U.S. Fish & Wildlife Service

Spotted Tilapia (*Pelmatolapia mariae*)
Ecological Risk Screening Summary

U.S. Fish and Wildlife Service, November 2023
Revised, January 2024
Web Version, 2/18/2026

Organism Type: Fish
Overall Risk Assessment Category: High

Photo: U.S. Geological Survey Archive. Licensed under CC BY-NC 3.0 US. Available: https://www.cabi.org/isc/datasheet/109161#toPictures (November 2023).

1 Native Range and Status in the United States

Native Range

From Nico and Neilson (2023):

"Tropical Africa. West Africa from middle Ivory Coast to southwestern Ghana and from southeastern Benin to southwestern Cameroon (Thys van den Audenaerde 1966; Philippart and Ruwet 1982)."

From Froese and Pauly (2026):

"Africa: coastal lagoons and lower river courses from the Tabou River (Côte d'Ivoire) to the Kribi River (Cameroon), but absent from the area between the Pra River (Ghana) and Benin [Teugels and Thys van den Audenaerde 2003]. Also recorded from the lower Ntem, Cameroon [Stiassny et al. 2008]."

Status in the United States

From Nico and Neilson (2023):

"Established in Florida; reported from Arizona and Nevada. Uncertain in Texas."

"The conclusion by some authors that this species was introduced into and is possibly established in Arizona apparently is based entirely on Minckley's (1973) presentation of a photograph of *Tilapia mariae* (incorrectly identified as "*Tilapia nilotica*") in his book on Arizona fishes. Minckley also described young tilapia that more closely matched *T. mariae* as opposed to *Tilapia nilotica* (= *Oreochromis niloticus*) (see Courtenay and Hensley 1979 […]; Courtenay et al. 1984, 1986). However, the conclusion that *T. mariae* was ever present in Arizona assumes that the specimens photographed and examined by Minckley actually were collected in Arizona. Spotted tilapia has been listed as present in the Salton Sea, Colorado River, and Los Angeles area in California; however, there are no substantiated records for that state (i.e., museum specimens), and this species likely has never been introduced there and these represent misidentifications of redbelly tilapia *T. zillii*."

Nico and Neilson (2023) indicate that the observations in Nevada were from thermally regulated waters (warm springs).

From Robins (2020):

"Populations in Florida may be found in no less than eight southern counties, with the first individuals found in Snapper Creek Canal, South Miami in 1974. In many South Florida canals the spotted tilapia is now the most abundant cichlid amongst a host of introduced cichlids."

Pelmatolapia mariae is present in the aquarium trade (e.g., Jasons Plecos and Cichlids 2023).

Regulations

Pelmatolapia mariae is regulated at the genus level (*Pelmatolapia*) in Texas (TDPW 2022). It may also be regulated under the genus *Tilapia*, to which it was previously assigned, in Florida (FFWCC 2022), Massachusetts (MassWildlife 2014), Minnesota (Minnesota DNR 2022), Nevada (Nevada Board of Wildlife Commissioners (2022), New Mexico (NMDGF 2023), Utah (Utah DWR 2023), Virginia (Virginia DWR 2022), Washington (WDFW 2022), and Wisconsin (Wisconsin DNR 2022). *P. mariae* may also be regulated under the common name 'tilapia' in Louisiana (Louisiana Revised Statutes 2022), New Hampshire (NHFG 2022), and 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 in the United States

From Nico and Neilson (2023):

"Spotted tilapia was introduced into Florida as a result of escapes or intentional releases from one or several aquarium fish farms in Dade County, probably between 1972 and 1974 (Hogg 1974, 1976a, b; Courtenay and Hensley [1979]; Courtenay and Stauffer 1990). The Nevada introduction was reportedly due to an aquarium release (Courtenay and Deacon 1982, 1983; Courtenay and Stauffer 1990)."

From Kurwie (2009):

"*T. mariae* was possibly introduced for experimental purposes into the waters of southern Arizona (Courtenay and Hensley, 1979; Courtenay et al., 1984; 1986) […]"

Remarks

This ERSS was previously published in October 2012 under the name *Tilapia mariae*. Revisions were completed to incorporate new information and conform to updated standards.

Mention of commercial products in this Ecological Risk Screening Summary does not entail endorsement by the U.S. Federal Government.

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From Froese and Pauly (2023b):

"Biota > Animalia (Kingdom) > Chordata (Phylum) > Vertebrata (Subphylum) > Gnathostomata (Infraphylum) > Osteichthyes (Parvphylum) > Actinopterygii (Gigaclass) > Actinopteri (Superclass) > Teleostei (Class) > Cichliformes (Order) > Cichlidae (Family) > Pseudocrenilabrinae (Subfamily) > *Pelmatolapia* (Genus) > *Pelmatolapia mariae* (Species)"

From Fricke et al. (2023):

"Valid as *Pelmatolapia mariae* (Boulenger 1899)."

The following synonym of *Pelmatolapia mariae* from Fricke et al. (2023) was used to search for information for this report: *Tilapia mariae*.

Size, Weight, and Age Range

From Froese and Pauly (2026):

"Max length: 32.3 cm SL [standard length] male/unsexed; [Stiassny et al. 2008]; common length: 17.5 cm TL [total length] male/unsexed; [Hugg 1996]; max. published weight: 1.4 kg [IGFA 2001]"

"Maximum size was recorded at 39.4 cm TL [IGFA 2001]."

