Rio Grande Cichlid (*Herichthys cyanoguttatus*)

Ecological Risk Screening Summary

U.S. Fish and Wildlife Service, February 2025
Revised, April 2025
Web Version, 6/13/2025

Organism Type: Fish
Overall Risk Assessment Category: High

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1 Native Range and Status in the United States

Native Range

From NatureServe (2025):

"This is the northernmost representative of the family. Native range includes the Nueces River and lower Rio Grande drainages in Texas and northeastern Mexico, excluding the Rio Conchos basin (Miller 2005, Page and Burr 2011) and extends southward into the upper Rio Soto la Marina in Mexico (Miller 2005)."

From Nico et al. (2025):

"Tropical and subtropical America. Northeast Mexico and southern Texas, on the Atlantic Coast from the Río Conchos to the Río Grande basin. Native Texas range limited to the Nueces and Rio Grande drainages (Hubbs et al. 1978)."

Status in the United States

From NatureServe (2025):

"This is the northernmost representative of the family. Native range includes the Nueces River and lower Rio Grande drainages in Texas […], excluding the Rio Conchos basin (Miller 2005, Page and Burr 2011) […]. Introduced in Edwards Plateau region of central Texas and in Florida. Introduced and established in Louisiana (Douglas and Jordan 2002, Fuentes and Cashner 2002)."

From Nico et al. (2025):

"Introduced and established or locally established in parts of Florida, Louisiana, and Texas. It was established locally in a power plant lake in Illinois but the species no longer is thought to be reproducing in that state (Laird and Page 1996). It was reported from Arizona and Nebraska. Formerly established in Nevada, but now considered extirpated in that state."

Nico et al. (2025) report additional nonindigenous occurrences of *Herichthys cyanoguttatus* in Ohio, Oklahoma, and Puerto Rico. They record a status of 'failed' for observations from Arizona, Nebraska, Ohio; a status of 'established' in Puerto Rico; and a status of 'unknown' for Oklahoma.

Herichthys cyanoguttatus is available in the pet trade in the United States (e.g., Aquatics Unlimited 2025; Tampa Bay Cichlids 2025), although no estimates of trade volume were available.

Regulations

Herichthys cyanoguttatus is regulated in Hawaii (HDOA 2019) and Louisiana (Louisiana Revised Statutes 2022). Please refer back to state agency regulatory documents for details on the regulations, including restrictions on activities involving this species. While effort was made to find all applicable regulations, this list may not be comprehensive. Notably, it does not include regulations that do not explicitly name this species or its genus or family, for example, when omitted from a list of authorized species with blanket regulation for all unnamed species.

Means of Introductions within the United States

From Nico et al. (2025):

"*Herichthys cyanoguttatum* was brought to the Guadalupe River drainage by the Fish Cultural Station, part of the U.S. Fish and Wildlife Service, at San Marcos, Texas, in 1928 and released into waters on the Edwards Plateau between 1928 and 1941 or 1943 (Brown 1953; Hubbs et al.

1978). Presumably, San Antonio River stocks came from near Mission, Texas (Hubbs et al. 1978). The species reportedly was introduced into Florida from Texas stocks around 1941 by a private individual from Mulberry, Polk County. The same individual is reported as having made additional introductions at Mulberry over a period of several years (Courtenay and Hensley 1979). A fish farm may have been the source of introduction into Six Mile Creek, Hillsborough County, Florida, because this species was cultured as an aquarium fish during the 1940s and early 1950s under the trade name "Texas bluespot" (Burgess 1958; Courtenay and Hensley 1979). Some Florida introductions supposedly were due to flooding of resident fish farms (Conkel 1993). Introductions elsewhere were most likely the result of aquarium releases or fish farm escapes."

From Maddern (2015):

"The further spread of *H. cyanoguttatus* by natural dispersal may occur in the USA. Lorenz (2008) stated that the species was further dispersed in bayous in the New Orleans area in Louisiana by hurricane Katrina during 2005."

Remarks

This ERSS was previously published in October 2019. Revisions were completed to incorporate new information and conform to updated standards.

From Maddern (2015):

"The internationally preferred common name of *H. cyanoguttatus* is the Rio Grande cichlid, though the species is commonly referred to in aquarium literature as the Texas cichlid (e.g. Berg, 2010; Seriously Fish, 2015). In Australia, the species is only known as the Texas cichlid. Within the ornamental fish industry, strains of *H. cyanoguttatus* are available that include the blue Texas cichlid, green Texas cichlid and red Texas cichlid (Berg, 2010). These common names may refer to colour variants of *H. cyanoguttatus* as well as to hybrids and entirely different species."

From NatureServe (2025):

"Formerly this species was included in the genus *Cichlasoma*; Page and Burr (2011) included it in the genus *Herichthys*."

"U.S. subspecies is *cyanoguttatum*; several trophic morphs (not taxa) occur in Cuatro Cienegas basin of Mexico (Lee et al. 1980)."

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 ITIS (2025):

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 *Herichthys*
Species *Herichthys cyanoguttatum* Baird and Girard, 1854

According to Fricke et al. (2025), *Herichthys cyanoguttatus* is the current valid name for this species. The taxonomic hierarchy presented by ITIS (2025) uses a misspelling of the species name but is valid for higher levels.

The following synonyms for *Herichthys cyanoguttatus* from Maddern (2015) were used to search for information for this report: *Cichlasoma cyanoguttatum, Cichlasoma pavonaceum, Herichthys cyanoguttatum, Heros pavonaceus*, and *Parapetenia cyanostigma*.

