

Redeye Piranha (*Serrasalmus rhombeus*)

Ecological Risk Screening Summary

U.S. Fish and Wildlife Service, April 2012
Revised, August 2018
Web Version, 9/11/2020

Organism Type: Fish
Overall Risk Assessment Category: Uncertain



Photo: J. O. Birindelli. Licensed under Creative Commons BY-NC. Available: http://eol.org/data_objects/26104614. (August 2018).

1 Native Range and Status in the United States

Native Range

From Froese and Pauly (2018):

“South America: Amazon and Orinoco River basins, north and eastern Guiana Shield rivers, and northeastern Brazilian coastal rivers [Bolivia, Brazil, Colombia, Ecuador, French Guiana, Guyana, Peru, Suriname, Venezuela].”

Froese and Pauly (2018) also list Uruguay among the countries where *S. rhombeus* is native.

Status in the United States

From Nico and Loftus (2020):

“**Status:** Failed and/or eradicated in Florida. A locally established population south Florida was exterminated in 1977.”

“This species was stocked in **Florida** in an isolated sinkhole pool at Monkey Jungle, a tourist attraction in the Miami area of Dade County in 1963 or 1964. Those fish reproduced and sustained the population for 13 or 14 years until all were killed with rotenone or removed alive by state personnel in September 1977 (Shafland and Foote 1979; identified as *Serrasalmus humeralis*) (museum specimen). Two specimens were taken from an abandoned swimming pool in South Miami, Dade County (Courtenay et al. 1974). A single fish was taken from a pond in Gainesville, Alachua County in 1985 (museum specimen).” [See Remarks regarding species identity.]

This species is currently in trade in the United States. For example:

From AquaScapeOnline (2018):

“Baby Black Piranha Peru .75"-1" (Serrasalmus Rhombeus [sic]) [...] Special 10 for 150.00
Our Price: \$25.00”

“Black Piranha 4.5" Peru (Serrasalmus Rhombeus [sic]) [...] Our Price: \$100.00”

“Black Piranha 14"-15" Peru (Serrasalmus Rhombeus [sic]) [...] Our Price: \$1,000.00”

Possession or importation of fish of the genus *Serrasalmus*, or fish known as “piranha” in general, is banned or regulated in many States. Every effort has been made to list all applicable State laws and regulations pertaining to this species, but this list may not be comprehensive.

From Alabama Department of Conservation and Natural Resources (2019):

“No person, firm, corporation, partnership, or association shall possess, sell, offer for sale, import, bring, release or cause to be brought or imported into the State of Alabama any of the following live fish or animals: [...] Any Piranha or any fish of the genera *Serrasalmus*, *Pristobrycon*, *Pygocentrus*, *Catorprion*, or *Pygopristus*; [...]”

From Alaska State Legislature (2019):

“Except as provided in (b) - (d) of this section, no person may import any live fish into the state for purposes of stocking or rearing in the waters of the state.

(b) Live oysters native to and originating from the Pacific Coast of North America may be imported [...]

(c) Ornamental fish not raised for human consumption or sport fishing purposes may be imported into the state, but may not be reared in or released into the waters of the state. Fish wastes and waste water from ornamental fish may not be released directly into the waters of the state.

(d) Weathervane scallops originating from wild stocks or cultured stocks in the Southeastern Alaska and Yakutat Areas may be imported for aquaculture purposes and may be released only into the waters of the Southeastern Alaska and Yakutat Areas under a stock transport permit required by this chapter [...]"

From Arizona Office of the Secretary of State (2013):

““Restricted live wildlife” means wildlife that cannot be imported, exported, or possessed without a special license or lawful exemption.”

“Fish listed below are considered restricted live wildlife [...]

Piranha, all species of the genera *Serrasalmus*, *Serrasalmo*, *Phygoцентrus*, *Teddyella*, *Rooseveltiella*, and *Pygoprictis* [...]"

From Arkansas Game and Fish Commission (2019):

“It is unlawful to import, transport, or possess any species commonly known as [...] piranha [...]"

“EXCEPTION: These species may be possessed for display and educational purposes by written permit approved by the Commission.”

From California Department of Fish and Wildlife (2019):

“All species of piranha are on California’s list of restricted animals and cannot be imported, transported, or possessed without a permit.”

From Colorado Secretary of State (2019):

“For the following aquatic species or viable gametes thereof, because of the potential for a detrimental affect [sic] on existing fish and their habitat in Colorado, and except as enumerated in these regulations, or as authorized in writing by the Division of Wildlife for management purposes only; the release or the importation, transportation, stocking, sale, acquisition or possession for release is prohibited. Persons who have proof of possession issued prior to January 1, 1978 or who obtain prior approval from the Division of Wildlife may possess the following species:

a. Piranha: including members of the genera *Serrasalmus*, *Roosevelthiella*, and *Pygocentrus*.”

From Connecticut Secretary of State (2016):

“The importation or possession of piranha of the subfamily: Serrasalminae, genera *Serrasalmus*, *Serrasalmo*, *Pygocentrus*, *Teddyella*, *Rosseveltiella* and *Pygopristus*, [...] is prohibited except that the Commissioner may at his discretion issue permits for the importation and possession, when it is in the public interest, for public display purposes, of specimens of piranha [...].”

FFWCC (2019) lists *S. rhombeus* as a prohibited nonnative species in Florida.