Environment

From Froese and Pauly (2026):

"Freshwater; brackish; demersal; pH range: 6.0 - 8.0; dH range: 5 - 19. […]; 20°C - 25°C [Riehl and Baensch 1991; assumed to be recommended aquarium water temperature]; […]"

From Kurwie (2009):

"*T. mariae* lives in still or flowing waters in rocky, sandy or mud-bottomed areas. It is found inhabiting temperatures of 11-37°C with a preferred temperature range of 25-33°C. Although *T. mariae* is a freshwater fish it is tolerant of higher salinity as they are also found in estuaries (ISSG, 2009)."

Kurwie (2009) also reports that this species can tolerate 1-8 parts per thousand salinity, and 4.4-8.5 mg/l dissolved oxygen levels.

Climate

From Froese and Pauly (2026):

"Tropical; […]; 9°N - 2°N, 9°W - 11°E [Florida Museum of Natural History 2005]"

Distribution Outside the United States

Native

From Nico and Neilson (2023):

"Tropical Africa. West Africa from middle Ivory Coast to southwestern Ghana and from southeastern Benin to southwestern Cameroon (Thys van den Audenaerde 1966; Philippart and Ruwet 1982)."

From Froese and Pauly (2026):

"Africa: coastal lagoons and lower river courses from the Tabou River (Côte d'Ivoire) to the Kribi River (Cameroon), but absent from the area between the Pra River (Ghana) and Benin [Teugels and Thys van den Audenaerde 2003]. Also recorded from the lower Ntem, Cameroon [Stiassny et al. 2008]."

Introduced
From Froese and Pauly (2026):

"Known from Victoria and Queensland [Australia; Native Fish Australia 2003]. Reported from the cooling pondage of the Hazelwood power station near Morewell (Vic), Eel Hole Creek below the pondage, and the Latrobe river, into which Eel Hole Creek drains via the Morwell river. Also recorded from the Cairns area (Qld) in small estuaries and tidal creeks north of the city, including the Barron river [Allen et al. 2002]."

"Reported [in Hong Kong] from the Ting Kok area, Tai Lam Chung Reservoir, and Pak Ngan Heung stream."

According to Froese and Pauly (2026), *Pelmatolapia mariae* has been introduced to but is probably not established in Russia.

From Lukas et al. (2017):

"Here, we report on the discovery of spotted tilapia (*Pelmatolapia mariae*) in the Gillbach [a thermally regulated stream in Germany], the first record of a reproducing population of this species in Europe."

Means of Introduction Outside the United States

From Kurwie (2009):

"*T. mariae* entered Australia through importation of a small number of fish for the aquarium trade. Captive individuals were dispersed to other areas by fish hobbyists. Some that escaped or were released established self-sustaining populations (Mather and Arthington, 1991)."

"From West Africa to former USSR (for warm water aquaculture) […]"

Short Description

From Froese and Pauly (2026):

"Dorsal spines (total): 15 - 17; Dorsal soft rays (total): 13-15; Anal spines: 3; Anal soft rays: 10 - 11. Diagnosis: body rather elevated (body depth 46.9-51.6% SL) [Teugels and Thys van den Audenaerde 2003]. Head profile rounded [Stiassny et al. 2008]. Outer teeth on jaws bicuspid [Teugels and Thys van den Audenaerde 2003], gracile [Stiassny et al. 2008] and spatulated [Teugels and Thys van den Audenaerde 2003, Stiassny et al. 2008]. Lower pharyngeal jaw teeth relatively small and narrow near posterior border of bone, forming an almost felt-like covering [Stiassny et al. 2008]. Micro-gillrakers present; adults (> 150 mm) with a series of dark blotches in the middle of the flanks (sometimes body entirely blackish) [Teugels and Thys van den Audenaerde 2003, Stiassny et al. 2008]. Juveniles with 7-9 large vertical bands [Teugels and Thys van den Audenaerde 2003]. Ventral scales with central red spot; 12 or more rakers on lower limb of first gill arch [Stiassny et al. 2008]."

From Kurwie (2009):

“The lower part of their anterior gill arch has 13 to 15 short gill rakers. There are 29 to 31 scales in a lateral series (Boulenger, 1915).”

From Robins (2020):

“Their bodies are essentially oval. The spinous and soft dorsal fins are confluent and originate well behind the head. The spinous dorsal is longer than the soft and the rigid spines, more numerous than the soft rays, are sharp. The caudal fin is fan shaped and truncate. The anal fin tapers to a point rearward and is armed with three stout spines in the front. The pelvic and pectoral fins are of a size proportional to the body and their placement is typical for an acanthopterygian fish. The mouth is terminal and the eye is large. The most distinctive features of this species are features of color.”

“Spotted tilapia vary in appearance according to age. Juveniles are not spotted at all, but bear a series of black bars set upon a yellow green or gold background that extend beyond the body and onto the dorsal fins. […] As the fish age, the juvenile pattern of bars become faint to absent. The new dress is a series of somewhat irregular, large spots centered near the midline of the body. It is for this series of spots that the species has been given its common name. Even on the largest adults however, it is sometimes possible to discern the faded remnants of their once barred pattern. Beyond this basic pattern, adult fish may also exhibit the occasional splash of pink or even an overall darker body tone depending upon the physical condition of the fish or its environment. Rapid changes in coloration in response to stimuli are not unusual in cichlids and have been noted in *Tilapia mariae*. The iris of this species is red.”

