published in October 2012. Revisions were completed to incorporate new information and conform to updated standards.

From Froese and Pauly (2023):

“Previously, three subspecies were recognized: *Sarotherodon melanotheron heudelotii*, *S. m. leonensis* and *S. m. melanotheron*.”

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 Labroidei
Family Cichlidae
Genus *Sarotherodon* Rüppell, 1852
Species *Sarotherodon melanotheron* Rüppell, 1852

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

The following synonyms (subspecies) of *Sarotherodon melanotheron* from Froese and Pauly (2023) were used to search for information for this report: *S. m. heudelotii*, *S. m. leonensis* and *S. m. melanotheron*.

Size, Weight, and Age Range

From Froese and Pauly (2023):

“Maturity: L_m [length at maturity] 12.1, range 13 - ? cm”

“Max length : 28.0 cm SL [standard length] male/unsexed; [Olaosebikan and Raji 1998];
common length : 17.5 cm TL [total length] male/unsexed [Hugg 1996]”

Environment

From Froese and Pauly (2023):

“Marine; freshwater; brackish; demersal; pH range: 7.0 - 8.0; dH range: 9 - 19; depth range 0 - 3 m [Page and Burr 1991].”

From Jennings (1991):

“Cold tolerance and behavioral responses of blackchin tilapia, *Sarotherodon melanotheron*, to rapidly decreasing temperatures were investigated at salinities of 5, 15, and 35 parts per thousand (ppt). Cold tolerance did not significantly differ with salinity or social rank. Mean temperatures were 10.7°C for beginning loss of equilibrium, 9.6°C for complete loss of equilibrium, and 6.9°C for death at all salinities. Behavioral activity declined with decreasing temperature and ceased between 10-12°C. Certain behavioral actions were significantly more frequent at 15 or 35 ppt salinity than at 5 ppt.”

“The blackchin tilapia is euryhaline, and occurs in brackish lagoons and estuaries in its native habitat. In closed lagoons, it acclimates to frequently occurring hypersaline conditions (Pauly 1976). In the laboratory, it tolerated salinities of at least 100 ppt, and produced viable offspring in salinities from 0 to at least 35 ppt (U.S. Fish and Wildlife Service, unpublished data). In its native habitat, however, it prefers brackish water and has been replaced by other species in areas that become totally freshwater (Trewavas 1983). Given this wide salinity tolerance, blackchin tilapias are probably moving into low-salinity canals in winter in response to temperature. During severe cold they should not be affected any more than if they were in areas of isotonic salinity, and therefore should not be reducing their fitness by moving into low-saline areas during winter.”

Climate

From Froese and Pauly (2023):

“Tropical; 27°N - 14°S, 18°W - 31°E”

Distribution Outside the United States

Native

From Froese and Pauly (2023):

“Africa: Lagoons and estuaries from Mauritania to Cameroon.”

From Nico and Neilson (2025):

“Tropical Africa. Brackish estuaries and lagoons from Senegal to Zaire (Trewavas 1983).”

From Konaté et al (2022):

“The black-chinned tilapia, *Sarotherodon melanotheron* (Rüppell, 1852) endemic to Africa, occurs naturally in estuaries, lagoons and lower parts of rivers from Senegal to Angola [Kone and Teugels 2003].”

Froese and Pauly (2023) lists the following countries as the native range for *Sarotherodon melanotheron*: Benin, Cameroon, Congo, Democratic Republic of the Congo, Cote d’Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mauritania, Nigeria, Senegal, Sierra Leone, and Togo.

Introduced

From Ordonez et al. (2015):

“*S. melanotheron* specimens from Manila Bay [Philippines] were collected from the landing sites in Tanza, Cavite [...] and Fisherman’s Wharf in Paranaque City [...] on October 31, 2013 while specimens from San Sebastian, Hagonoy, Bulacan [...] were collected on October 25, 2013 from the local public market [...].”

“A total of 47 samples were collected from two areas [...]: (1) Hagonoy, Bulacan (N=16) and Manila Bay (N=31) adjacent to Paranaque City and Tanza, Cavite.”

“According to anecdotal reports, *S. melanotheron* has occurred in Bulacan and Bataan since 2011. Therefore, it is very likely that this species has already established populations in these areas.”

From Pèlèbè et al. (2021):

“A large population of presumed *S. melanotheron* was discovered prior to 2001 in the Atchakpa freshwater reservoir (SUCOBE dam built in 1982), which is located in central Benin, about 230 km north of Agonlin-Lowé [Laleye et al. 2004; Fagnon et al. 2013]. This population, which was only morphologically identified, thrived in the landlocked reservoir. [...] In this study, the use of DNA barcoding allowed us to identify the cichlid population that became landlocked in the Atchakpa freshwater reservoir as *Sarotherodon melanotheron*.”

According to Raksasiri et al. (2022), *S. melanotheron* is established in “the area of Phet Samut Khiri Province group (Samut Sakhon, Samut Songkhram, Phetchaburi and Prachuap Khiri Khan Province) in Thailand.”