Size, Weight, and Age Range

From Froese and Pauly (2025):

"Max length : 30.0 cm TL [total length] male/unsexed; [Page and Burr 1991]; common length : 11.3 cm TL male/unsexed; [Hugg 1996]"

Environment

From Froese and Pauly (2025):

"Freshwater; benthopelagic; pH range: 6.5 - 7.5; dH range: 5 - 12. […] 20°C - 33°C [Conkel 1993; assumed to be aquarium water temperature range]"

From Maddern (2015):

"*H. cyanoguttatus* is known as a pollution-tolerant species that has been observed to dominate in degraded habitats. It is used by San Antonio River Authority biologists as a biological indicator of unbalanced or stressed ecosystems (Gonzales and Moran, 2005)."

“Lorenz (2008) reported that salinities up to 16 ppt had no significant effect on the growth of *H. cyanoguttatus*. It has been recorded at salinities as high as 27 psu, but long-term survival (one year) was poor at 16 psu (Lorenze, unpublished data).”

“Introduced populations of *H. cyanoguttatus* occur in estuarine environments in the New Orleans area (Lake Pontchartrain) of Louisiana. They have been observed to spawn there in salinities as high as 8 psu (OT Lorenz, Georgia Southwestern State University, USA, personal communication, 2015).”

“*H. cyanoguttatus* is one of the most cold-tolerant cichlids. Lee et al. (1980) (referencing Hubbs, 1951) reported a lower temperature tolerance of between 14°C and 19°C for fish at Colorado River in Austin, Texas, USA.”

“Low water temperatures probably restrict the northern spread of *H. cyanoguttatus* in the USA. Tomelleri and Eberle (1990) report that the species can only survive cool winters in the ‘cooling lakes’ of power plants or in rivers near the outlets of warm springs at the northern limit of its distribution in the Edwards Plateau, Texas, USA.”

“The temperature tolerance of *H. cyanoguttatus* goes below 7°C in outdoor artificial ponds and it can be active at 10°C (Lorenz, unpublished data). Shafland and Pestrak (1982), reported a lower lethal temperature of 5°C under experimental conditions.”

From Soto Galera (2019):

“[…] depths to 2.75 m, usually 1.5m or less (Miller et al., 2005).”

Climate

From Froese and Pauly (2025):

“Subtropical; […] 32°N - 25°N”

Distribution Outside the United States

Native

A portion of the native range of *Herichthys cyanoguttatus* is within the United States, see section 1 for a full description.

From NatureServe (2025):

“Native range includes the […] lower Rio Grande drainages in […] northeastern Mexico, excluding the Rio Conchos basin (Miller 2005, Page and Burr 2011) and extends southward into the upper Rio Soto la Marina in Mexico (Miller 2005).”

Introduced
From Froese and Pauly (2025):

“Introduced […] Verde River basin (La Media Luna region), Mexico [Kullander 2003].”

“Reported from Kai Tak River [Hong Kong].”

Froese and Pauly (2025) also list an introduction to the Philippines in 1970 but report the status of that introduction as ‘unknown.’

Xiong et al. (2015), citing Mu et al. (2008), report *Herichthys cyanoguttatus* as present in China. However, they also report its status as uncertain.

Means of Introduction Outside the United States

From Froese and Pauly (2025):

“Reason: ornamental”

From Xiong et al. (2015):

“Aquarium”

Short Description

From Maddern (2015):

“Its morphology and colour pattern vary greatly across its natural and introduced range (Miller et al., 2005).”

“Juvenile *H. cyanoguttatus* are pearly grey with white dots on the body and fins and two characteristic black spots on the centre of the body and the caudal fin base (Berg, 2010).”

“Adults are dusky to olive above with 4-6 dark blotches (1st blotch most prominent) along the rear half of the body and a black blotch on caudal fin base. There are numerous small white to blue spots on blue-green or grey sides. There are iridescent blue-green spots or wavy lines on head, body and fins. Females are generally less colourful than males (Page and Burr, 1991). Breeding adults have a white head and front half of the body, and the rear half of the body, particularly the ventral surface, is black (Page and Burr, 1991; Berg, 2010).”

“There are 5 or 6 anal fin spines; 15-18 dorsal fin spines; 10-12 dorsal rays and 9-10 anal rays (Hubbs et al., 1991; Page and Burr, 1991). There is one nostril opening on each side of the head and an interrupted lateral line (Itzkowitz and Nyby, 1982) that is doubled for a short distance on the caudal peduncle (Tomelleri and Eberle, 1990). Breeding males have a prominent nuchal hump (Page and Burr, 1991), and males are typically larger than females (Itzkowitz and Nyby, 1982).”

Biology

From Maddern (2015):

"Parental care of offspring exhibited by cichlid fishes greatly increases offspring survival rates. *H. cyanoguttatus* is a biparental substrate spawner/brooder with preferred spawning sites usually solid substrates (rocks) in shallow water (Itzkowitz and Nyby, 1982). Pair formation occurs before territory establishment and pairs will actively defend their territory to defend the eggs and fry. Both parents are active in guarding the eggs and fry though the male and female alternate in the performance of parental responsibilities. Males appear to spend more time patrolling the pair's territory, whereas females spend more time in close proximity to and attending the eggs/fry. Although breeding pairs will attack most other fishes in the vicinity of the nest, attacks are more pronounced against conspecifics. Itzkowitz and Nyby (1982) reports that established pairs will travel up to 3 m to harass newly formed pairs/conspecifics."

"Seriously Fish (2015) states that eggs hatch in 2-3 days and the parents immediately move the fry to a pre-excavated pit in the substrate where the fry remain until the yolk sac is absorbed. The fry will become free swimming in 4-5 days."

"The species matures at approximately 100 mm standard length (SL), after one year of growth (Buchanan, 1971)."

"*H. cyanoguttatus* is diurnal and nonmigratory (Froese and Pauly, 2015)."

