

Gibbus Piranha (*Serrasalmus gibbus*)

Ecological Risk Screening Summary

U.S. Fish and Wildlife Service, April 2012

Revised, July 2018

Web Version, 8/22/2019

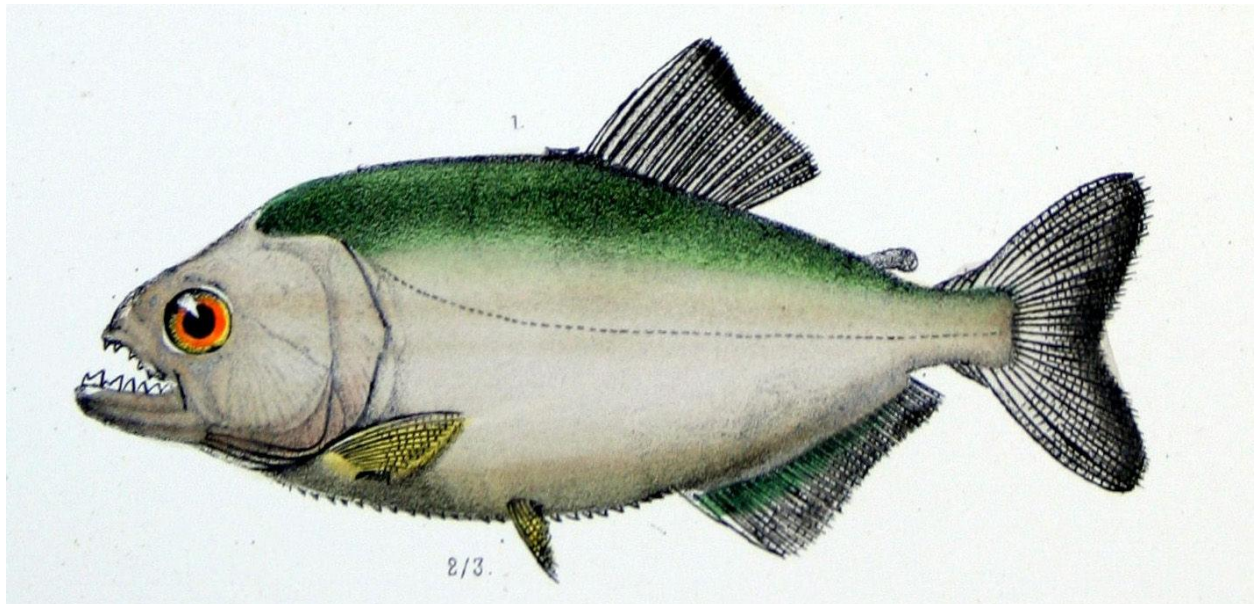


Image: Francis de Laporte de Castelnau. Public domain. Available: http://eol.org/data_objects/27269923. (July 2018).

1 Native Range and Status in the United States

Native Range

From Froese and Pauly (2018):

“South America: Tocantins River basin in Brazil.”

From Anonymous (2016):

“Museum records show that the type specimens came from Goiás in the Rio Araguaia [tributary of Tocantins River] basin in Brazil. Subsequent specimens have also been collected from the Rio das Mortes in the Mato Grosso, and the Maroni basin in French Guiana.”

Additional reports of this species come from Amapá State in northeastern Brazil (Sá-Oliveira et al. 2015a, 2015b, 2017).

Status in the United States

This species has not been reported as introduced or established in the wild in the United States.

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

From AquaScapeOnline (2018):

“Gibbus Piranha 3"-4" (*Serrasalmus Gibbus* [*sic*]) [...] Our Price: \$200.00”

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*, *Phygoctrus*, *Teddyella*, *Rooseveltiella*, and *Pygoprists* [...]

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 *Pygocetrus*.”

From Connecticut Secretary of State (2016):

“The importation or possession of piranha of the subfamily: Serrasalminae, genera *Serrasalmus*, *Serrasalmo*, *Pygocentrus*, *Teddyella*, *Rooseveltiella* 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 [...]”

Serrasalmus gibbus is listed on Florida’s Prohibited Nonnative Species List (FFWCC 2019).

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 gibbus 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 gibbus 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 (2016):

“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 is- sued [*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

This species has not been reported as introduced or established in the wild in the United States.