Additionally, Froese and Pauly (2023) lists *Sarotherodon melanotheron* as introduced in Cambodia and Suriname with no establishment status. *S. melanotheron* is listed as not established in Japan and Russia.

Means of Introduction Outside the United States

From Ordonez et al. (2015):

“We suspect that the *S. melanotheron* population in [Manila Bay, Philippines] might have come from nearby fishponds and later might have escaped into the coastal waters through flooding events. Intentional introduction by fish-farmers to enhance fishery production in the area is also a possible pathway of introduction. However, the method of introduction into the country still remains unknown.”

From Raksasiri et al. (2022):

“The epidemic [established populations of *Sarotherodon melanotheron*] began in nature in Thailand for the first time in 2012 in Yi San Subdistrict, Amphawa District, Samut Songkhram Province, after the Blackchin tilapia were imported to Thailand for breeding improvement in 2010 [...]”

From Pèlèbè et al. (2021):

“Although we could not unambiguously determine the origin of the population, we found no indication that the population in the Atchakpa reservoir belongs to a different strain than the rest of the specimens from Benin. Hence, it could have arrived in the reservoir naturally, or via pumping of river water into the reservoir.”

Short Description

From Froese and Pauly (2023):

“Dorsal spines (total): 15 - 17; Dorsal soft rays (total): 10-12; Anal spines: 3; Anal soft rays: 8 - 10; Vertebrae: 26 - 28. Diagnosis: length of caudal peduncle 0.6-0.9 times in its depth [Teugels and Thys van den Audenaerde 2003]. Melanic areas in adult usually present on lower parts of head, on cleithrum and on apices of caudal and soft dorsal fins; occasional irregular and asymmetrical spots on flanks probably representing vertical bars; median spot or transverse bar on nape rather constant [Trewavas 1983].”

Biology

From Froese and Pauly (2023):

“This species can tolerate high salinity [Page and Burr 1991]. It occurs abundantly in mangrove areas and ventures in to both fresh, like lower reaches of streams [Page and Burr 1991] and salt waters in native and non-native ranges [GSMFC 2003, Teugels and Thys van den Audenaerde 2003]. In West Africa, this species is confined to brackish lagoons and estuaries, and is abundant in the mangrove zone [Trewavas 1983]. Forms schools; is mainly nocturnal with intermittent daytime feeding. Feeds on aufwuchs and detritus [Trewavas 1983], as well as on bivalves and zooplankton [Diouf 1996]. Feeding behaviour: picking up and swallowing "bites" (no gill rakers) [Pauly 1976].”

“Spawns in shallow water close inshore. Initiative in courtship, pit digging and mating activities are taken by the female. Eventually a male is stimulated to react in a mainly passive manner and a pair-bond is established; sexual dimorphism minimal; no T-stand by the partners during fertilization. Exhibits mouth-brooding habit [Eyeson 1983]. Males exclusively incubate the eggs [Trewavas 1983, Eyeson 1979].”

From Kishida and Specker (2000):

“The black-chinned tilapia (*Sarotherodon melanotheron*) is a mouthbrooding cichlid fish in which the male picks up the fertilized eggs and incubates them until they are released as free-swimming fry (Trewavas, 1983). After about 5 days of incubation, the eggs hatch and the newly hatched embryos remain in his mouth for a little more than a week. The entire mouthbrooding behavior lasts about 2 weeks.”

From Jennings (1991):

“Blackchin tilapias spawn throughout the year in their native habitat (Fagade 1974) probably due to the nearly constant water temperatures.”

From Nico and Neilson (2025):

“This species is planktivorous, primarily consuming phytoplankton (i.e., cyanobacteria, algae, diatoms) and organic detritus with zooplankton comprising a varying portion of the diet among populations (Kone and Teugels 2003; Ayoade and Ikulala 2007).”

Human Uses

From Froese and Pauly (2023):

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

From Nico and Neilson (2025):

“At one time, the species was very popular in the aquarium fish trade (Goldstein 1973).”

From Ordonez et al. (2015):

“*S. melanotheron* has been harvested and sold in the market at a relatively cheaper price than *Oreochromis* spp. This may be because the species has not been well accepted by consumers due to its small size and unappealing taste.”

From Ouattara et al. (2003):

“In the man-made Lake Ayame (Côte d’Ivoire), a population of *S. melanotheron* has been landlocked following the construction of a dam in 1959. The fishery statistics show that this species represents 51% of commercial catches, which, in 1996, included over 1000 t (Gourene, Teugels, Hugueny & Thys van den Audenaerde 1999).”

According to Raksasiri et al. (2022), Blackchin Tilapia can be used in the production of meatloaf to increase income for farmers, consumption, and control of the species in Thailand.

Diseases

No information was found associating *Sarotherodon melanotheron* with any diseases listed by the World Organisation for Animal Health (2023).