"*H. cyanoguttatus* is omnivorous with great variation observed in diets of specimens in differing locales. Tomelleri and Eberle (1990) report that the dentition of the species suggests a chiefly carnivorous diet that may include fish eggs, insects and small fishes."

"Buchanan (1971) reported that fish from indigenous populations in the Rio Grande valley (south Texas) were omnivorous, whereas introduced populations from the San Marcos River (Edwards Plateau, central Texas) were almost exclusively herbivorous. Buchanan (1971) suggested the competitive interactions between *H. cyanoguttatus* and a diverse assemblage on centrarchids resulted in a more diverse diet in native populations."

"Darnell (1962) and Birkhead (1980) recorded that populations from northeastern Mexico were detritivorous."

"Mills and Vevers (1989) report a diet of worms, crustaceans, insects and plant matter."

From Soto Galera (2019):

"Ponds, lagoons, creeks, rivers (in pools and backwaters), and springs, thriving under lake like conditions in slight to strong currents and clear to murky or turbid water; substrates boulders, bedrock, stones, mud, sand, clay; vegetation green algae, Chara, Myriophyllum, Ceratophyllum, Ludwigia, water lilies, Utricularia, Typha, Juncus, water hyacinth, Vallisneria, Potamogeton […]"

From NatureServe (2025):

"Spawns March-August with peak in April in San Marcos River, Texas. Apparently spawns in late spring in northeastern Mexico."

"Habitat includes rivers and, in Edwards Plateau region, larger springs and their outflows where winter water temperatures are favorable (Lee et al. 1980); pools and runs of small to large rivers; prefers warm water and vegetation (Page and Burr 2011). This species often thrives in disturbed habitats."

Human Uses

From Maddern (2015):

"*H. cyanoguttatus* is a moderately popular ornamental fish species maintained by hobbyists worldwide."

"*H. cyanoguttatus* is captured by recreational anglers and the species is considered very palatable (Mardon, 2012; Texas Parks and Wildlife, 2015). In Louisiana, USA, they are often eaten and are popular with fly fishermen (OT Lorenz, Georgia Southwestern State University, USA, personal communication, 2015). In Mexico, *Herichthys* species, including both *H. cyanoguttatus* and *H. carpintis*, are considered legitimate food fish."

"*H. cyanoguttatus* is used by San Antonio River Authority biologists as an indicator of unbalanced or stressed ecosystems as it is pollution tolerant (Gonzales and Moran, 2005)."

From Soto Galera (2019):

"This species is of minor value in commercial aquaria."

Diseases

No information was found associating *Herichthys cyanoguttatus* with any diseases listed by the World Organisation for Animal Health (2025).

From Froese and Pauly (2025):

"List of diseases for *Herichthys cyanoguttatus* […]
Cryptobia Infestation (Cryptobia iubilans.), Parasitic infestations (protozoa, worms, etc.)
Crassicutis Infection, Parasitic infestations (protozoa, worms, etc.)
Genarchella Infection, Parasitic infestations (protozoa, worms, etc.)
Rhabdochona Infestation 6, Parasitic infestations (protozoa, worms, etc.)"

From Maddern (2015):

"Salgado-Maldonado et al. (2004) listed *H. cyanoguttatus* as host to the following parasites: *Crassicutis cichlasomae, Centrocestus formosanus, Clinostomum complanatum, Diplostomum*

sp., Posthodiplostomum minimum, Bothriocephalus acheilognathi, Neoechinorhynchus golvani, Rhabdochona kidderi and *Contracaecum* sp."

From Moravec et al. (2012):

"Moravec & Huffman (1988) described conspecific nematodes from the cichlids *Herichthys cyanoguttatus* and *Oreochromis mossambicus* (Peters) […] from central Texas, USA, for which they established an independent subspecies, *Rhabdochona kidderi texensis* Moravec & Hoffman [sic], 1988 […]"

From Salgado-Maldonado and Pineda-López (2003):

"[*Bothriocephalus*] *acheilognathi* [Asian fish tapeworm] is reported from Mexico for the first time in […] *Cichlasoma cyanoguttatum* [synonym of *Herichthys cyanoguttatus*] […]"

Poelen et al. (2014) lists the following additional parasites of *Herichthys cyanoguttatus*: *Aeromonas jandaei*, *Camallanus oxycephalus*, *Clinostomum*, *Crassicutis bravoae*, *Genarchella isabellae*, *Leptorhynchoides thecatus, Neoechinorhynchus cylindratus*, *Sciadicleithrum bravohollisae*, and *Spiroxys*.

Threat to Humans

From Nico et al. (2025):

"In an isolated incident, Rio Grande Cichlids where observed biting several swimmers in the Frio River, TX. The swimmers sustained several abrasions on their ankles. Texas Parks and Wildlife Department assumed that the swimmers had disturbed the nests of the cichlids (Texas Chapter American Fisheries Society 2016)."

3 Impacts of Introductions

From Maddern (2015):

"Laboratory intraspecific behavioural studies have shown that *H. cyanoguttatus* is aggressive as an invader into the territory of heterospecifics, and also as a territorial holder or resident (Turner, 1994, Draud et al., 2004). These research findings are supported by Lorenz (2008) and Lorenz et al. (2011) who conducted interspecific behavioural experiments to examine potential agonistic interactions between *H. cyanoguttatus* and the US native centrarchid bluegill *Lepomis macrochirus*. It was found that *H. cyanoguttatus* was highly aggressive both as a territory holder and also entering the territory of *L. macrochirus* indicating potential competition for space with native centrarchids. These authors concluded that these behaviours may suggest a mechanism for the continued range expansion of *H. cyanoguttatus* in Louisiana, USA. Both Courtenay et al. (1974) and the personal observations of Lorenz (2008) support the proposition that *H. cyanoguttatus* competes with *L. macrochirus* for breeding sites in Florida and Louisiana, respectively."