Remarks

From Anonymous (2016):

“*Serrasalmus* is the largest serrasalmid genus with around 24 species. The *Serrasalmus* species can be very tricky to identify, and there is little published information on the majority of species.”

OPEFE (2012) includes the statement: “It is certain that *S. gibbus* is a valid species, different from *S. rhombeus*.” However, the following statements from the same source raise doubts about the validity of the species.

From OPEFE (2012):

“The species *S. gibbus* is based on a single drawn plate and approximately four lines of description (see image above). The holotype was lost during WWII and there are no paratypes of this species to collaborate its actual existence.”

“The specimens that are presently being imported to the aquarium trade as *S. gibbus* do present a similar appearance to the description by Castelnau. But so do other forms of piranha, such as *S.*

elongatus. The name *S. gibbus* is available should any of the catalogued specimens be considered that species. But just as likely the species that hobbyist [*sic*] are calling *S. gibbus* and Dr. Jégu thought looked similar to his drawings could simply be a morphotype of *S. rhombeus*.”

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 gibbus* Castelnau, 1855”

From Fricke et al. (2019):

“**Current status:** Valid as *Serrasalmus gibbus* Castelnau 1855. Serrasalmidae.”

Size, Weight, and Age Range

From Froese and Pauly (2018):

“Max length : 25.5 cm SL male/unsexed; [Garcia-Ayala et al. 2014]”

Environment

From Froese and Pauly (2018):

“Freshwater; pelagic.”

Climate/Range

From Froese and Pauly (2018):

“Tropical”

Distribution Outside the United States

Native

From Froese and Pauly (2018):

“South America: Tocantins River basin in Brazil.”

From Anonymous (2016):

“Museum records show that the type specimens came from Goiás in the Rio Araguaia [tributary of Tocantins River] basin in Brazil. Subsequent specimens have also been collected from the Rio das Mortes in the Mato Grosso, and the Maroni basin in French Guiana.”

Additional reports of this species come from Amapá State in northeastern Brazil (Sá-Oliveira et al. 2015a, 2015b, 2017).

Introduced

No introductions of this species have been reported.

Means of Introduction Outside the United States

No introductions of this species have been reported.

Short Description

From Tropical Fish Finder (2018):

“Another medium-sized species noted for the bright gold colouration that covers the face and belly. The trailing edge of the tail fin is dark grey. Maximum size is about 20 cm, but aquarium specimens tend to be a bit smaller.”

Biology

From Sá-Oliveira et al. (2017):

“The gibbus piranha, *Serrasalmus gibbus* Castelnau 1855, is a carnivorous species of the family Serrasalminae, which feeds on fish, insects, and other invertebrates, and is found primarily along the margins of rivers and lakes [Santos et al. 2006].”

From Sá-Oliveira et al. (2015a):

“[...] cuts its prey into pieces before swallowing.”

From Sá-Oliveira et al. (2015b):

“[...] three species—*Ageneiosus ucayalensis* (14.39 %), *Hemiodus unimaculatus* (12.95 %), and *Serrasalmus gibbus* (10.60 %)—accounted for almost 40 % of the specimens collected [in the Araguari river and Coaracy Nunes reservoir, northeastern Brazil].”

From Anonymous (2016):

“Females are normally thicker and stockier than males. They become dark in colour prior to spawning and typically construct a pit, into which several thousand eggs may be laid. The male normally guards the brood.”

Human Uses

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

From AquaScapeOnline (2018):

“Gibbus Piranha 3"-4" (*Serrasalmus Gibbus* [sic]) [...] Our Price: \$200.00”

Diseases

No OIE-reportable diseases (OIE 2019) have been documented in this species.

From Gentil-Vasconcelos and Tavares-Dias (2015):

“*Excorallana* Stebbing, 1904 (Corallanidae) are isopods consisting of 24 species (Schotte, 2014) occurring predominantly in marine environments of tropical and subtropical latitudes (Guzmán et al., 1988; Delaney 1989).”

“*Excorallana berbicensis* infestations occurred on the mouth, gills and integument of the hosts, except for *S. gibbus*, which only had infestation on its integument.”

Threat to Humans

From Froese and Pauly (2018):

“Harmless”

3 Impacts of Introductions

No introductions of this species have been reported; therefore, there is no information on impacts of introductions.

The importation, possession, or trade of the piranha *Serrasalmus gibbus* 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 2016), 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 Global Distribution



Figure 1. Known global distribution of *Serrasalmus gibbus*, reported from northern South America. Map from GBIF Secretariat (2017).