Poelen et al. (2014) states *S. melanotheron* can have the following parasites: *Arnola microcirrus*, *Ascaris lumbricoides*, *Bacciger israelensis*, *Centroderma spinosissima*, *Cichlidogyrus acerbus*, *Cichlidogyrus halinus*, *Cichlidogyrus halli*, *Cichlidogyrus lagoonaris*, *Clinostomum tilapiae*, *Distomum fractum*, *Enterogyrus foratus*, *Fasciola hepatica*, *Gyrodactylus cichlidarum*, *Lepocreadium album*, *Mesometra brachycoelia*, *Mesometra orbicularis*, *Necator americanus*, *Podocotyle*, *Robphildollfusium fractum*, *Scutogyrus longicornis*, and *Scutogyrus minus*.

From Nico and Neilson (2025):

“An estimated 20,000 tilapia, most of them *S. melanotheron* and representing about 0.05% or less of the total tilapia population, were killed in Wahiawa Reservoir, Hawaii, by fungal infections in early 1991; populations of this tilapia appear to be a reservoir for fungal disease and may be responsible for spreading infection to other fish species (Devick 1991a).”

From Mauel et al. (2003):

“In 1994, tilapia (*Oreochromis mossambicus* and *Sarotherodon melanotheron*) in wild and farmed populations on Oahu, Hawaii, USA, began to die of an unknown disease that was similar but not identical to piscirickettsiosis in salmonids. Only tilapia were affected. Diseased tilapia often swam erratically and had trouble staying at depth. Scattered cutaneous haemorrhage and exophthalmia were often noted. In many cases, fish were found dead with no clinical signs. Gills exhibited epithelial hyperplasia with severe multifocal consolidation of secondary lamellae. Multiple granulomas were observed in the gills, spleen, kidney, choroid gland and testes, but not in the liver. Tilapia mortalities occurred only during the cooler months (October to April) of the year and were not recorded during the warmer months (May to September). [...] Unlike *Piscirickettsia salmonis*, the agent of piscirickettsiosis, the Hawaiian tilapia *Piscirickettsia*-like

organism (HTPLO) does not form craterform lesions in the liver and is active above 20°C. HTPLO can be transmitted horizontally by cohabitation, and cold stress induces the syndrome in juvenile tilapia from farms where the disease is endemic.”

Threat to Humans

From Froese and Pauly (2023):

“Potential pest”

3 Impacts of Introductions

From Nico and Neilson (2025):

“In Lithia Springs, Florida, *S. melanotheron* comprised ~90% of the total fish biomass, with a reduction in abundance and condition of native centrarchids and other fishes (Courtenay et al. 1974).

From Ordonez et al. (2015):

“*S. melanotheron* has been reported to compete with the native species in freshwater springs in Florida, causing malnourishment and disease in largemouth bass [*Micropterus nigricans* (Cuvier, 1828)] and bluegill *Lepomis macrochirus* (Rafinesque, 1819) (Courtenay et al. 1974).”

From Faunce (2000):

“*S. melanotheron* was also reported to plague the fish ponds in the nearby province of Bataan [Philippines], causing decrease in fish catch (e.g. tilapia) of fish-farmers operating in the affected area. These observed declines in catch are also probably due to competition of food resources by the *S. melanotheron*, since already established populations of the fish have been associated with a reduction of aquatic vegetation due to overgrazing (Courtenay et al. 1974).”

From Raksasiri et al. (2022):

“[Phet Samut Khiri Province Group, Thailand] is an area where agriculture and fishing are important, especially economic shrimp farming. and raising economic fish such as black tiger prawns and snapper, as well as local fisheries, etc., This fishery has been greatly affected by the spread of Blackchin tilapia, especially in the area adjacent to the Bang Pakong River Phetchaburi River and other natural water sources.”

From Chaianunporn et al. (2024):

“The introduction of blackchin tilapia in Thailand is resulting in significant ecological and socio-economic impacts [Burapha University 2024, Thai PBS World 2024]. Their dominance in brackish habitats has caused declines in indigenous fish populations, disrupted ecological balance, and reduced biodiversity by overgrazing aquatic vegetation and outcompeting native species for food and habitat. Invasive blackchin tilapia have long been a significant concern for

commercial aquaculture, particularly in fish and shrimp farms, where they cause substantial damage by consuming fry, roe, and other important food sources like phytoplankton and zooplankton, which are critical for the development of fish and shrimp. Thai shrimp farmers and coastal fishermen have complained regarding the detrimental impact of this species for several years [Thai PBS World 2024]. In addition, similar to other invasive tilapias, the presence of blackchin tilapia potentially deteriorates water quality, including promoting sediment resuspension, increased turbidity, altered nutrient levels, and enhancing eutrophication [Yongo et al. 2023].”

Sarotherodon melanotheron is regulated in the following U.S. States: Florida (FFWCC 2022), Hawaii (Hawaii Department of Land and Natural Resources 2023), Minnesota (Minnesota DNR 2023), Nevada (Nevada Board of Wildlife Commissioners 2022), New Mexico (NMDGF 2023), Oklahoma (ODWC 2023), Oregon (ODFW 2022), Texas (TPDW 2022), Utah (Utah DWR 2023), and Washington (WDFW 2022). See section 1.