“Lorenz (2008) also provided anecdotal field observations of agonistic behaviour between *H. cyanoguttatus* and largemouth bass (*Micropterus salmoides*), western mosquitofish (*Gambusia affinis*), sailfin mollies (*Poecilia latipinna*) and blue crabs (*Callinectes sapidus*). Similarly, Lorenz (2008) cited anecdotal evidence of the decline *of Gambusia affinis, Poecilia latipinna* and *Heterandria formosa* in areas of Louisiana where *H. cyanoguttatus* has become well established.”

“Mire (2001, referenced in Lorenz, 2008) recorded that agonistic behaviour of *H. cyanoguttatus* may cause the reproductive failure of native sheepshead minnows (*Cyprinodon variegatus*) in experimental pools.”

“San Antonio River Authority biologists in Texas have observed that *H. cyanoguttatus* will displace native Centrarchidae in stressed habitats and dominate the ecosystem (Gonzales and Moran, 2005).”

“*H. cyanoguttatus* may predate on aquatic invertebrate communities (Lorenz et al., in review).”

From Espinosa-Pérez and Ramírez (2015):

“Some authors mentioned that this species has already hybridized with a native closely related species in Cuatro Cienegas, Coahuila [Mexico], however this has not been well documented ([Hulsey et al. 2004]).”

The States of Hawaii and Louisiana regulate *Herichthys cyanoguttatus*. See section 1.

4 History of Invasiveness

The History of Invasiveness for *Herichthys cyanoguttatus* is classified as High. There are records of nonnative introductions of *Herichthys cyanoguttatus* that have resulted in established populations. There is documented information of aggressive behavior towards native species, displacement of native species, and hybridization with native species as results of these introductions. The information on these negative impacts comes from observations in the field and behavioral studies in the laboratory described in several reliable peer-reviewed sources.

5 Global Distribution

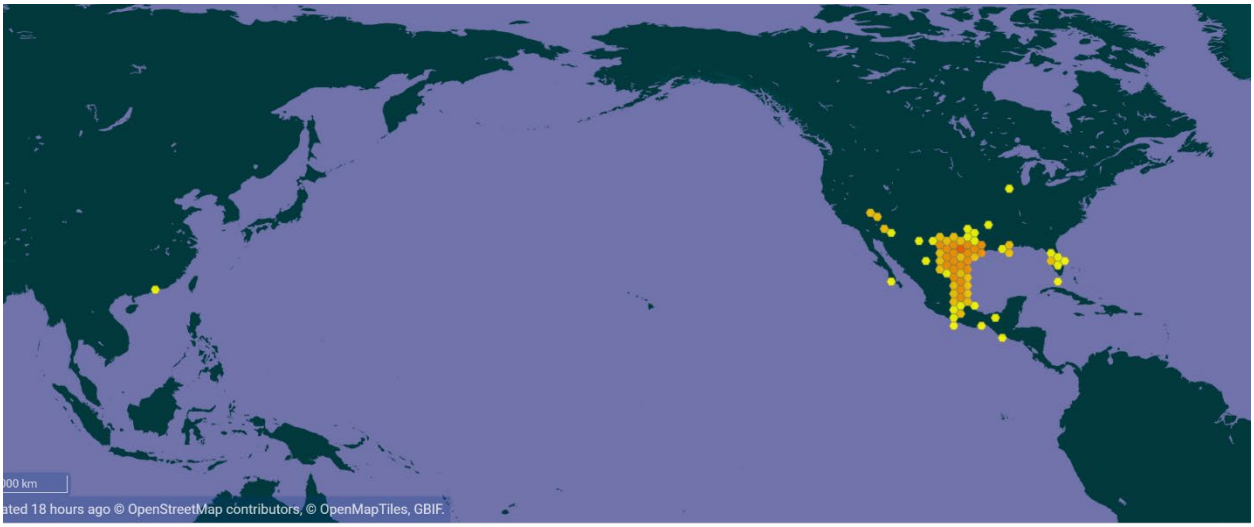

Figure 1. Reported global distribution of *Herichthys cyanoguttatus*. Map from GBIF Secretariat (2023). Observations are reported from the United States, Mexico, Guatemala, and Hong Kong. Points in Hong Kong and Guatemala do not represent established populations. Therefore, these points were excluded from climate matching analyses. Northern and western observations in the United States were also not used in the climate matching analysis, see section 6.

6 Distribution Within the United States

Figure 2. Reported distribution of *Herichthys cyanoguttatus* in the contiguous United States. Map from Nico et al. (2025). Observations are reported from Arizona, Florida, Illinois, Louisiana, Nebraska, Nevada, Ohio, Oklahoma, and Texas. Points in Arizona, Oklahoma, Ohio, Nebraska, and Nevada do not represent currently established populations; points in Illinois represent populations from a warmwater discharge facility. These points were excluded from climate matching analyses. Established populations in thermal water environments, such as the one in Illinois, were not included in the climate matching analysis because the environmental conditions experienced by these populations do not reflect the ambient climate in their location.

Figure 3. Reported distribution of *Herichthys cyanoguttatus* in Puerto Rico. Map from Nico et al. (2025). Observations are reported from Loiza Reservoir in Trujillo Alto County.