5 Distribution within the United States

This species has not been reported as introduced or established in the United States.

6 Climate Matching

Summary of Climate Matching Analysis

The climate match (Sanders et al. 2018; 16 climate variables; Euclidean Distance) for *Serrasalmus gibbus* was medium in southern Florida and low elsewhere in the contiguous United States. The Climate 6 score for the contiguous United States was 0.000. This score is classified as a low overall climate match (scores between 0.000 and 0.005, inclusive, are classified as low). Furthermore, all states had low individual Climate 6 scores.

All reported occurrences of this species (GBIF Secretariat 2017) were included as source locations for the climate matching analysis despite conflicting descriptions of range and apparent difficulties in identifying this species correctly. Limiting the source locations to the Tocantins River basin, from which *S. gibbus* was originally described, would have little effect on the results of the climate match. The

Tocantins River basin is the most temperate of the locations where *S. gibbus* has been reported, and therefore provides the best match to climates present in the contiguous United States.

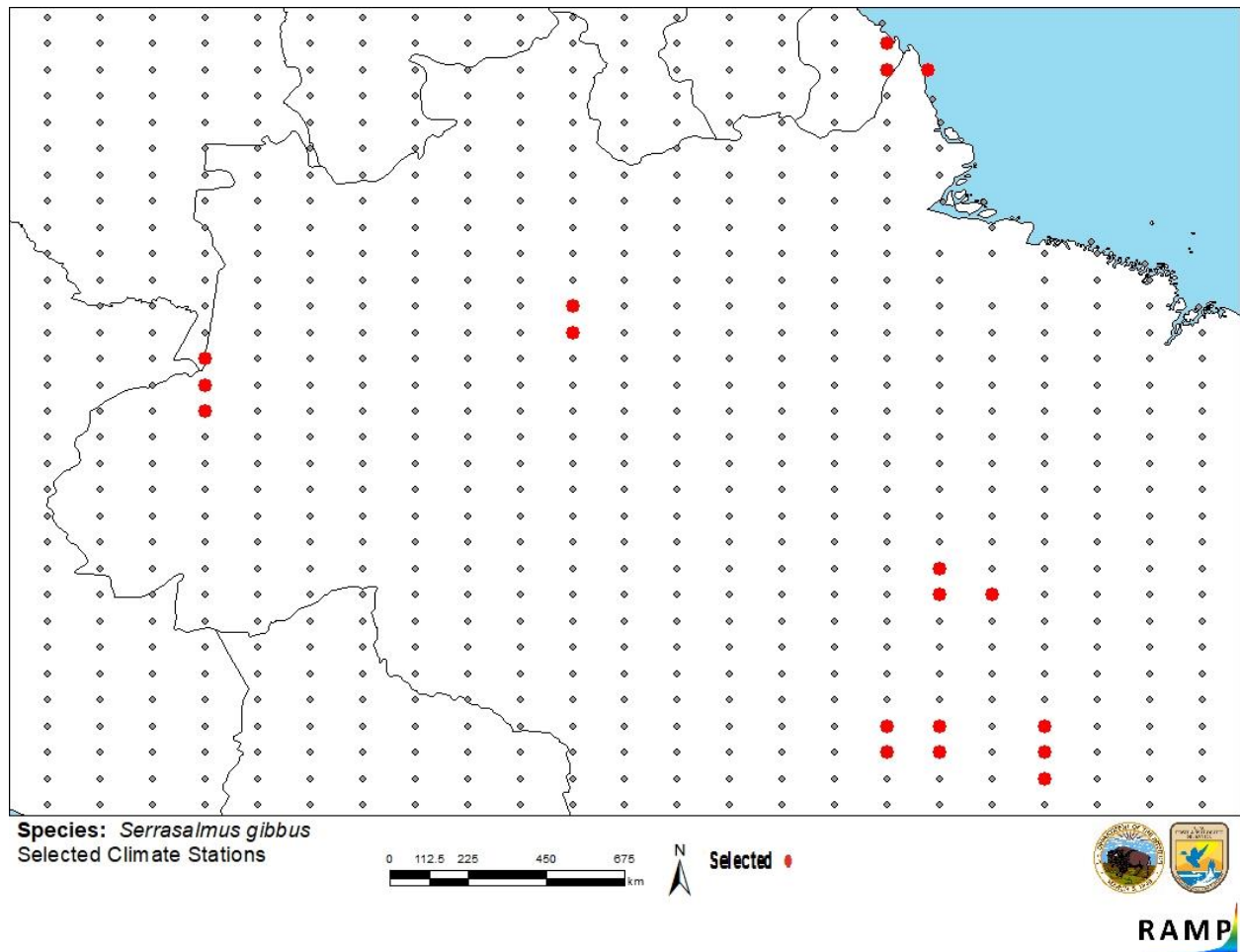


Figure 2. RAMP (Sanders et al. 2018) source map showing weather stations in South America selected as source locations (red; Brazil, French Guiana) and non-source locations (gray) for *S. gibbus* climate matching. Source locations from GBIF Secretariat (2017).

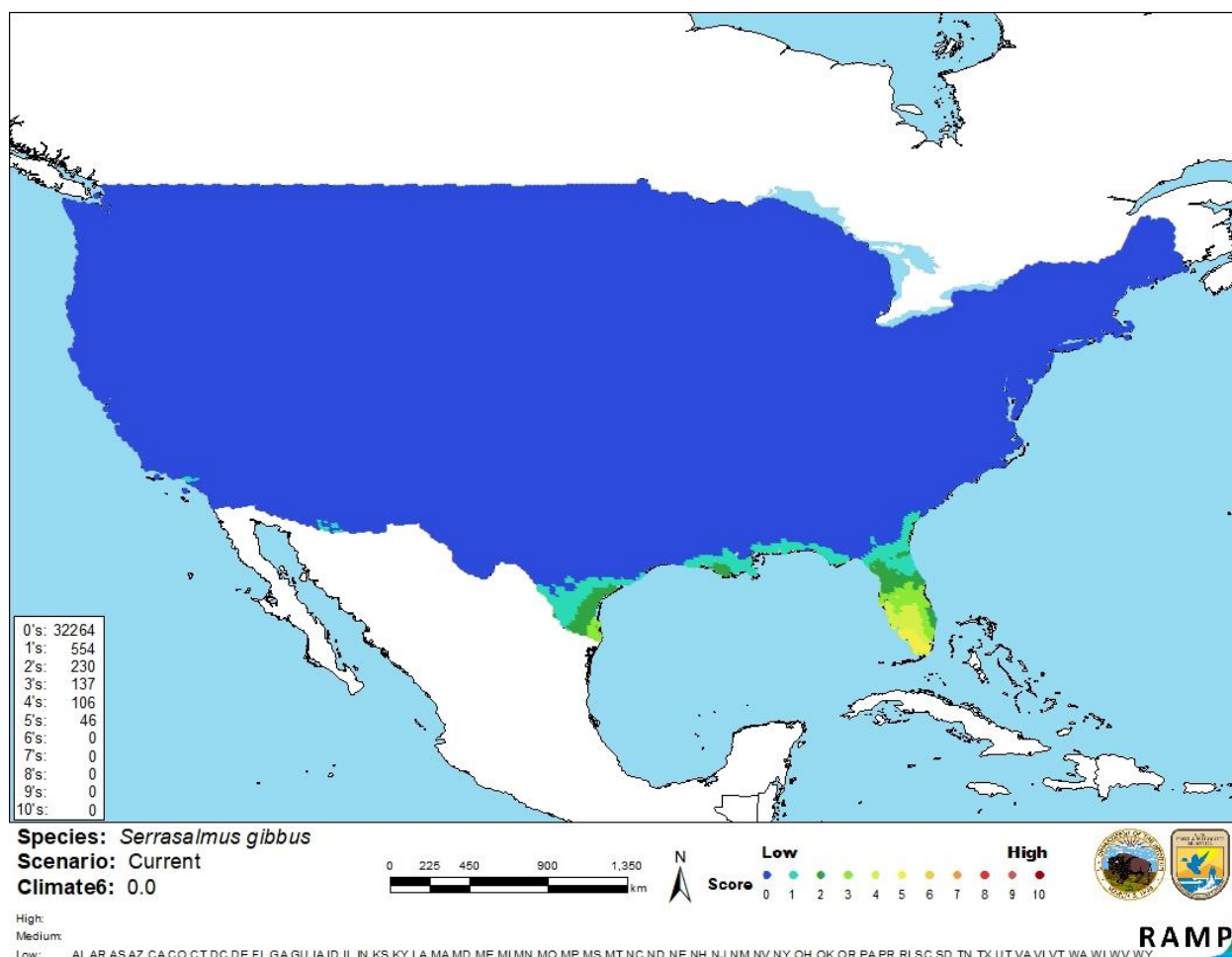


Figure 3. Map of RAMP (Sanders et al. 2018) climate matches for *S. gibbus* in the contiguous United States based on source locations reported by GBIF Secretariat (2017). 0=Lowest match, 10=Highest match.