4 History of Invasiveness

Sarotherodon melanotheron has been introduced to several countries outside of its native range, and is established in the United States, Thailand, and the Philippines. Established populations in the United States and the Philippines have resulted in documented negative impacts including competition with native species, overgrazing of aquatic vegetation, and reduced catches in target fisheries. The History of Invasiveness for *Sarotherodon melanotheron* is classified as High.

5 Global Distribution

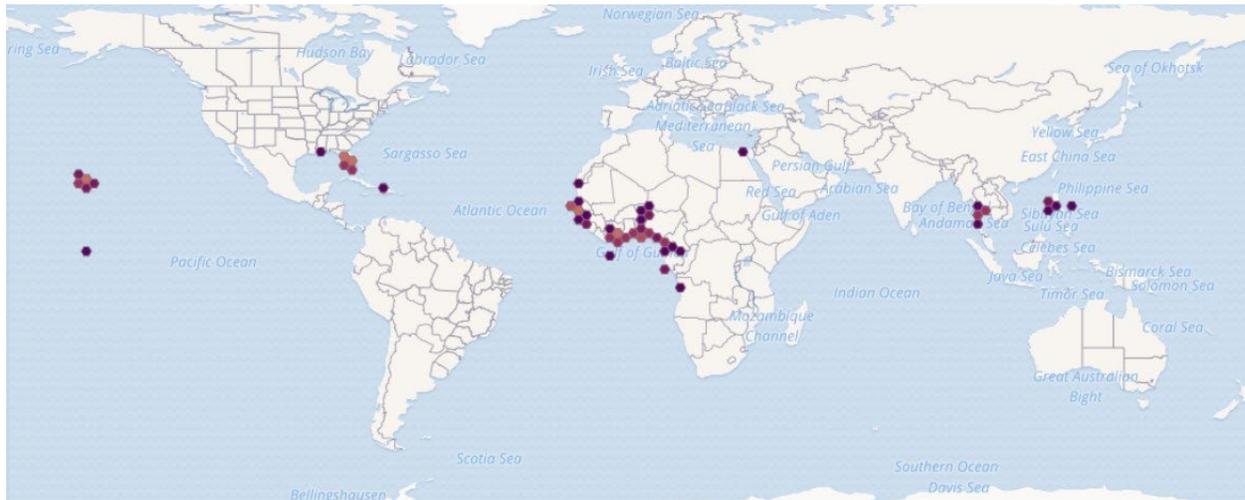


Figure 1. Reported global distribution of *Sarotherodon melanotheron*. Map from GBIF Secretariat (2023). Observations are reported from the western coast of Africa, United States (Mississippi, Florida, and Hawaii), Thailand, and the Philippines. No information supporting the presence of established populations was found for observations in Egypt, Dominican Republic, Kiribati, or Mississippi. These locations do not represent established populations and therefore were not used in the climate matching analysis. Because the climate matching analysis is not valid for marine waters, no marine occurrences were used in the climate matching analysis.

6 Distribution Within the United States



Figure 2. Reported distribution of *Sarotherodon melanotheron* in the contiguous United States. Map from Nico and Neilson (2025). Majority of reported observations occur along coastal Florida. Because the climate matching analysis is not valid for marine waters, no marine occurrences were used in the climate matching analysis.