Biology

From Nico and Neilson (2023):

“This species is generally a benthic herbivore, with algae, diatoms, detritus, and aquatic macrophytes representing the major portion of its diet (~85%) and terrestrial insects and benthic invertebrates comprising a small fraction (~5%) (Fagade 1971; Ikomi and Jessa 2003). However, in southern Florida, anglers also take it using worms and small shrimps. Spotted tilapia are substrate spawners that exhibit biparental care of offspring (Whitehead and Trewavas [1962]; Schwanck 1989), with reproduction in tropical areas occurring year round with seasonal peaks dependent on local climate (Ikomi and Jessa 2003; King and Etim 2004).”

From Froese and Pauly (2026):

“Live in still or flowing waters in rocky or mud-bottom areas [Allen et al. 2002]. Occur in warm springs and mud-bottomed to sand-bottomed canals [Page and Burr 1991]. […] [Reaches] sexual maturity at 10-15 centimeters length. Parents prepare nest site on logs, leaves and other debris. Prolific species [Lamboj 2004]. The eggs (600-3300 per female) are guarded by the parents and hatch in 1-3 days. Larvae need 6-8 additional days to develop before they can swim freely [Lamboj 2004]. Parental care of the brood continues until the fish are about (1.5 cm, [Lamboj

2004]) 2.5-3.0 centimeters [Allen et al. 2002]. Occurs in mixed groups composed of individuals of varying size/age, along with individuals of other species [Lamboj 2004]."

From Robins (2020):

"Spotted tilapia form pair bonds well in advance of the act of spawning and remain together to care for their young. While a pair tends a brood together, whether their offspring are in the egg stage or have hatched, they are reported to be monogamous. Spawning in this species is believed to take place in the spring and fall. Peak spawning may be related to the lunar cycle — at least for those spotted tilapia inhabiting clear waters. Spawning in relation to lunar periodicity is an unusual trait for a freshwater fish, but it is thought that such a strategy may provide adult spotted tilapia a better opportunity to defend their young from nocturnal predators as they tend to spawn in synchronization with the full moon. Spotted tilapia typically gather together in breeding colonies."

"Spotted tilapia are substrate spawners that prefer the clean underside of rocky surfaces for egg deposition. Females produce approximately 200-400 bluish colored eggs, approximately 1.8mm in diameter, that adhere to the substrate upon which they are laid. Two days or so after spawning the female will remove all fertile eggs to a nearby pit, returning to the original spawning site to consume any infertile eggs. Early stage larvae of *Tilapia mariae* possess "head glands," an unusual feature that allows young tilapia to secure themselves to the substrate via a thread like structure produced by these glands. Secure from the perils of drifting away prior to having developed a functional swimming ability, the nascent tilapia are thought to enjoy the added benefit of having risen above the siltier, less oxygenated waters of the bottom. Young enjoy the protection of both parents and are free swimming at approximately 9 days."

Human Uses

According to Froese and Pauly (2026), *P. mariae* is utilized as a gamefish and in the aquarium industry.

From Robins (2020):

"In West Africa, the spotted tilapia is a source of protein."

Diseases

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

Pariselle et al. (2013) lists *Scutogyrus vanhovei*, *Ciclidogyrus digitatus*, *C. ergensi*, *C. flexicolpos*, *C. lemoallei*, *C. ouedraogoi*, *C. slembroucki*, *C. testificatus*, *C. tiberianus* and *C. tilapiae* as parasites of *Pelmatolapia mariae*.

Threat to Humans

From Froese and Pauly (2026):

"Harmless"

3 Impacts of Introductions

From Kroon et al. (2015):

"Kroon *et al*. (2011) documented that the presence of three non-native species of fishes (*P. reticulata, P. mariae* and *X. maculatus*) significantly changed the composition of species abundance assemblages in the Mulgrave River basin [Australia]. Specifically, five native species of fishes were more abundant at sites without these non-natives, namely *Glossamia aprion* (Richardson 1842), *Hephaestus fuliginosus* (Macleay 1883), and the endemic species *C. rhombosomoides*, *G. bellendenensis* and *T. tropicanus*. This suggests that the presence of the three non-native species of fishes may detrimentally affect the presence and abundance of at least some native species, including species endemic to the Wet Tropics. […] Outside the Wet Tropics region, documented effects of the six non-native fish species include […] (2) aggressive behaviour towards native fishes, such as […] exclusion (*O. mossambicus* and *P. mariae*); (3) diet overlap and food competition (*G. holbrooki, P. reticulata, O. mossambicus and P. mariae*); […] (5) habitat alteration through, e.g. […] nest building (*P. mariae*) (Dussault & Kramer, 1981; Arthington, 1991; Pyke, 2008; Bradford *et al*., 2011; Russell *et al*., 2012). Combined, these potential effects raise concern for the high fish diversity of the Wet Tropics region (Olden *et al*., 2008)."

From Bradford et al. (2011):

"In Nevada, the species competes with smaller native fish and invertebrates for green algae in the desert springs (Courtenay and Deacon 1983)."

From Brooks and Jordan (2010):

"[…] we also provide the first empirical evidence for competitively-induced spatial displacement of *Lepomis* sunfishes by *T. mariae*. Our results suggest that enhanced interspecific aggression has likely contributed significantly to the invasion success of *T. mariae* in South Florida."