From Georgia Department of Natural Resources (2019):

“The animals listed below are examples of the exotic species regulated under Georgia Law. [...] The exotic species listed below, except where otherwise noted, may not be held as pets in Georgia. [...] Piranha; all species”

From Hawaii Department of Agriculture (2019):

“For example, the following are prohibited from entry or possession by private individuals in the State. [...] *Piranhas*”

From Idaho Office of the Administrative Rules Coordinator (2019):

“No person may possess, cultivate, import, ship, or transport any invasive species [...] into or through the state of Idaho following the effective date of this rule, unless the person possessing, importing, shipping or transporting has obtained a permit under Section 103, or unless otherwise exempt by this rule, as set forth in Section 104.”

“INVASIVE SPECIES – FISH. [...]

05. Piranhas, *Serrasalmus* spp., *Rosseveltiella* spp., *Pygocentrus* spp. [...].”

From Illinois Department of Natural Resources (2015):

“For the purposes of Section 20-90 of the Fish and Aquatic Life Code [515 ILCS 5/20-90], the Aquatic Life Approved Species List is established. The following aquatic life categories will be considered approved for aquaculture, transportation, stocking, importation and/or possession in the State of Illinois.”

Serrasalmus rhombeus does not appear on the Aquatic Life Approved Species List for Illinois.

From Kentucky General Assembly (2019):

“The live aquatic organisms established in subsections (1) through (7) of this section shall not be imported, bought, sold, or possessed in aquaria:

(1) Subfamily Serrasalminae - piranha, piraya, pirae, or tiger characins; [...].”

From Louisiana State Legislature (2019):

“No person shall have in possession or sell in this state [Louisiana] a piranha or Rio Grande Cichlid; except that, piranha may be possessed and displayed at the Aquarium of the Americas, Audubon Institute, New Orleans, as authorized by a special permit issued by the department, under conditions the department deems necessary to prevent their introduction into waters of the state.”

From Maine Department of Inland Fisheries and Wildlife (2019):

“Unrestricted List [...] (no permit needed): Maine law allows the Department to maintain a list of species of fish and wildlife, including tropical fish and invertebrates, which do not require an importation, exhibition, or possession permit, and may be traded by commercial pet shops.”

Serrasalmus rhombeus does not appear on the Maine Department of Inland Fisheries and Wildlife’s Unrestricted List.

From Massachusetts Division of Fisheries and Wildlife (2014):

“All aquarium trade fish may be kept without a permit except species categorically non-exempt pursuant to 321 CMR 9.01(3), and except that the following species are prohibited without a permit: [...]

(b) Piranha (*Pygocentrus* spp. and *Serrasalmus* spp.)”

From Mississippi Secretary of State (2019):

“All species of the following animals and plants have been determined to be detrimental to the State's native resources and further sales or distribution are prohibited in Mississippi. No person shall import, sell, possess, transport, release or cause to be released into the waters of the state any of the following aquatic species or hybrids thereof. However, species listed as prohibited may be allowed under a permitting process where environmental impact has been assessed.”

“[The list includes all piranhas and all species of] Subfamily Serrasalminae”

From State of Nevada (2018):

“Except as otherwise provided in this section and NAC [Nevada Administrative Code] 504.486, the importation, transportation or possession of the following species of live wildlife or hybrids thereof, including viable embryos or gametes, is prohibited: [...]

Piranhas..... All species in the genera *Serrasalmus*, *Serrasalmo*, *Pygocentrus*, *Teddyella*, *Rooseveltiella* and *Pygopristis*”

From New Mexico Department of Game and Fish (2010):

“Species importation list group IV may be for live non-domesticated animals that are considered dangerous, invasive, undesirable, state or federal listed threatened, endangered, a furbearer or

any other species of concern as identified by the director. The importation of these species are prohibited for the general public but may be allowed for, scientific study, department approved restoration and recovery plans, zoological display, temporary events/entertainment, use as service animal or by a qualified expert.”

All piranha and pacu (Family Characidae) are listed in Group IV of the Director’s Species Importation List for New Mexico.

From New York State Senate (2019):

“No person shall import, export, own, possess, acquire or dispose of live piranha fish (*Serrasalmus*, *Rooseveltiella* or *Pyrocentrus* [sic]), grass carp (*Ctenopharyngodon idella*) or hybrid grass carp within the state without a license or permit issued at the discretion of the department for scientific, biological or exhibition purposes.”

From North Carolina Office of Administrative Hearings (2019):

“It shall be unlawful to transport, purchase, possess, sell, or stock in the public or private waters of North Carolina any live individuals of [...] piranha; [...]”

From Oklahoma Secretary of State (2019):

“Until such time as is necessary for the Department of Wildlife Conservation to obtain adequate information for the determination of other harmful or potentially harmful exotic species, the importation into the State and/or the possession of the following exotic fish or their eggs is prohibited: [...]

“Piranha group: *Serrasalmus* spp., *Pygocentrus* spp., *Rooseveltiella* spp., *Catoprion* spp., *Hydrocynus* spp., and *Salminus* spp.”

From South Carolina Legislature (2019):

“A person may not possess, sell, offer for sale, import, bring, cause to be brought or imported into this State [South Carolina], or release in this State the following species at any stage of its life cycle: [...] piranha (all members of *Serrasalmus*, *Rooseveltiella*, and *Pygocentrus* genera) [...]

From Texas Parks and Wildlife (2019):

“The organisms listed here are legally classified as exotic, harmful, or potentially harmful. No person may possess or place them into water of this state except as authorized by the department.”