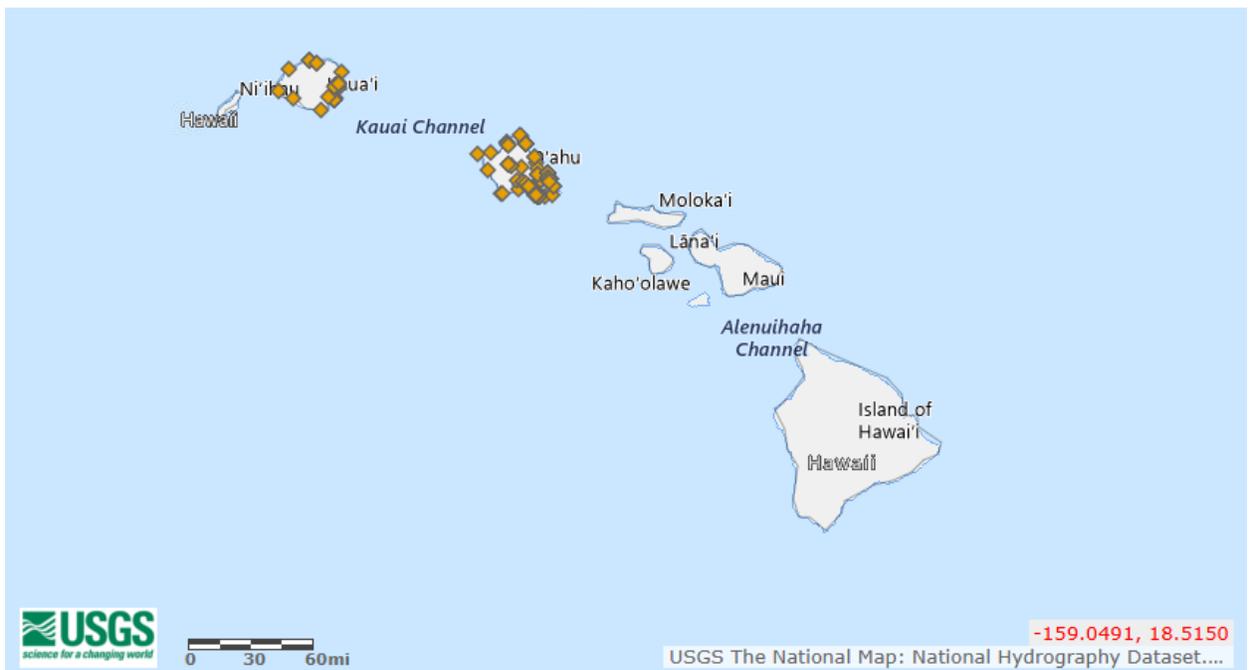


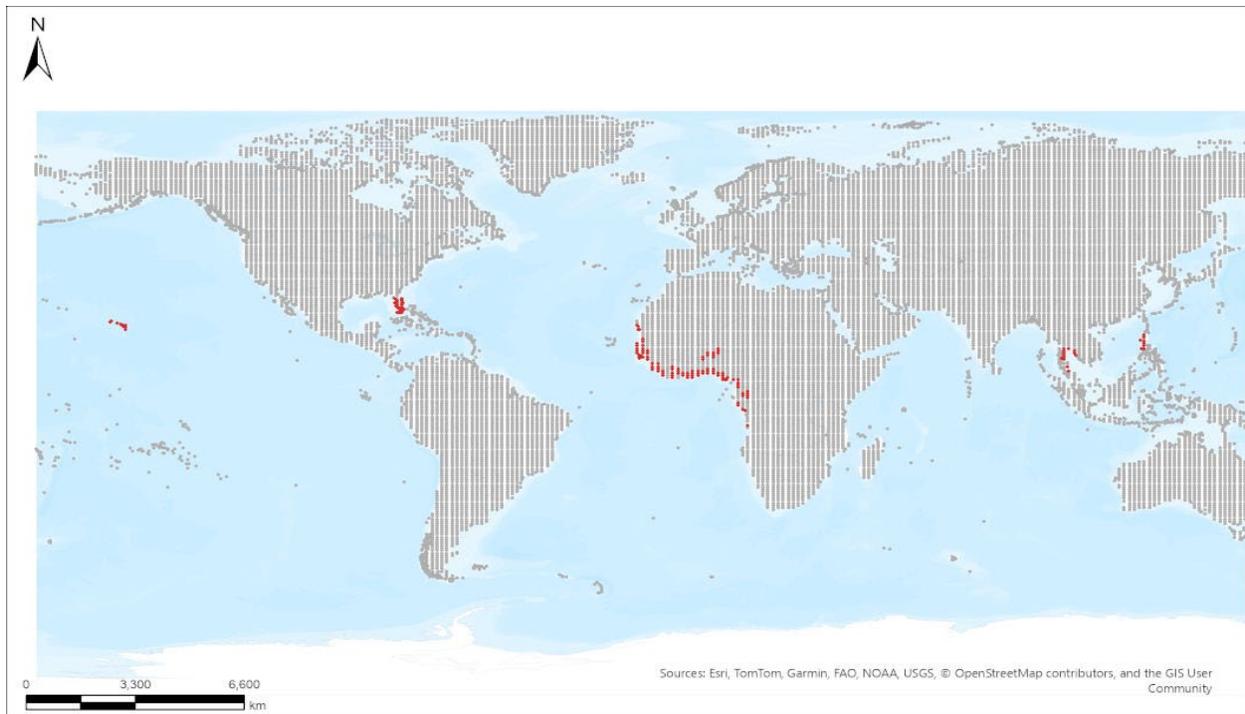
Figure 3. Reported distribution of *Sarotherodon melanotheron* in Hawaii. Map from Nico and Neilson (2025). Because the climate matching analysis is not valid for marine waters, no marine occurrences were used in the climate matching analysis.

7 Climate Matching

Summary of Climate Matching Analysis

The climate match for *Sarotherodon melanotheron* to the contiguous United States was high along the Southern Atlantic Coast and in Southern Florida. Medium matches were found throughout much of the Southeastern United States and from southern California into Texas and along the Gulf Coast. The remainder of the contiguous United States had low climate matches. The overall Climate 6 score (Sanders et al. 2023; 16 climate variables; Euclidean distance) for the contiguous United States was 0.051, 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 *Sarotherodon melanotheron* (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.