"Our laboratory trials demonstrate that *T. mariae* and *Lepomis* sunfishes compete for territory when space is a limiting factor. As *T. mariae* are significantly more aggressive and bolder than their *Lepomis* sunfish counterparts, they have an advantage in the acquisition and retention of territories. *T. mariae* are entirely able to defend their territories from intruding *Lepomis* sunfishes while usurping up to 30% of established *Lepomis* sunfish territories at any given time. Additionally, *T. mariae* outcompete *Lepomis* sunfishes for new territories with nearly 80% of new territories being dominated by *T. mariae* and the other 20% remaining unclaimed."

From GISD (2023):

"*Tilapia mariae* dominates introduced habitats, representing a competitive threat to native species and can lower biodiversity. They are extremely aggressive and territorial while breeding. They are capable of rapid invasion and have high fecundity. *T. mariae* can compete with native fish for resources such as prey or breeding sites which can cause the displacement of native fish species. In much of its introduced range, *T. mariae* is the dominant species both by number and biomass [ACTFR, 2007; Cribb, 2006; GSMFC, 2005]."

From Robins (2020):

"In areas outside of its native range the species has overrun its new environments to the point of becoming a pest. In Queensland, Australia the species is officially classified as an exotic pest fish and attempts to eradicate it from some areas using methods as drastic as the poisoning of a whole body of water have been implemented."

Pelmatolapia maria may be regulated in Florida, Louisiana, Massachusetts, Minnesota, New Hampshire, Nevada, New Mexico, Oklahoma, Texas, Utah, Virginia, Washington, and Wisconsin. See section 1.

4 History of Invasiveness

Pelmatolapia mariae has been introduced to and established populations in the United States, Hong Kong, Germany, and Australia. It has been introduced mainly as an ornamental fish. According to the literature, *P. mariae* is an aggressive species, outcompeting native fishes for space and food. High rates of displacement of *Lepomis* sunfishes by *P. mariae* has been observed. The History of Invasiveness for this species is classified as High.

5 Global Distribution

Figure 1. Known global distribution of *Pelmatolapia mariae.* Observations are reported from Australia, Benin, Cameroon, Côte d'Ivoire, French Polynesia, Germany, Ghana, Guatemala, Hong Kong. Nigeria, and the United States (Alabama, Arizona, Florida, Nevada). Map from GBIF Secretariat (2023). Some observations in the United States (Alabama, Arizona) and French

Polynesia could not be confirmed to represent an established population and were not used in the climate matching analysis. The observations in Germany, Victoria (southern Australia), and Nevada (United States) were not used in the climate matching analysis due to the populations living in the thermally regulated waters (outflows of power plants) which do not reflect ambient climate and cannot be accounted for in the climate matching analysis.

6 Distribution Within the United States

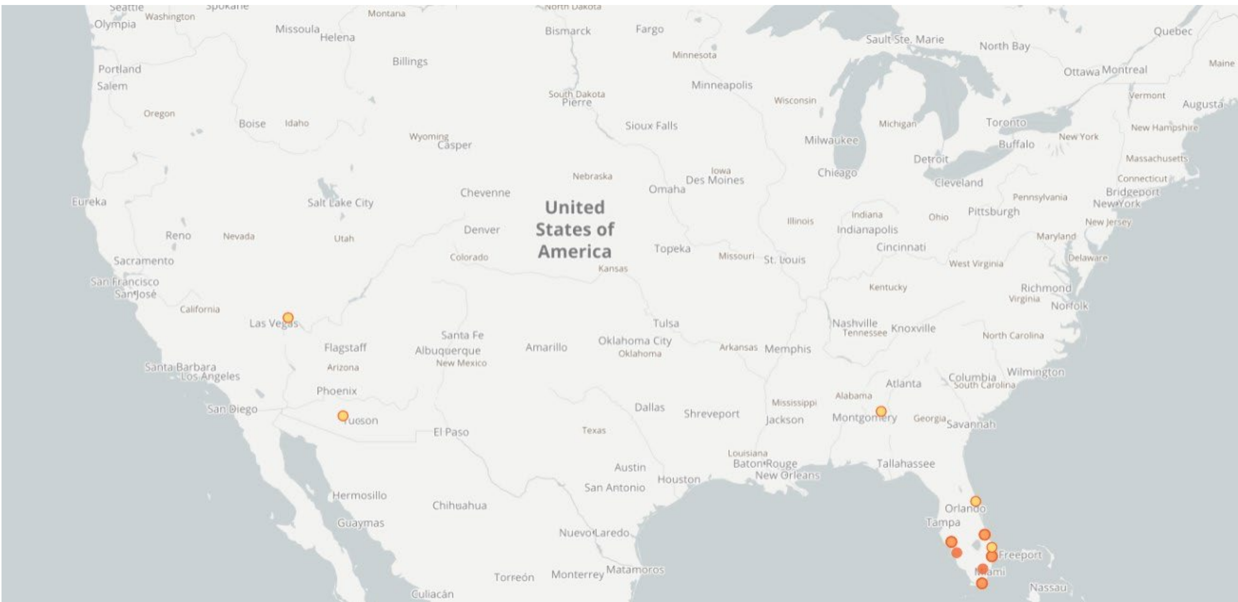

Figure 2. Known distribution of *Pelmatolapia mariae* in the United States. Map from GBIF-US (2023). Observations are reported from Nevada, Arizona, Alabama, and Florida. Locations in Alabama and Arizona were not used as source points in the climate matching analysis because they do not represent established wild populations. The observations in Nevada were from thermally regulated waters which do not reflect ambient climate and cannot be accounted for in the climate matching analysis; these observations were not used as source points in the climate matching analysis.