The “High”, “Medium”, and “Low” climate match categories are based on the following table:

Climate 6: Proportion of (Sum of Climate Scores 6-10) / (Sum of total Climate Scores)	Climate Match Category
$0.000 \leq X \leq 0.005$	Low
$0.005 < X < 0.103$	Medium
≥ 0.103	High

7 Certainty of Assessment

Limited information is available on the biology, ecology, and distribution of *Serrasalmus gibbus*. Disagreement and confusion over the validity of this species and its true native distribution are apparent in the aquarium literature, although there is little discussion of uncertainty in the peer-reviewed literature. No introductions of this species have been reported, so any impacts of introduction remain unknown. The certainty of this assessment for *S. gibbus* is low.

8 Risk Assessment

Summary of Risk to the Contiguous United States

The Gibbus Piranha (*Serrasalmus gibbus*) is native to the Tocantins River basin in eastern Brazil. It has also been reported from other parts of the Amazon River basin and from French Guiana and the adjacent Brazilian state of Amapá. No introductions of this species have been reported, but identification in the native range as well as any potential introduced range may be difficult given the morphological similarities among many serrasalmids. *S. gibbus* is present in the aquarium trade in the United States, but many States prohibit the possession or trade of piranhas. The history of invasiveness is uncertain. Climate match to the contiguous United States is low overall, with medium match occurring only in southern Florida. Due to lack of information and taxonomic uncertainty, the certainty of assessment is low. The overall risk assessment category for *S. gibbus* is uncertain.

Assessment Elements

- **History of Invasiveness (Sec. 3): Uncertain**
- **Climate Match (Sec. 6): Low**
- **Certainty of Assessment (Sec. 7): Low**
- **Overall Risk Assessment Category: Uncertain**

9 References

Note: The following references were accessed for this ERSS. References cited within quoted text but not accessed are included below in Section 10.

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.

- Anonymous. 2016. Gold piranha, *Serrasalmus gibbus*. Practical Fishkeeping. Available: <https://www.practicalfishkeeping.co.uk/features/articles/gold-piranha-serrasalmus-gibbus>. (July 2018).
- AquaScapeOnline. 2018. Gibbus Piranha. Available: <https://www.aquascapeonline.com/prodList.asp?item=Gibbus%20Piranha&idCategory=384>. (July 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. Habitat Conservation Planning Branch, California Department of Fish and Wildlife, Sacramento, California. 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.
- FFWCC (Florida Fish and Wildlife Conservation Commission). 2019. Prohibited nonnative species list. Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida. Available: <https://myfwc.com/wildlifehabitats/nonnatives/prohibited-species-list/>. (August 2019).
- Fricke, R., W. N. Eschmeyer, and R. Van der Laan, editors. 2019. Eschmeyer's Catalog of Fishes: genera, species, references. Available: <http://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp>. (August 2019).
- Froese, R., and D. Pauly, editors. 2018. *Serrasalmus gibbus* Castelnau, 1855. FishBase. Available: <https://www.fishbase.de/summary/Serrasalmus-gibbus.html>. (July 2018).
- GBIF Secretariat. 2017. GBIF backbone taxonomy: *Serrasalmus gibbus* Castelnau, 1855. Global Biodiversity Information Facility, Copenhagen. Available: <https://www.gbif.org/species/2354159>. (July 2018).