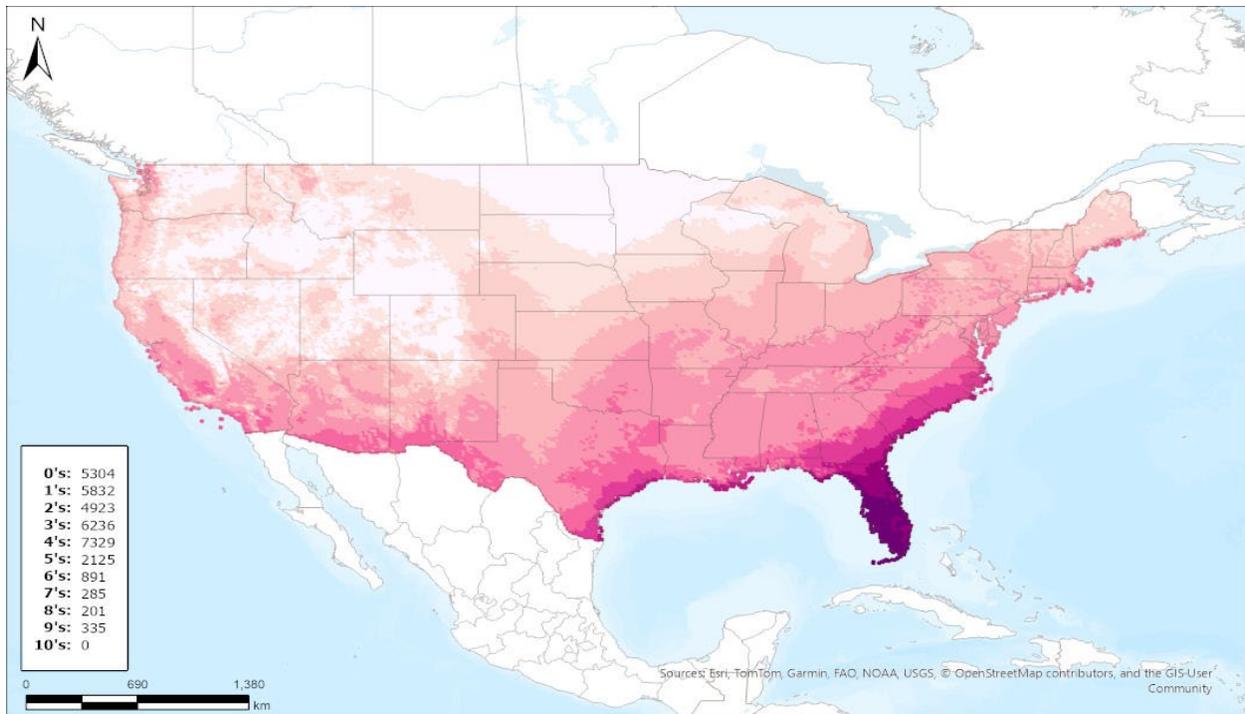


Species: *Sarotherodon melanotheron* Selected Climate Stations ●



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Figure 4. RAMP (Sanders et al. 2023) source map showing weather stations in southeastern North America, western Africa, and Southeast Asia selected as source locations (red; Florida and Hawaii in the United States; Angola, Benin, Burkina Faso, Cameroon, Republic of the Congo, Democratic Republic of the Congo, Cote d’Ivoire, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, and Togo in Africa; Thailand, Myanmar, and the Philippines in Asia) and non-source locations (gray) for *Sarotherodon melanotheron* 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.



Species: *Sarotherodon melanotheron*

Current

Climate 6 Score: 0.051



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Figure 5. Map of RAMP (Sanders et al. 2023) climate matches for *Sarotherodon melanotheron* 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 *Sarotherodon melanotheron* is classified as High. There was an adequate amount of information available for the biology and ecology of this species. Records of introductions and established populations were available. Information regarding the impacts of introductions of *S. melanotheron* was available from reliable sources.

9 Risk Assessment

Summary of Risk to the Contiguous United States

Sarotherodon melanotheron, Blackchin Tilapia, is a tropical cichlid fish native to the western coast of Africa. This species inhabits brackish lagoons and estuaries in its native range, but it is tolerant of a wide range of salinities. *S. melanotheron* has been introduced outside of its native range and has become established in the Philippines, Thailand, and the United States. Within the United States, it is established in both brackish and freshwater environments in Florida and Hawaii. Negative impacts have been reported from those introductions such as reduction in biodiversity through competition, overgrazing of aquatic vegetation, and reduced catches in target fisheries. *S. melanotheron* was introduced to the United States via aquaculture and

aquarium pathways. *S. melanotheron* is regulated in several U.S. States. The History of Invasiveness for *S. melanotheron* is classified as High due to multiple established nonnative populations resulting in reported negative impacts. The climate matching analysis for the contiguous United States indicates establishment concern for this species. The highest climate matches in the contiguous United States were located in Florida and along the Southern Atlantic Coast. The Certainty of Assessment for this ERSS is classified as High due to the reliable information on negative impacts of established populations. The Overall Risk Assessment Category for *S. melanotheron* in the contiguous United States is High.

Assessment Elements

- **History of Invasiveness (see Section 4): High**
- **Establishment Concern (see Section 7): Yes**
- **Certainty of Assessment (see Section 8): High**
- **Remarks, Important additional information: No additional remarks.**
- **Overall Risk Assessment Category: High**

10 Literature Cited

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

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Appendix

Summary of Future Climate Matching Analysis

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

Under the future climate scenarios (figure A1), on average, high climate match for *Sarotherodon melanotheron* was projected to occur in the Southern Florida region of the contiguous United States. Areas of low climate match were projected to occur in the Colorado Plateau, Great Basin, Northern Plains, and Western Mountains regions. The Climate 6 scores for the individual future scenario models (figure A2) ranged from a low of 0.026 (model: UKESM1-0-LL, SSP5, 2085) to a high of 0.078 (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 (0.051, 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 Great Lakes saw a large increase in the climate match relative to current conditions.