“Piranhas, Family Characidae

All species of genera *Catoprion*, *Pristobrycon*, *Pygocentrus*, *Pygopristis*, and *Serrasalmus*”

From Utah Office of Administrative Rules (2019):

“All species of fish listed in Subsections (2) through (30) are classified as prohibited for collection, importation and possession [...] (22) Piranha, (*Serrasalmus*, All species) family Characidae.”

From Virginia Department of Game and Inland Fisheries (2019):

“A special permit is required, and may be issued [sic] by the Department, if consistent with the Department’s fish and wildlife management program, to import, possess, or sell the following non-native (exotic) amphibians, fish, mollusks, aquatic invertebrates, and reptiles: [...] piranhas [...]”

Means of Introduction into the United States

From Nico and Loftus (2020):

“All fish were probably aquarium releases. A small number of live fish were intentionally stocked at one locality in Florida in the early 1960s (Shafland and Foote 1979).”

Remarks

From Nico and Loftus (2020):

“*Serrasalmus rhombeus* represents a geographically widespread complex of closely related species in need of systematic review.”

Various other common names are applied to this species, including white piranha (Nico and Loftus 2020), spotted piranha (ITIS 2018), and black piranha (GBIF Secretariat 2017).

From Shafland et al. (2008):

“This fish [introduced then eradicated in Florida] was originally identified as *S. humeralis* because the “third infraorbital does not entirely cover the cheek” (Fink, 1979 [personal communication]). Since then, Fuller and co-workers (1999) reported this species had subsequently been identified as *S. rhombeus* based on specimens in the Florida Museum of Natural History in Gainesville (UF 87975 and UF 97059). As noted in Shafland and Foote (1979) these two species are very similar, and possibly synonymous, but until taxonomic clarity is attained, we retain the name *S. humeralis* for these Florida specimens.”

For the purposes of evaluating the history of invasiveness and climate match to the contiguous United States, this report follows Nico and Loftus (2020) in considering the eradicated population in Florida most likely to have been *S. rhombeus* and not *S. humeralis*. Nico and Loftus (2020) report the Florida population of *Serrasalmus* on the *S. rhombeus* page of U.S. Geological Survey’s National Aquatic Species Database.

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From ITIS (2018):

Kingdom Animalia
Subkingdom Bilateria
Infrakingdom Deuterostomia
Phylum Chordata
Subphylum Vertebrata
Infraphylum Gnathostomata
Superclass Actinopterygii
Class Teleostei
Superorder Ostariophysi
Order Characiformes
Family Characidae
Genus *Serrasalmus*
Species *Serrasalmus rhombeus* (Linnaeus, 1766)

From Eschmeyer et al. (2018):

“**Current status:** Valid as *Serrasalmus rhombeus* (Linnaeus 1766). Serrasalmidae.”

Size, Weight, and Age Range

From Froese and Pauly (2018):

“Max length : 41.5 cm SL male/unsexed; [Merckx et al. 2000]; max. published weight: 3.0 kg [Planquette et al. 1996]”

Environment

From Froese and Pauly (2018):

“Freshwater; benthopelagic; pH range: 5.8 - 7.0; dH range: ? - 10.”

“[...] 23°C - 27° [Riehl and Baensch 1991; assumed to represent recommended aquarium water temperature]”

Climate

From Froese and Pauly (2018):

“Tropical [...]”

From Nico and Loftus (2020):

“The Florida population at Monkey Jungle survived the winter of 1976-1977, one of the areas' coldest periods on record for this area (Shafland and Foote 1979).”

Distribution Outside the United States

Native

From Froese and Pauly (2018):

“South America: Amazon and Orinoco River basins, north and eastern Guiana Shield rivers, and northeastern Brazilian coastal rivers [Bolivia, Brazil, Colombia, Ecuador, French Guiana, Guyana, Peru, Suriname, Venezuela].”

Froese and Pauly (2018) also list Uruguay among the countries where *S. rhombeus* is native.

Introduced

No introductions have been reported outside the United States.

Means of Introduction Outside the United States

No introductions have been reported outside the United States.

Short Description

From Nico and Loftus (2020):

“Live *Serrasalmus rhombeus* have red eyes; body color changes from silver in juveniles and young adults to black or dark purple in large adults.”

From Nico and Taphorn (1988):

“Juvenile *S. rhombeus* have a somewhat elongate body and sharp snout [...]. They resemble *S. irritans* in body form, but are slightly more robust. Adults have heavy rhomboidal bodies. The body and fins of large individuals, some well over 300 mm SL, are black or blue-black, and the iris is often deep red.”

Biology

From Froese and Pauly (2018):

“Occurs in the rapids but is also captured in deep zones of main rivers with the use of fish bait. Is essentially a carnivore, feeds on small fish, crabs, mammals, lizards and coleopteran insects. Its opportunistic behavior allows it to adapt to various biotopes [Planquette et al. 1996].”

From Nico and Taphorn (1988):

“Fishes identified from the stomachs of larger *S. rhombeus* included characins (*Astyanax bimaculatus* and *Charax* sp.) and the fins of a large fish, possibly *Hoplias*. Three large *S. rhombeus* collected at night in Canio Maporal contained whole or partial individuals of small (20-30 mm SL) doradid catfishes. One individual had eaten a small adult frog.”

Human Uses

From Froese and Pauly (2018):

“Fisheries: minor commercial; aquarium: commercial”

“[...] the incorporation of this species in fish-based house security systems has been proposed (see [Dunnit and Kneesun-Boomsadaisy 1994]).”