7 Climate Matching

Summary of Climate Matching Analysis

The climate match for *Pelmatolapia mariae* to the contiguous United States was high across Florida and in southern Texas. Small areas of high match were also found along the Gulf and Southern Atlantic coasts. Areas of low climate match were found in the West, Northern Plains, interior Southeast, and Northeast. The overall Climate 6 score (Sanders et al. 2023; 16 climate variables; Euclidean distance) for the contiguous United States was 0.178, 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 match analysis may underrepresent where the species could become established as it is known to be able to establish in thermally regulated waters in temperate areas.

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

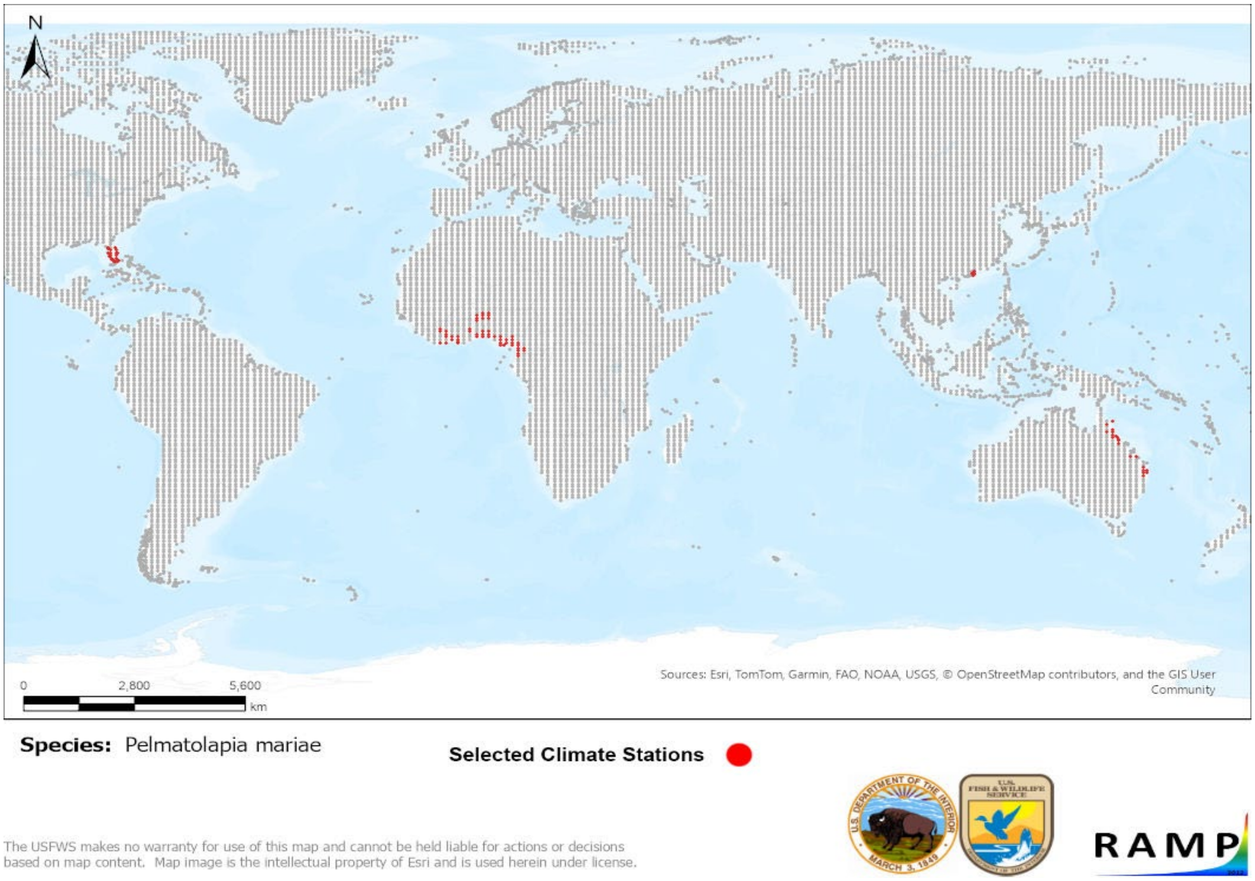

Figure 3. RAMP (Sanders et al. 2023) source map showing weather stations across the world selected as source locations (red; Australia, Benin, Cameroon, China, Côte d'Ivoire, Equatorial Guinea, Ghana, Hong Kong, Niger, Nigeria, Togo, and United States [Florida]) and non-source locations (gray) for *Pelmatolapia mariae* climate matching. Source locations from GBIF Secretariat (2023). Selected source locations are within 100 km of one or more species occurrences, and do not necessarily represent the locations of occurrences themselves.