7 Climate Matching

Summary of Climate Matching Analysis

On average, the climate match for *Herichthys cyanoguttatus* was high across portions of the Gulf Coast, Southeast, Southern Atlantic Coast, Southern Florida, Southern Plains, and Southwest regions. The areas of high match included the portion of the species' native range that is found within the United States. Areas of low climate match were found in portions of the Northeast, Northern Pacific Coast, and Western Mountain regions. The overall Climate 6 score (Sanders et al. 2023; 16 climate variables; Euclidean distance) for the contiguous United States was 0.564, 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 2023). A population of *Herichthys cyanoguttatus* was known to be established in a thermal outflow and was not represented in the climate match which matches to ambient climate conditions.

Projected climate matches in the contiguous United States under future climate scenarios are available for *Herichthys cyanoguttatus* (see Appendix). These projected climate matches are provided as additional context for the reader; future climate scenarios are not factored into the Overall Risk Assessment Category.

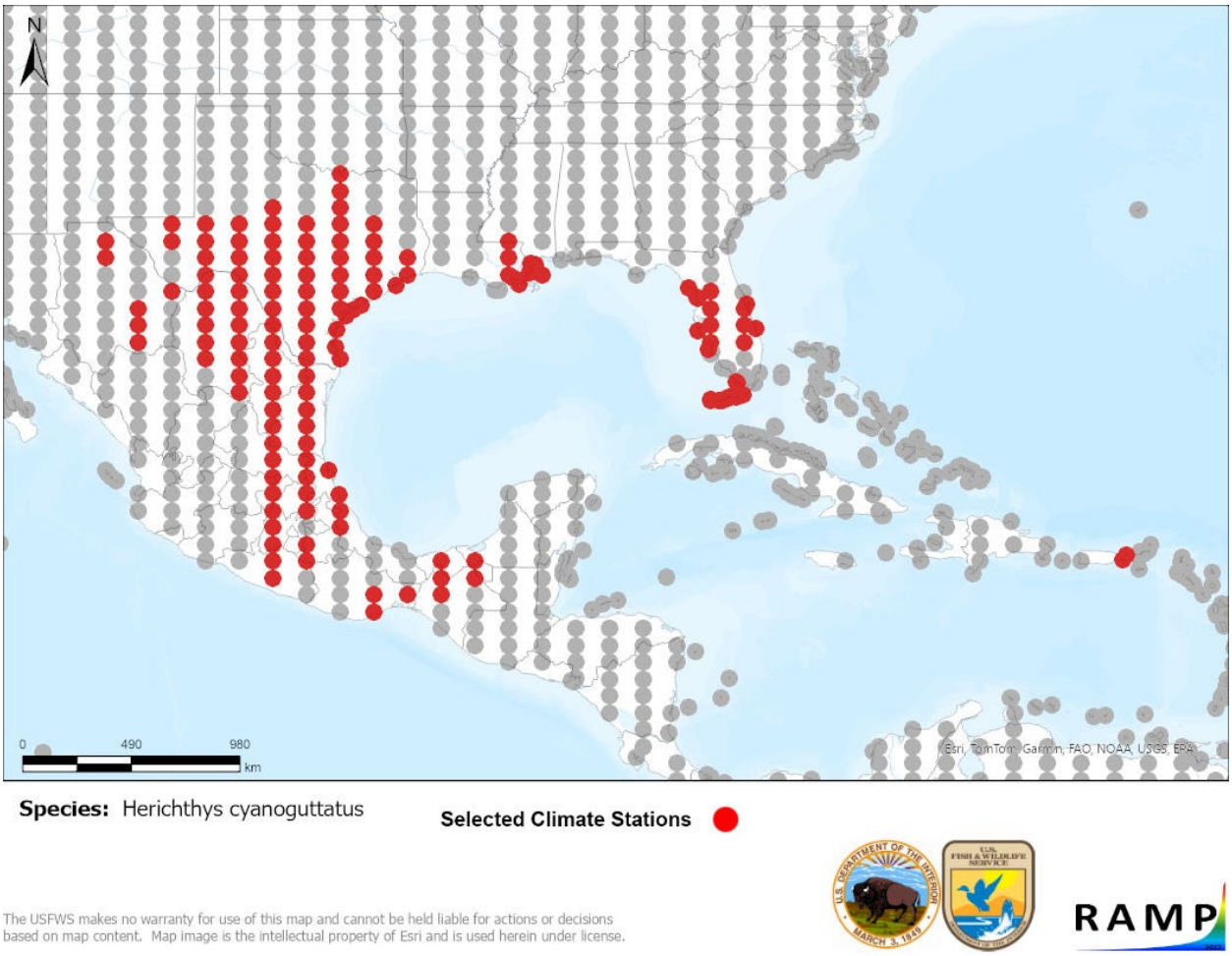

Figure 4. RAMP (Sanders et al. 2023) source map showing weather stations in southern United States and Mexico selected as source locations (red; Florida, Texas, Louisiana, Puerto Rico, and Mexico) and non-source locations (gray) for *Herichthys cyanoguttatus* climate matching. Source locations from GBIF Secretariat (2023) and Nico et al. (2025). Selected source locations are within 100 km of one or more species occurrences, and do not necessarily represent the locations of occurrences themselves.