This species is currently in trade in the United States. For example:

From AquaScapeOnline (2018):

“Baby Black Piranha Peru .75"-1" (Serrasalmus Rhombeus [sic]) [...] Special 10 for 150.00
Our Price: \$25.00”

“Black Piranha 4.5" Peru (Serrasalmus Rhombeus [sic]) [...] Our Price: \$100.00”

“Black Piranha 14"-15" Peru (Serrasalmus Rhombeus [sic]) [...] Our Price: \$1,000.00”

Diseases

No OIE-reportable diseases (OIE 2020) have been documented for this species.

From Walliker (1969):

“Recorded from freshwater fishes of the Amazon region of Brazil [is] a new species of *Myxobolus*: *M. serrasalmi*, from the piranha, *Serrasalmus rhombeus* [...]”

Tavares and Luque (2005) report *S. rhombeus* as a host for the parasitic copepod *Ergasilus yumaricus*.

Tavares-Dias et al. (2014) report *S. rhombeus* as a host for the crustacean ectoparasite *Braga patagonica*.

According to Van Every and Kritsky (1992), *Serrasalmus rhombeus* is a host for the monogenoid parasites *Anacanthorus amazonicus*, *A. gravihamulatus*, *A. jegui*, *A. mesocondylus*, *A. prodigiousus*, *A. sciponophallus*, and *A. serrasalmi*.

From Agarwal and Kritsky (1998):

“*Amphithecium diclonophallum*, *A. falcatum*, *A. junki*, *A. muricatum*, *Enallothecium aegidatum*, *E. cornutum*, *E. umbelliferum*, *Mymarothecium dactylosum*, *M. galeolum*, *M. whittingtoni*, *Notothecium cyphophallum*, *N. deleastum*, *N. phyleticum*, *Notozotheicum minor*, *N. teinodendrum*.”

From Thatcher (1999):

“Two new species of Bucephalidae (Trematoda) are described from fishes of the Brazilian Amazon. [...] *Prosorhynchus piranhus* sp. n. from *Serrasalmus rhombeus* [...]”

Threat to Humans

From Froese and Pauly (2018):

“Traumatogenic”

“It is timid and not aggressive but it possesses powerful dentition that can cause serious bites, and is therefore, potentially dangerous.”

From Nico and Loftus (2020):

“[...] *Serrasalmus rhombeus* is one of the more aggressive piranha species; however, most experts consider its danger to humans to be greatly exaggerated.”

From Lima et al. (2015):

“[...] Hg [mercury concentration] in [...] *Serrasalmus rhombeus* (0.548 $\mu\text{g g}^{-1}$) were above the legal limit. [...] the high concentrations of heavy metals in the environment and muscle tissue of fish indicate a high degree of contamination in the Cassiporé river basin and risk to human health.”

3 Impacts of Introductions

From Nico and Loftus (2020):

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

The importation, possession, or trade of the piranha *Serrasalmus rhombeus* is prohibited or restricted in the following states: Alabama (Alabama Department of Conservation and Natural Resources 2019), Alaska (Alaska State Legislature 2019), Arizona (Arizona Office of the Secretary of State 2013), Arkansas (Arkansas Game and Fish Commission 2019), California (California Department of Fish and Wildlife 2019), Colorado (Colorado Secretary of State 2019),

Connecticut (Connecticut Secretary of State 2016), Florida (FFWCC 2019), Georgia (Georgia Department of Natural Resources 2019), Hawaii (Hawaii Department of Agriculture 2019), Idaho (Idaho Office of the Administrative Rules Coordinator 2019), Illinois (Illinois Department of Natural Resources 2015), Kentucky (Kentucky General Assembly 2019), Louisiana (Louisiana State Legislature 2019), Maine (Maine Department of Inland Fisheries and Wildlife 2019), Massachusetts (Massachusetts Division of Fisheries and Wildlife 2014), Mississippi (Mississippi Secretary of State 2019), Nevada (State of Nevada 2018), New Mexico (New Mexico Department of Game and Fish 2010), New York (New York State Senate 2019), North Carolina (North Carolina Office of Administrative Hearings 2019), Oklahoma (Oklahoma Secretary of State 2019), South Carolina (South Carolina Legislature 2019), Texas (Texas Parks and Wildlife 2019), Utah (Utah Office of Administrative Rules 2019), and Virginia (Virginia Department of Game and Inland Fisheries 2019).

4 History of Invasiveness

Serrasalmus rhombeus was stocked in Dade County Florida in 1963 or 1964. This population was intentionally eradicated in 1977. Two other introductions have been reported from Florida, but neither of these resulted in established populations. Because the species was successfully established outside its native range and its demise was not due to natural circumstances, history of invasiveness is Data Deficient.

5 Global Distribution



Figure 1. Known global distribution of *S. rhombeus*. Map from GBIF Secretariat (2019). No georeferenced occurrences are available for the range of the species in Uruguay (Froese and Pauly 2018). The location reported by GBIF Secretariat (2019) in Germany was excluded from the extent of this map and the climate matching analysis because it is a report from a botanical garden and does not represent an established population of the species.

6 Distribution Within the United States



Figure 2. Known distribution of *S. rhombeus* in the United States. Map from Nico and Loftus (2020). The occurrence in Dade County, Florida, represents an established population that was purposefully extirpated in 1977 (Nico and Loftus 2020). Because the species was successfully established in this location and its demise was not due to natural circumstances, this occurrence was included in the climate matching analysis. Other occurrences do not represent established populations and were not included in the climate matching analysis.