Additionally, areas within the Colorado Plateau, Great Basin, Northeast, Northern Pacific Coast, Northern Plains, Southern 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 Gulf Coast, 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 magnitude of change from current conditions was more pronounced in time step 2085 than in time step 2055 under both scenarios, SSP3 and SSP5.

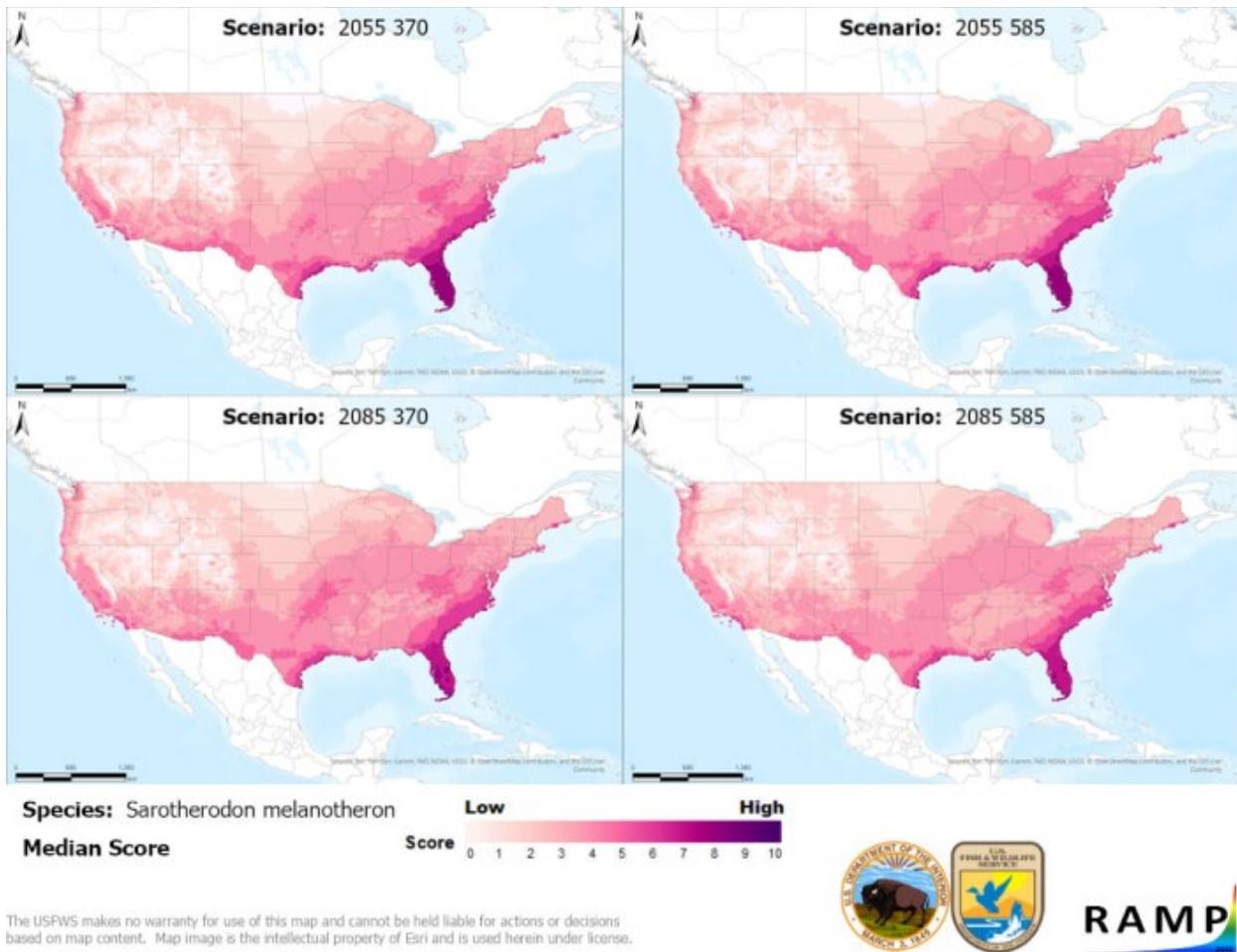


Figure A1. Maps of median RAMP (Sanders et al. 2023) climate matches projected under potential future climate conditions using five global climate models for *Sarotherodon melanotheron* in the contiguous United States. Climate matching is based on source locations reported by GBIF Secretariat (2023).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