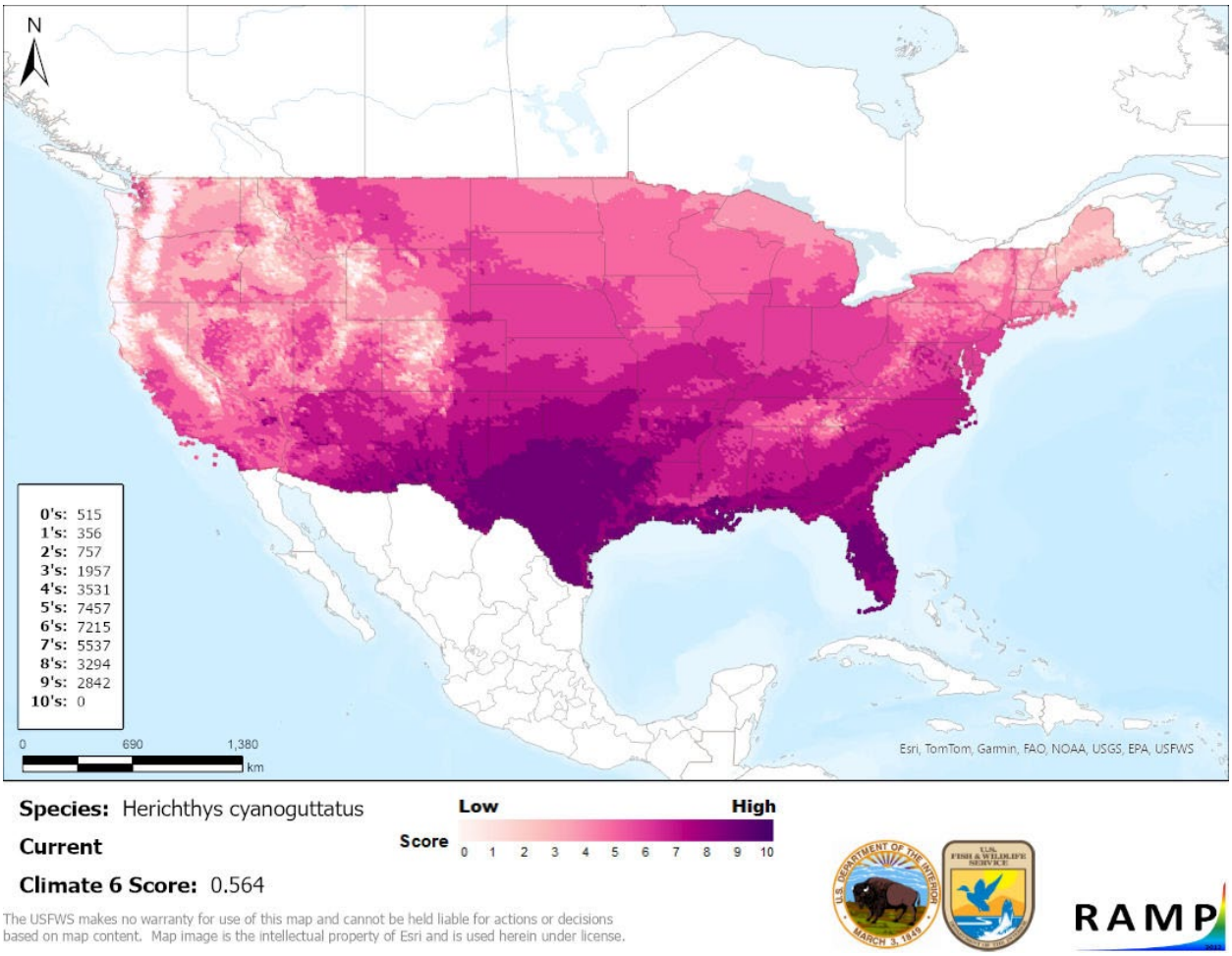

Figure 5. Map of RAMP (Sanders et al. 2023) climate matches for *Herichthys cyanoguttatus* in the contiguous United States based on source locations reported by GBIF Secretariat (2023) and Nico et al. (2025). Counts of climate match scores are tabulated on the left. 0/Pale Pink = Lowest match, 10/Dark Purple = Highest match.

8 Certainty of Assessment

The Certainty of Assessment for *Herichthys cyanoguttatus* is classified as High. There is sufficient information relating to the species distribution, biology, and ecology. Records of nonnative introduction and establishment were found. Most of the information available on *Herichthys cyanoguttatus* distribution and impacts is clear and convincing from peer-reviewed scientific literature. There is evidence that *Herichthys cyanoguttatus* can become established in thermally polluted waters, although these occurrences were not included in the climate matching analysis, which addresses ambient environmental conditions.

9 Risk Assessment

Summary of Risk to the Contiguous United States

Herichthys cyanoguttatus, Rio Grande Cichlid, is a fish that is native to Mexico and southern Texas. This fish can inhabit a wide range of environmental conditions but may be limited by cold

water. Breeding pairs will provide parental care of eggs and fry. *Herichthys cyanoguttatus* is utilized as a sport and food fish and found in the aquarium trade. This species has been introduced and become established outside of its native range, with aquaculture and the aquarium trade being the predominant pathways for introductions. The States of Hawaii and Louisiana regulate *Herichthys cyanoguttatus.* The History of Invasiveness for *Herichthys cyanoguttatus* is classified as High due to records of nonnative introductions that have resulted in established populations. Existing research has documented the aggressive behavior of *Herichthys cyanoguttatus* towards native species, with implications for the reproductive success and population trends of native species. Hybridization with native species has also been reported. The climate matching analysis for the contiguous United States indicates establishment concern for this species outside its native range. *Herichthys cyanoguttatus* has an overall high climate match with the contiguous United States, with highest matches occurring in the Gulf Coast states and lower matches occurring in most northern and western states. The Certainty of Assessment for this ERSS is classified as High. The Overall Risk Assessment Category for *Herichthys cyanoguttatus* 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: Can become established in thermally polluted waters**
- **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) and Nico et al. (2025).