7 Climate Matching

Summary of Climate Matching Analysis

The climate match (Sanders et al. 2018; 16 climate variables; Euclidean Distance) was high in peninsular Florida, where the formerly established population occurred. The climate match was medium in northern Florida, southern and eastern Georgia, southern South Carolina, far southern Louisiana, coastal Texas, coastal California, and in Washington in the vicinity of Puget Sound. The remainder of the contiguous United States had a low climate match. The Climate 6 score indicated that the contiguous United States has a medium climate match overall (scores between 0.005 and 0.103, exclusive, are classified as medium). The Climate 6 score for *S. rhombeus* was 0.014. All States had a low individual climate score, except Florida, which had a high individual climate score.

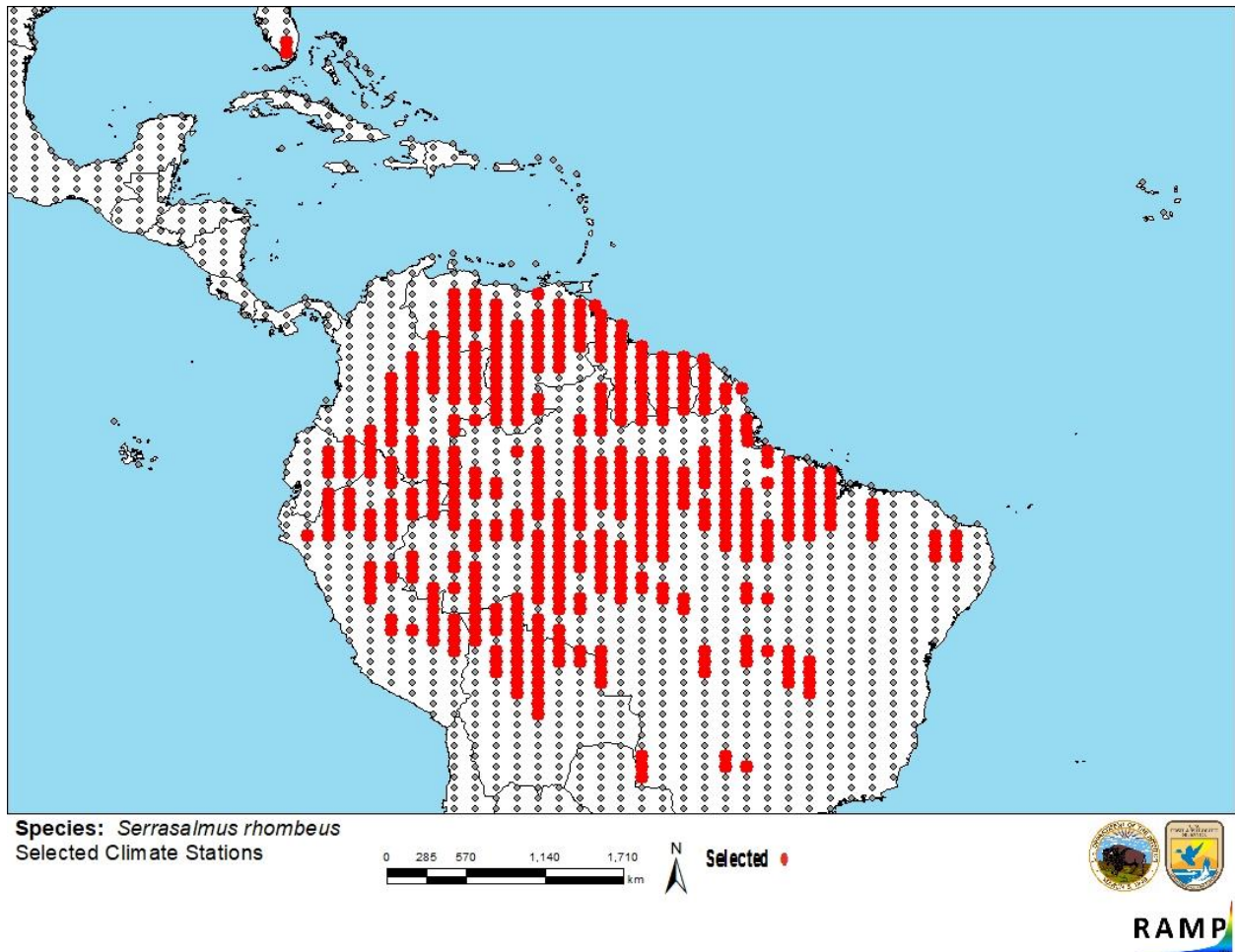


Figure 2. RAMP (Sanders et al. 2018) source map showing weather stations in northern South America and the United States selected as source locations (red; Bolivia, Brazil, Colombia, Ecuador, French Guiana, Guyana, Peru, Suriname, United States [Florida], and Venezuela) and non-source locations (gray) for *S. rhombeus* climate matching. Source locations from GBIF Secretariat (2019). Selected source locations are within 100 km of one or more species occurrences, and do not necessarily represent the locations of occurrences themselves.