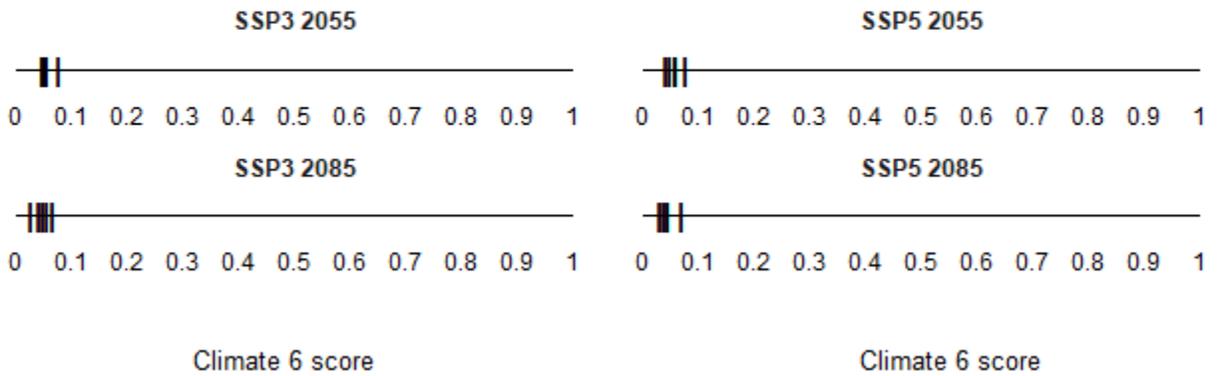
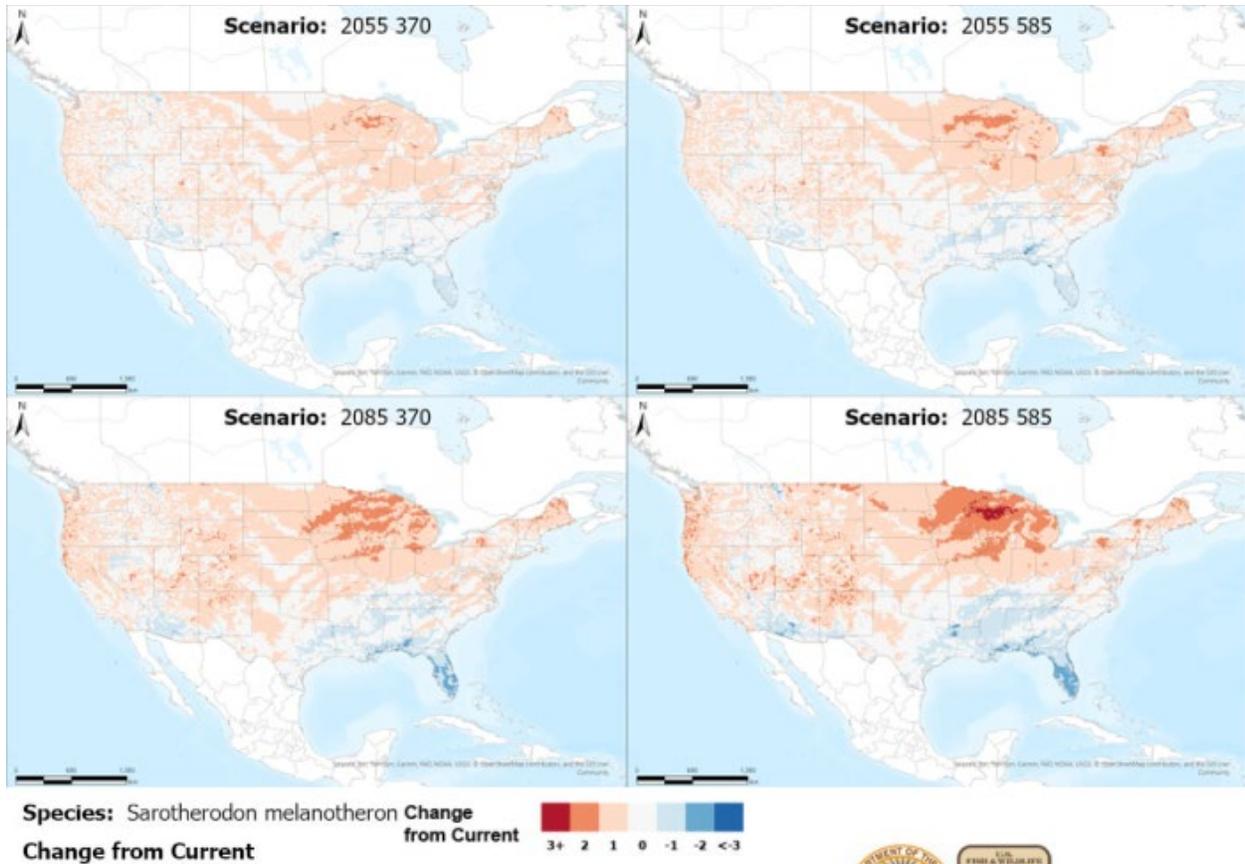


Figure A2. Comparison of projected future Climate 6 scores for *Sarotherodon melanotheron* in the contiguous United States for each of five global climate models under four combinations of Shared Socioeconomic Pathway (SSP) and time step. SSPs used (from left to right): SSP3, SSP5 (Karger et al. 2017,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



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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 *Sarotherodon melanotheron* 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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