Under the future climate scenarios (figure A1), on average, high climate match for *Herichthys cyanoguttatus* was projected to occur in the Gulf Coast, Mid-Atlantic, Southern Atlantic Coast, Southern Florida, and Southern Plains regions of the contiguous United States. Areas of low climate match were projected to occur in the Northern Pacific Coast region and along the Cascade and Sierra-Nevada ranges. The Climate 6 scores for the individual future scenario models (figure A2) ranged from a low of 0.608 (model: MPI-ESM1-2-HR, SSP5, 2085) to a high of 0.804 (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 under future scenarios. The Climate 6 score for the current climate match (0.564, figure 5) falls below 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. Primarily under the 2085 time step in both SSP3 and SSP5, areas within the Colorado Plateau, Great Basin, Great Lakes, and Northeast saw a large increase in the climate match relative to current conditions. Under one or more time step and climate scenarios, areas within the Appalachian Range, Mid-Atlantic, Northern Plains, Southern Plains, and Western Mountains saw a moderate increase in the climate match relative to current conditions. Primarily under the 2085 time step in both SSP3 and SSP5,, areas within the Gulf Coast saw a large decrease in the climate match relative to current conditions. Additionally, areas within the Southeast, Southern Atlantic Coast, Southern Florida, Southern Plains, and Southwest saw a moderate decrease in the climate match relative to current conditions under one or more time step and climate scenarios. Additional, very small areas of large or moderate change may be visible on the maps (figure A3).

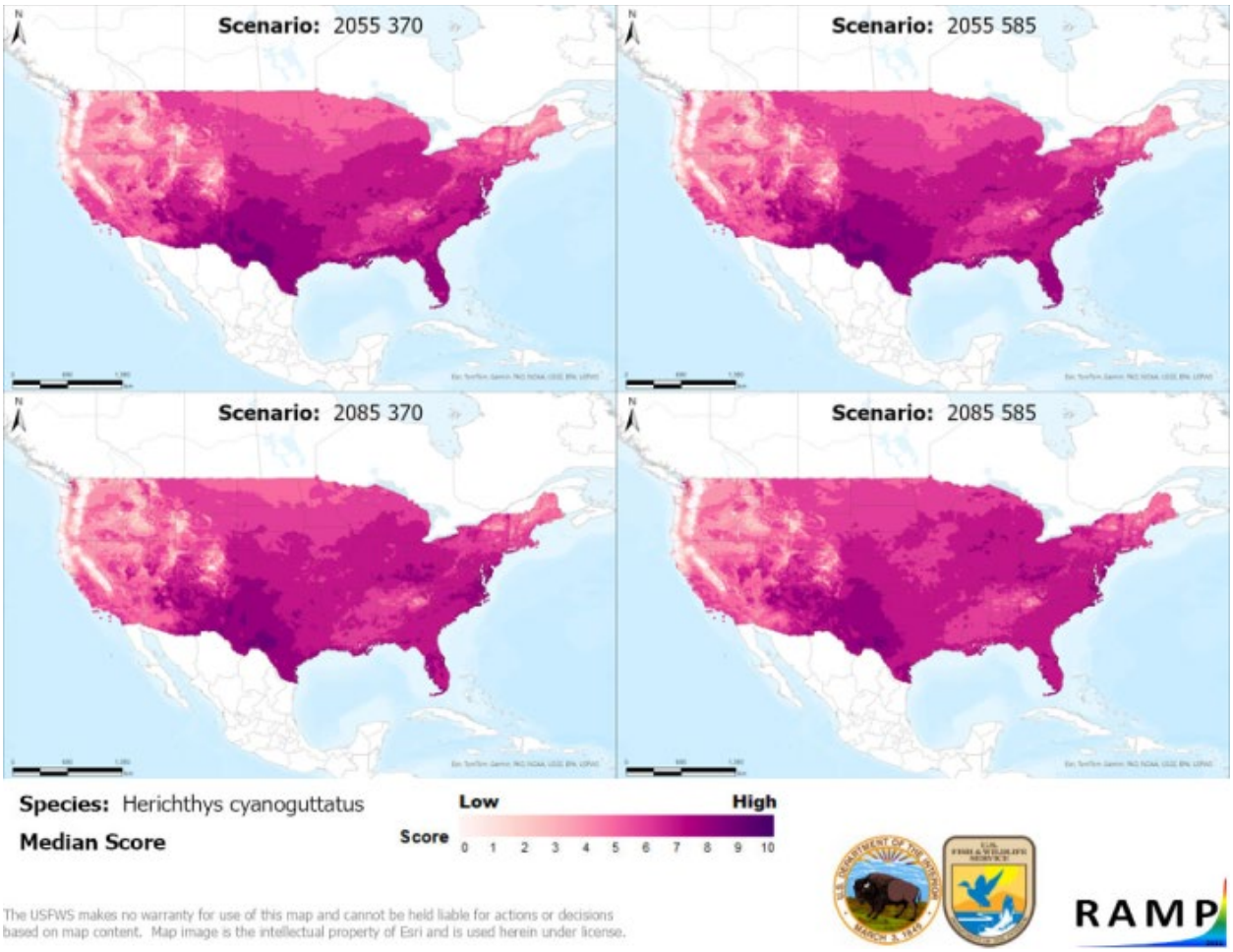

Figure A1. Maps of median RAMP (Sanders et al. 2023) climate matches projected under potential future climate conditions using five global climate models for *Herichthys cyanoguttatus* in the contiguous United States. Climate matching is based on source locations reported by GBIF Secretariat (2023) and Nico et al. (2025). 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.