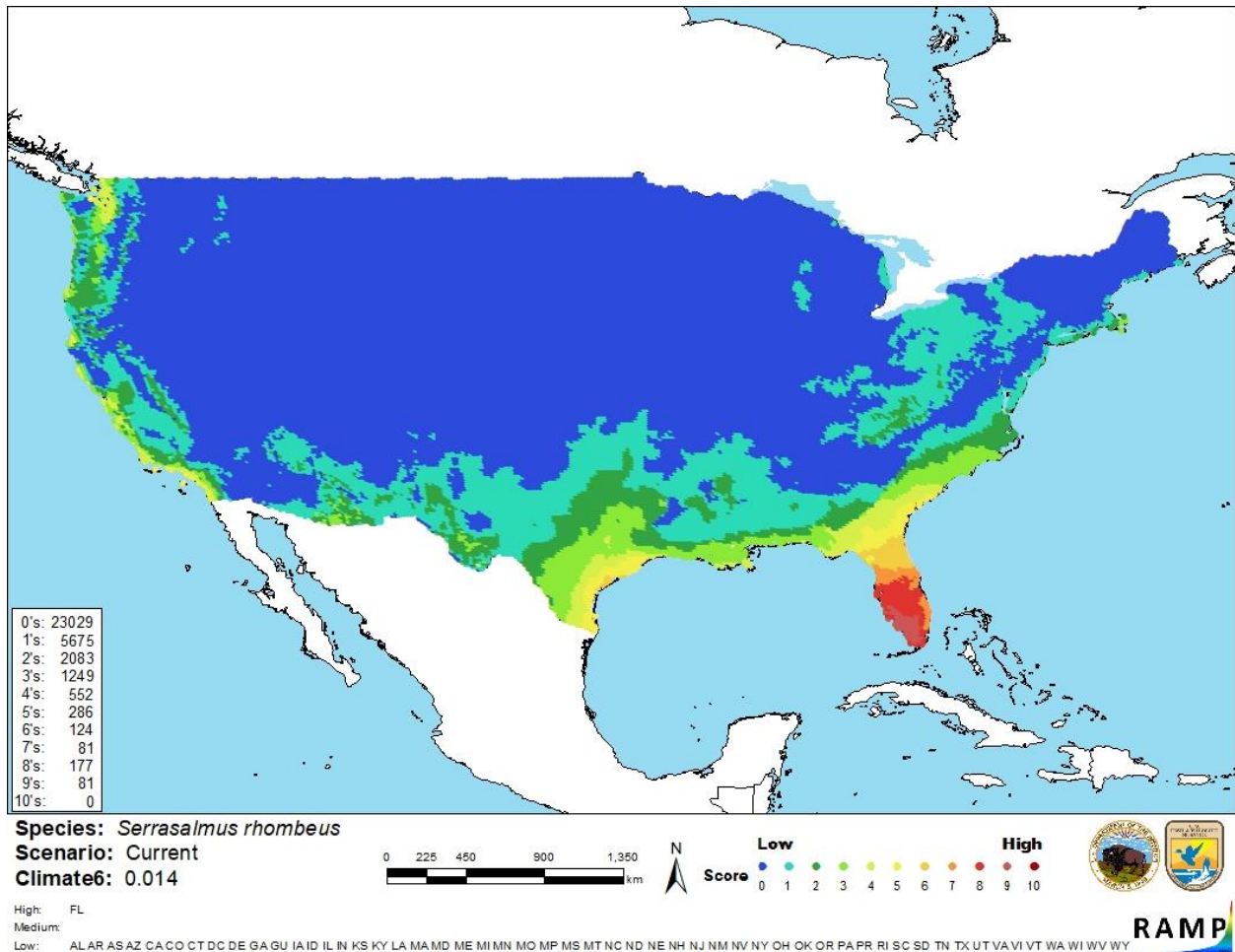


Figure 3. Map of RAMP (Sanders et al. 2018) climate matches for *S. rhombeus* in the contiguous United States based on source locations reported by GBIF Secretariat (2017). Counts of climate match scores are tabulated on the left. 0/Blue = Lowest match, 10/Red = Highest match.

The High, Medium, and Low Climate match Categories are based on the following table:

Climate 6: (Count of target points with climate scores 6-10)/ (Count of all target points)	Overall Climate Match Category
$0.000 \leq X \leq 0.005$	Low
$0.005 < X < 0.103$	Medium
≥ 0.103	High

8 Certainty of Assessment

Information is available on the biology, ecology, and distribution of *S. rhombeus*. This species was formerly established in Florida, but no populations are extant and impacts of introduction are unknown. Further work is needed on the taxonomy of this and closely related species. Certainty of this assessment is low.

9 Risk Assessment

Summary of Risk to the Contiguous United States

Redeye Piranha (*Serrasalmus rhombeus*) is a species of piranha native to northern South America. It is present in the aquarium trade, including in the United States, and is a minor target for commercial fishing. *S. rhombeus* can be harmful to humans through its aggressive behavior and bioaccumulation of mercury (when caught in areas with mercury contamination and eaten). The species is host to numerous parasites. *S. rhombeus* has been introduced to Florida three times; one introduction resulted in an established population that was intentionally extirpated after 13 or 14 years, while the other two appear to have failed before establishment occurred. No other introductions have been reported, and the impacts of introduction are unknown. Numerous U.S. States prohibit the import of piranhas. History of invasiveness is classified as Data Deficient. Climate match to the contiguous United States was medium overall, with the highest match in southern Florida where the species was previously established. Certainty of assessment is low due to lack of information about impacts. Overall risk posed by *S. rhombeus* is Uncertain.