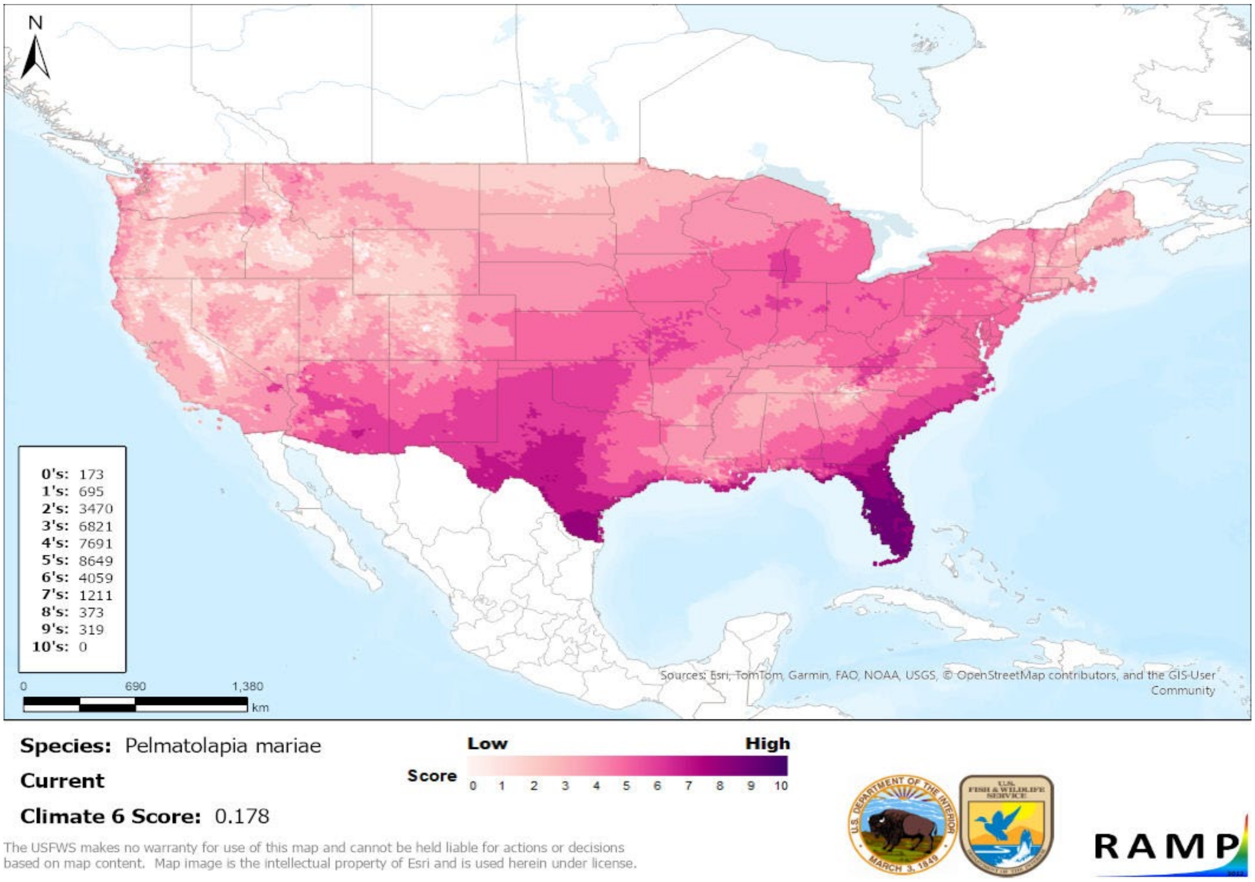

Figure 4. Map of RAMP (Sanders et al. 2023) climate matches for *Pelmatolapia mariae* in the contiguous United States based on source locations reported by GBIF Secretariat (2023). Counts of climate match scores are tabulated on the left. 0/Pale Pink = Lowest match, 10/Dark Purple = Highest match.

8 Certainty of Assessment

Information on the biology and distribution of *Pelmatolapia mariae* was available, as well as information on negative impacts of *P. mariae* on native species where it has invaded. A history of specimen misidentification has led to this species being erroneously noted as introduced in some locations. The climate match may underrepresent areas where the species could become established as it can establish in thermally regulated waters in locations that might otherwise be too cold. The Certainty of Assessment for *P. mariae* is classified as High.

9 Risk Assessment

Summary of Risk to the Contiguous United States

Pelmatolapia mariae, the spotted tilapia, is an adaptable and aggressive fish native to coastal drainages of west central Africa. This species is a benthic herbivore but is also known to eat small invertebrates. It is typically found in flowing waters and can tolerate brackish water. *P. mariae* is an aquarium species and has the potential to be raised for aquaculture purposes. It is a known food source in its native range. This species is regulated in Texas under its current genus of *Pelmatolapia* and 14 other U.S. States under the genus *Tilapia* or the umbrella of all tilapia species (see section 1). *P. mariae* has been introduced and become established in Florida, eastern Australia, Hong Kong, and Germany. In Germany and southern Australia, *P. mariae* has become established in thermally regulated waters. Records of introductions exist in Nevada, Arizona, and California but due to the uncertainty of these records, including potential misidentifications, the status in those locations is unknown. Negative effects from this species' introduction have been reported, including impacts to native sunfishes. The History of Invasiveness for *P. mariae* is High due to its ability to outcompete native fish for habitat and food. The climate matching analysis for the contiguous United States indicates establishment concern for this species. The highest climate match was recorded in Florida (where this species is established) and portions of southern Texas. The Certainty of Assessment is High due to the known introductions and documented negative impacts. The Overall Risk Assessment Category for *Pelmatolatpia mariae* 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: *Pelmatolapia mariae* can establish in thermally regulated waters in temperate climates.**
- **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 *Pelmatolapia mariae* 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 Great Basin and Western Mountains regions. Areas and extent of high and low match had consistency across SSP and time step scenarios. The Climate 6 scores for the individual future scenario models (figure A2) ranged from a low of 0.133 (model: MPI-ESM1-2-HR, SSP5, 2085) to a high of 0.207 (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 (0.178, 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 (figure A3). Primarily under the 2085 time step, small areas within California, the Colorado Plateau, Great Basin, Great Lakes, Northern Pacific Coast, Northern Plains, and Western Mountains regions saw a moderate increase in the climate match relative to current conditions. No large increases were observed regardless of time step and climate scenarios. Also primarily under the 2085 time step, small areas within the Appalachian Range, Gulf Coast, Southeast, Southern Atlantic Coast, Southern Florida, and Southwest 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).