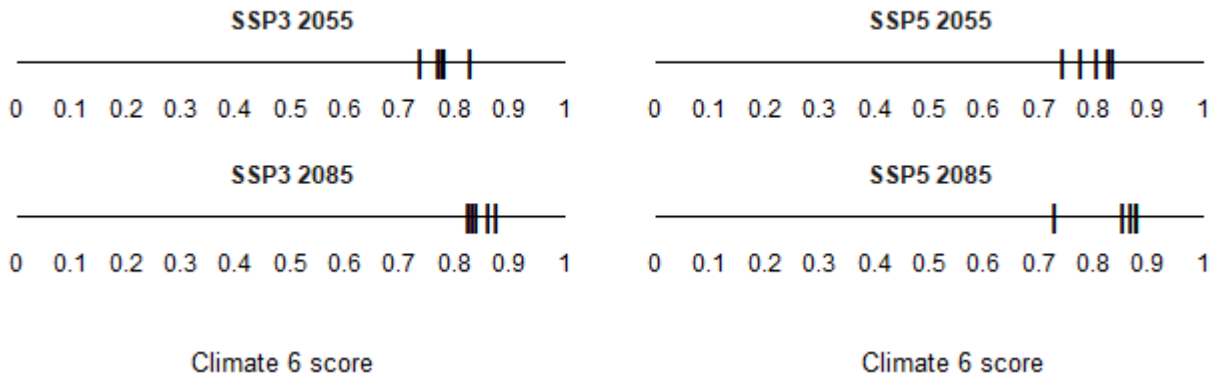

Figure A2. Comparison of projected future Climate 6 scores for *Herichthys cyanoguttatus* in the contiguous United States for each of five global climate models under four combinations of Shared Socioeconomic Pathway (SSP) and time step. SSPs used (from left to right): SSP3, SSP5 (Karger et al. 2017, 2018; IPCC 2021). Time steps: 2055 (top row) and 2085 (bottom row). Climate source data from CHELSA (Karger et al. 2017, 2018); global climate models used: GFDL-ESM4, UKESM1-0-LL, MPI-ESM1-2-HR, IPSL-CM6A-LR, and MRI-ESM2-0.

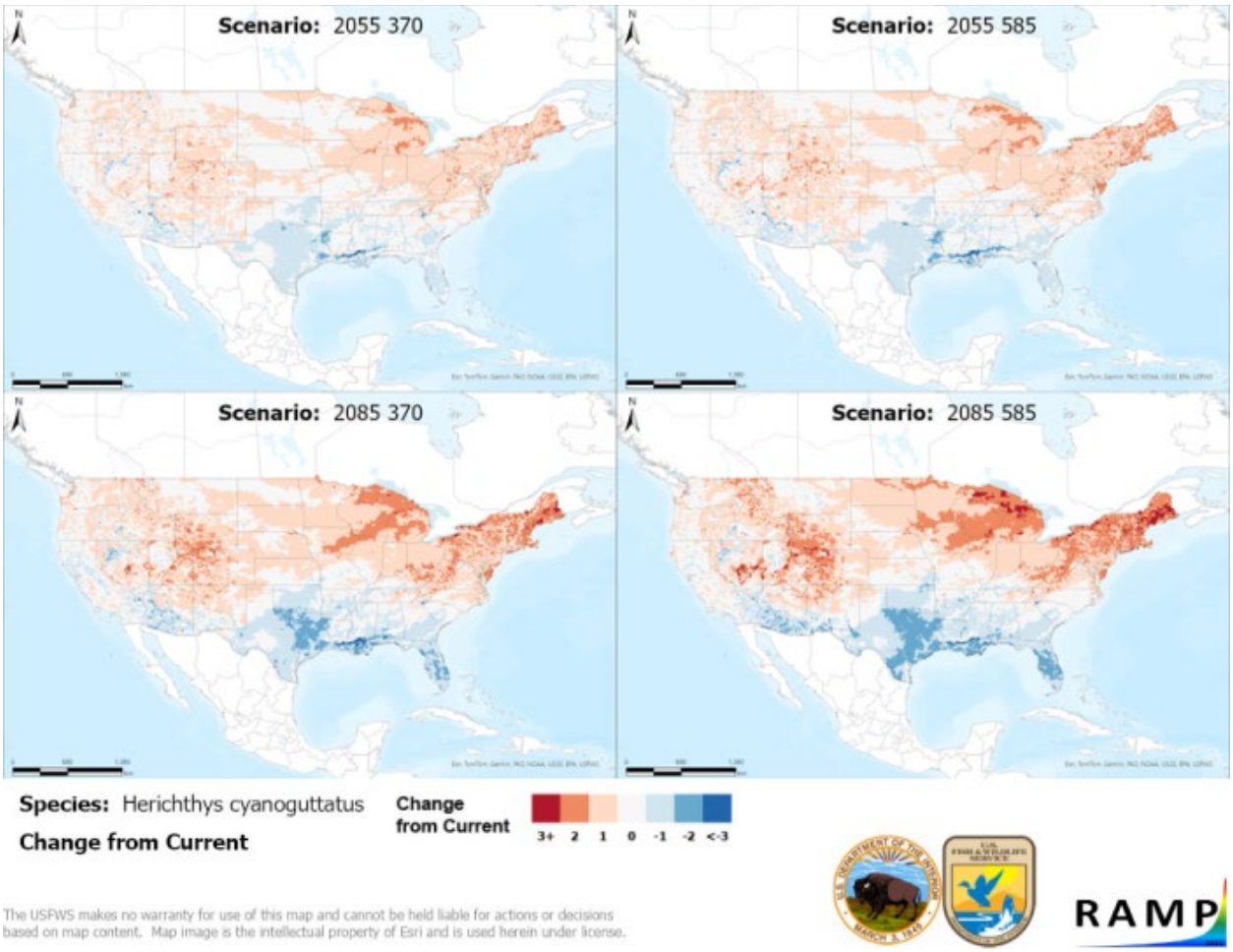

Figure A3. RAMP (Sanders et al. 2023) maps of the contiguous United States showing the difference between the current climate match target point score (figure 5) and the median target point score for future climate scenarios (figure A1) for *Herichthys cyanoguttatus* based on source locations reported by GBIF Secretariat (2023) and Nico et al. (2025). 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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