Assessment Elements

- **History of Invasiveness (Sec. 4): Data Deficient**
- **Climate Match (Sec. 7): Medium**
- **Certainty of Assessment (Sec. 8): Low**
- **Remarks, Important additional information: None**
- **Overall Risk Assessment Category: Uncertain**

10 Literature Cited

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

- Agarwal N, Kritsky DC. 1998. Neotropical Monogenoidea. 33. Three new species of *Ancistrohaptor* n. g. (Dactylogyridae, Ancyrocephalinae) on *Triportheus* spp. (Teleostei, Characidae) from Brazil, with checklists of ancyrocephalines recorded from neotropical characiform fishes. *Systematic Parasitology* 39:59-69.
- Alabama Department of Conservation and Natural Resources. 2019. Restrictions on possession, sale, importation and/or release of certain animals and fish. Alabama Department of Conservation and Natural Resources Administrative Code, Chapter 220-2-.26.
- Alaska State Legislature. 2019. Prohibitions on importation and release of live fish. Alaska Administrative Code, Title 5, Chapter 41, Section 70.
- AquaScapeOnline. 2018. *Serrasalmus Rhombeus*. AquaScapeOnline, Belleville, New Jersey. Available: <https://aquascapeonline.com/aquatic-live-stock-fresh-water-fish-piranhas-genus-serrasalmus-black-piranha-peru/>. (August 2018).

- Arizona Office of the Secretary of State. 2013. Live wildlife. Arizona Administrative Code, Game and Fish Commission, Title 12, Chapter 4, Article 4.
- Arkansas Game and Fish Commission. 2019. Certain exotic species prohibited. Arkansas Game and Fish Commission Code of Regulations 26.13.
- California Department of Fish and Wildlife. 2019. California's invaders: Piranha. Sacramento, California: Habitat Conservation Planning Branch, California Department of Fish and Wildlife. Available:
<https://www.wildlife.ca.gov/Conservation/Invasives/Species/Characidae>. (August 2019).
- Colorado Secretary of State. 2019. Prohibited species. Code of Colorado Regulations, Chapter 00, Article VIII #008.
- Connecticut Secretary of State. 2016. Importation, transportation or liberation of live fish or live fish eggs. Regulations of Connecticut State Agencies, Section 26-55-1.
- Eschmeyer WN, Fricke R, van der Laan R, editors. 2018. Catalog of fishes: genera, species, references. California Academy of Science. Available:
<http://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp> (August 2018).
- [FFWCC] Florida Fish and Wildlife Conservation Commission. 2019. Prohibited nonnative species list. Tallahassee, Florida: Florida Fish and Wildlife Conservation Commission. Available: <https://myfwc.com/wildlifehabitats/nonnatives/prohibited-species-list/>.
- Froese R, Pauly D, editors. 2018. *Serrasalmus rhombeus* (Linnaeus, 1766). FishBase. Available: <https://www.fishbase.de/summary/Serrasalmus-rhombeus.html>. (August 2018).
- GBIF Secretariat. 2019. GBIF backbone taxonomy: *Serrasalmus rhombeus* (Linnaeus, 1766). Copenhagen: Global Biodiversity Information Facility. Available:
<https://www.gbif.org/species/2354124>. (July 2020).
- Georgia Department of Natural Resources. 2019. Wild animals/exotics. Social Circle, Georgia: Georgia Department of Natural Resources Law Enforcement Division. Available:
<http://gadnrle.org/exotics>. (August 2019).
- Hawaii Department of Agriculture. 2019. Animal guidelines. Honolulu, Hawaii: Hawaii Department of Agriculture, Plant Industry Division. Available:
<http://hdoa.hawaii.gov/pi/pq/import-program/animal-guidelines/>. (August 2019).
- Idaho Office of the Administrative Rules Coordinator. 2019. Rules governing invasive species. Idaho Administrative Code 02.06.09.

- Illinois Department of Natural Resources. 2015. Aquatic life approved species list. Springfield, Illinois: Illinois Department of Natural Resources. Available: https://www.ifishillinois.org/programs/aquaculture/aquatic_approved_species.pdf. (August 2019).
- [ITIS] Integrated Taxonomic Information System. 2018. *Serrasalmus rhombeus* (Linnaeus, 1766). Reston, Virginia: Integrated Taxonomic Information System. Available: https://www.itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=163268#null. (August 2018).
- Kentucky General Assembly. 2019. Importation, possession, and prohibited aquatic species. Kentucky Administrative Regulations, Tourism, Arts, and Heritage Division, Department of Fish and Wildlife Resources, 301 KAR 1:122.
- Lima DP, Santos C, Silva RS, Yoshioka ETO, Bezerra RM. 2015. Heavy metal contamination in fish and water from Cassiporé River basin, State of Amapá, Brazil. *Acta Amazonica* 45(4):405-414. (In Portuguese, with English abstract.)
- Louisiana State Legislature. 2019. Exotic fish; importation, sale, and possession of certain exotic species prohibited; permit required; penalty. Louisiana Revised Statutes, Title 56, Section 319.
- Maine Department of Inland Fisheries and Wildlife. 2019. Fish and wildlife in captivity. Augusta, Maine: Maine Department of Inland Fisheries and Wildlife. Available: <https://www.maine.gov/ifw/fish-wildlife/captivity.html>. (August 2019).
- Massachusetts Division of Fisheries and Wildlife. 2014. Exemption list. Code of Massachusetts Regulations, Title 321, Section 9.00.
- Mississippi Secretary of State. 2019. Guidelines for aquaculture activities. Mississippi Administrative Code, Title 2, Part 1, Subpart 4, Chapter 11. Jackson, Mississippi: Regulatory and Enforcement Division, Office of the Mississippi Secretary of State.
- New Mexico Department of Game and Fish. 2010. Director's species importation list. Santa Fe, New Mexico: New Mexico Department of Game and Fish. Available: http://www.wildlife.state.nm.us/download/enforcement/importation/information/Directors-Species-Importation-List-08_03_2010.pdf. (August 2019).
- New York State Senate. 2019. Importation, possession and sale of fish without license or permit; prohibitions. Laws of New York, Article 11, Title 17, Section 11-1703.
- Nico L, Loftus B. 2020. *Serrasalmus rhombeus* (Linnaeus, 1766). Gainesville, Florida: U.S. Geological Survey, Nonindigenous Aquatic Species Database. Available: <https://nas.er.usgs.gov/queries/FactSheet.aspx?SpeciesID=431>. (September 2020).