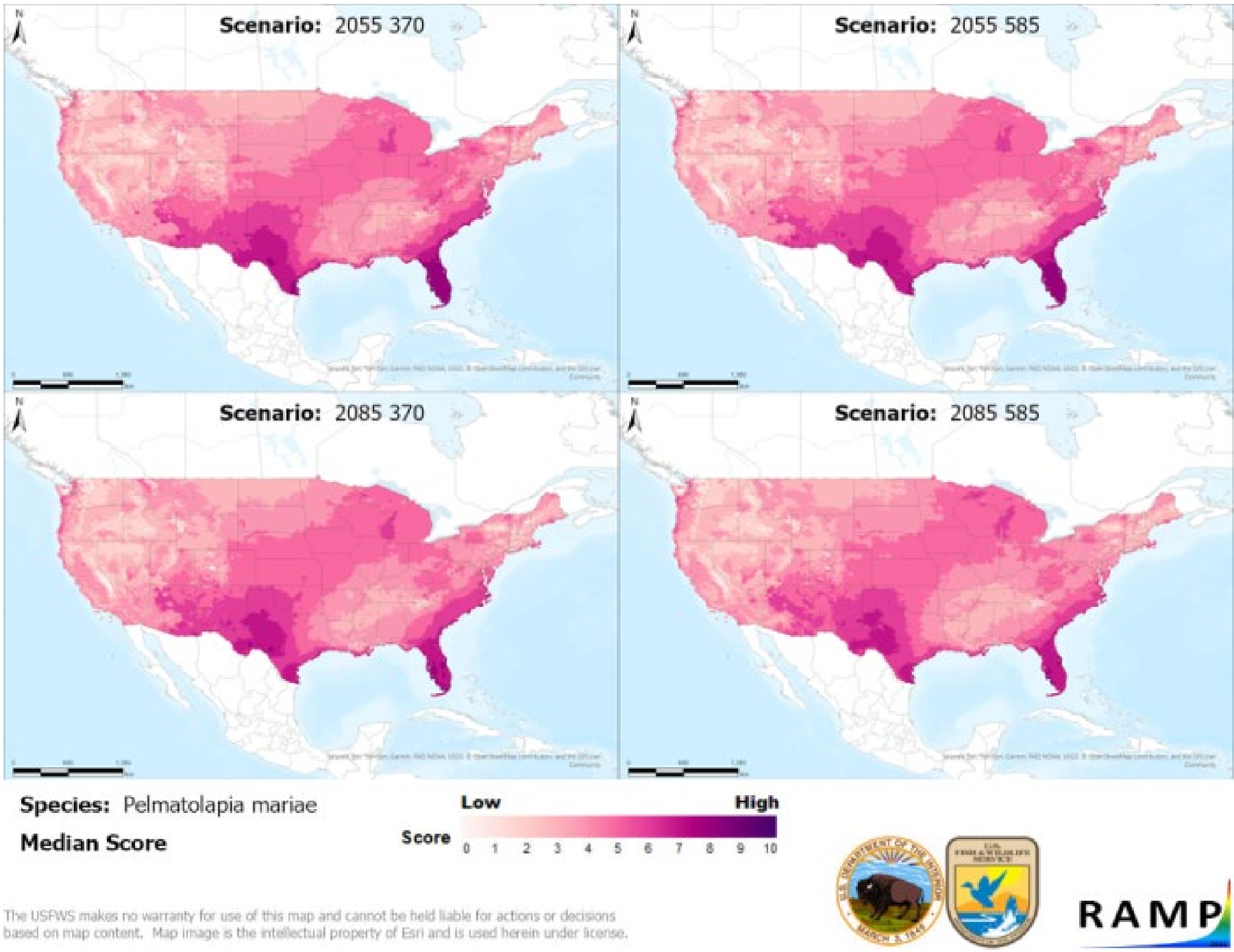

Figure A1. Maps of median RAMP (Sanders et al. 2023) climate matches projected under potential future climate conditions using five global climate models for *Pelmatolapia mariae* in the contiguous United States. Climate matching is based on source locations reported by GBIF Secretariat (2023). Shared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