- Nico LG, Taphorn DC. 1988. Food habits of piranhas in the low llanos of Venezuela. *Biotropica* 20:311-321.
- North Carolina Office of Administrative Hearings. 2019. Possession of certain fishes. North Carolina Administrative Code, Title 15A, Chapter 10, SubChapter C, Section 211.
- [OIE] World Organisation for Animal Health. 2020. OIE-listed diseases, infections and infestations in force in 2020. Available: <http://www.oie.int/animal-health-in-the-world/oie-listed-diseases-2020/> (February 2020).
- Oklahoma Secretary of State. 2019. List of restricted exotic species. Oklahoma Administrative Code, Title 800, Chapter 20-1-2.
- Sanders S, Castiglione C, Hoff M. 2018. Risk Assessment Mapping Program: RAMP. Version 3.1. U.S. Fish and Wildlife Service.
- Shafland PL, Gestring KB, Stanford MS. 2008. Florida's exotic freshwater fishes—2007. *Florida Scientist* 71:220-245.
- South Carolina Legislature. 2019. Importing, possessing, or selling certain fish unlawful; special permits for research; Department to issue rules and regulations; penalties. South Carolina Code of Laws, Title 50, Chapter 13, Section 1630.
- State of Nevada. 2018. Restrictions on importation, transportation and possession of certain species. Nevada Administrative Code, Chapter 503, Section 110.
- Tavares LER, Luque JL. 2005. *Ergasilus youngi* sp. nov. (Copepoda, Poecilostomatoida, Ergasilidae) parasitic on *Aspistor luniscutis* (Actinopterygii, Ariidae) from off the State of Rio de Janeiro, Brazil. *Acta Parasitologica* 50:150-155.
- Tavares-Dias M, Araújo CSO, Barros MS, Viana GM. 2014. New hosts and distribution records of *Braga patagonica*, a parasite Cymothoidae of fishes from the Amazon. *Brazilian Journal of Aquatic Science and Technology* 18:91-97.
- Texas Parks and Wildlife. 2019. Invasive, prohibited and exotic species. Austin, Texas: Texas Parks and Wildlife. Available: https://tpwd.texas.gov/huntwild/wild/species/exotic/prohibited_aquatic.phtml. (August 2019).
- Thatcher VE. 1999. Two new Bucephalidae (Trematoda) from fishes of the Brazilian Amazon. *Acta Amazonica* 29:331-335.
- Utah Office of Administrative Rules. 2019. Classification and specific rules for fish. Utah Administrative Code, Rule R657-3-23.

Van Every LR, Kritsky DC. 1992. Neotropical Monogenoidea. 18. *Anacanthorus* Mizelle and Price, 1965 (Dactylogyridae, Anacanthorinae) of piranha (Characoidea, Serrasalminae) from the Central Amazon, their phylogeny, and aspects of host-parasite coevolution. *Journal of the Helminthological Society of Washington* 59:52-75.

Virginia Department of Game and Inland Fisheries. 2019. Nongame fish, reptile, amphibian and aquatic invertebrate regulations. Henrico, Virginia: Virginia Department of Game and Inland Fisheries. Available: <https://www.dgif.virginia.gov/fishing/regulations/nongame/>. (August 2019).

Walliker D. 1969. Myxosporidea of some Brazilian freshwater fishes. *Journal of Parasitology* 55:942-948.

11 Literature Cited in Quoted Material

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

Courtenay WR Jr., Sahlman HF, Wiley II WW, Herrema DJ. 1974. Exotic fishes in fresh and brackish waters of Florida. *Biological Conservation* 6:292-302.

Dunnit H, Kneesun-Boomsadaisy H. 1994. On the introduction of exotic freshwater fish species to the South Pacific. Twenty-fifth regional technical meeting on fisheries, Noumea, New Caledonia, 14-18 March 1994. South Pacific Commission, SPC/Fisheries 25/WP 99.

Fuller PL, Nico LG, Williams JD. 1999. Nonindigenous fishes introduced into inland waters of the United States. Bethesda, Maryland: American Fisheries Society Special Publication 27.

Merckx A, Jégu M, Mendes Dos Santos G. 2000. Une nouvelle espèce de *Serrasalmus* (Teleostei: Characidae: Serrasalminae), *S. altispinis* n. sp., décrite du rio uatumã (Amazonas, Brésil) avec une description complémentaire de *S. rhombeus* (Linnaeus, 1766) du plateau Guyanais. *Cybium* 24:181-201.

Planquette P, Keith P, Le Bail P-Y. 1996. Atlas des poissons d'eau douce de Guyane. Volume 1. Collection du Patrimoine Naturel 22. Paris: IEGB-Muséum national d'Histoire naturelle, INRA, CSP, Ministère de l'Environnement.

Riehl R, Baensch HA. 1991 *Aquarien Atlas*. Volume 1. Melle, Germany: Mergus, Verlag für Natur- und Heimtierkunde.

Shafland PL, Foote KJ. 1979. A reproducing population of *Serrasalmus humeralis* Valenciennes in southern Florida. *Florida Scientist* 42:206-214.