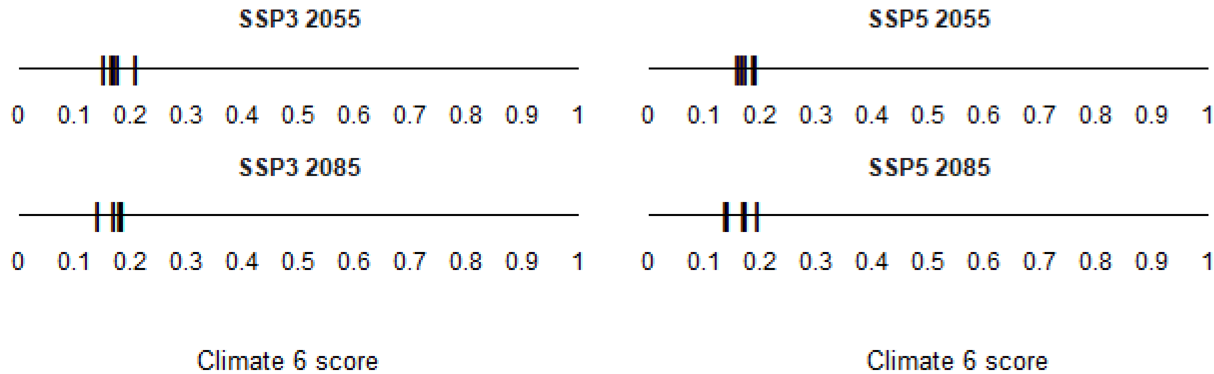

Figure A2. Comparison of projected future Climate 6 scores for *Pelmatolapia mariae* in the contiguous United States for each of five global climate models under four combinations of Shared Socioeconomic Pathway (SSP) and time step. SSPs used (from left to right): SSP3, SSP5 (Karger et al. 2017, 2018;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

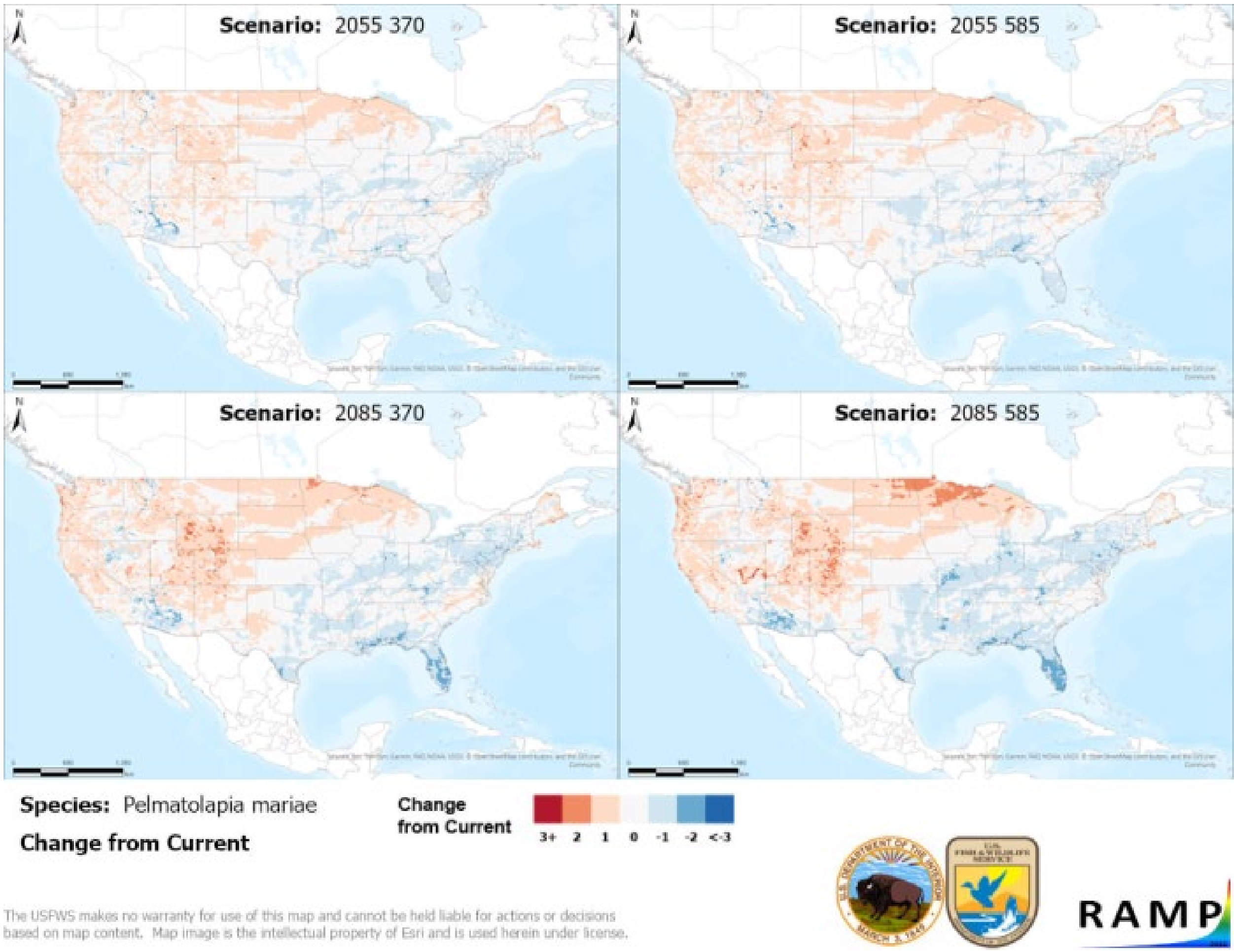

Figure A3. RAMP (Sanders et al. 2023) maps of the contiguous United States showing the difference between the current climate match target point score (figure 4) and the median target point score for future climate scenarios (figure A1) for *Pelmatolapia mariae* based on source locations reported by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