- Gentil-Vasconcelos, H. C., and M. Tavares-Dias. 2015. First study on infestation of *Excorallana berbicensis* (Isopoda: Corallanidae) on six fishes in a reservoir in Brazilian Amazon during dry and rainy seasons. *Latin American Journal of Aquatic Research* 43(5):936–943.
- Georgia Department of Natural Resources. 2019. Wild animals/exotics. Georgia Department of Natural Resources Law Enforcement Division, Social Circle, Georgia. Available: <http://gadnrle.org/exotics>. (August 2019).
- Hawaii Department of Agriculture. 2019. Animal guidelines. Hawaii Department of Agriculture, Plant Industry Division, Honolulu, Hawaii. 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. Illinois Department of Natural Resources, Springfield, Illinois. Available: https://www.ifishillinois.org/programs/aquaculture/aquatic_approved_species.pdf. (August 2019).
- ITIS (Integrated Taxonomic Information System). 2018. *Serrasalmus gibbus* Castelnau, 1855. Integrated Taxonomic Information System, Reston, Virginia. Available: https://www.itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=641737#nuli. (July 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.
- 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. Maine Department of Inland Fisheries and Wildlife, Augusta, Maine. 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.

- Melo, T. L., F. L. Tejerina-Garro, and C. E. Melo. 2009. Influence of environmental parameters on fish assemblage of a Neotropical river with a flood pulse regime, central Brazil. *Neotropical Ichthyology* 7(3):421–428.
- Mississippi Secretary of State. 2019. Guidelines for aquaculture activities. Mississippi Administrative Code, Title 2, Part 1, Subpart 4, Chapter 11. Regulatory and Enforcement Division, Office of the Mississippi Secretary of State, Jackson, Mississippi.
- New Mexico Department of Game and Fish. 2010. Director's species importation list. New Mexico Department of Game and Fish, Santa Fe, New Mexico. 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.
- 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). 2019. OIE listed diseases, infections and infestations in force in 2019. Available: <http://www.oie.int/animal-health-in-the-world/oie-listed-diseases-2019/>. (August 2019).
- Oklahoma Secretary of State. 2019. List of restricted exotic species. Oklahoma Administrative Code, Title 800, Chapter 20-1-2.
- OPEFE (Oregon Piranha Exotic Fish Exhibit). 2012. *Serrasalmus gibbus*, Caribe Dorado. Oregon Piranha Exotic Fish Exhibit, Sutherlin, Oregon. Available: <https://www.opefe.com/gibbus.html>. (July 2018).
- Sá-Oliveira, J. C., S. F. Ferrari, H. C. Gentil Vasconcelos, A. S. Araujo, C. E. Costa Campos, C. A. Gellis Mattos-Dias, A. A. Fecury, E. Oliveira, R. N. G. Mendes-Junior, and V. J. Isaac. The Scientific World Journal 2017:8064126.
- Sá-Oliveira, J. C., J. E. Hawes, V. J. Isaac-Nahum, and C. A. Peres. 2015a. Upstream and downstream responses of fish assemblages to an Eastern Amazonian hydroelectric dam. *Freshwater Biology* 60(10):2037–2050.
- Sá-Oliveira, J. C., V. J. Isaac, and S. F. Ferrari. 2015b. Fish community structure as an indicator of the long-term effects of the damming of an Amazonian river. *Environmental Biology of Fishes* 98:273–286.

- Sanders, S., C. Castiglione, and M. Hoff. 2018. Risk Assessment Mapping Program: RAMP, version 3.1. U.S. Fish and Wildlife Service.
- 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. 2016. Restrictions on importation, transportation and possession of certain species. Nevada Administrative Code, Chapter 503, Section 110.
- Texas Parks and Wildlife. 2019. Invasive, prohibited and exotic species. Texas Parks and Wildlife, Austin, Texas. Available: https://tpwd.texas.gov/huntwild/wild/species/exotic/prohibited_aquatic.phtml. (August 2019).
- Tropical Fish Finder. 2018. Piranhas: not just killing machines. Tropical Fish Finder, Hawkhurst, Kent, U.K. Available: <https://www.tropicalfishfinder.co.uk/article-detail?id=78>. (July 2018).
- Utah Office of Administrative Rules. 2019. Classification and specific rules for fish. Utah Administrative Code, Rule R657-3-23.
- Virginia Department of Game and Inland Fisheries. 2019. Nongame fish, reptile, amphibian and aquatic invertebrate regulations. Virginia Department of Game and Inland Fisheries, Henrico, Virginia. Available: <https://www.dgif.virginia.gov/fishing/regulations/nongame/>. (August 2019).

10 References Quoted But Not Accessed

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.

- Delaney, P. M. 1989. Phylogeny and biogeography of the marine isopod family Corallanidae (Crustacea, Isopoda, Flabellifera). Contributions in Science. Natural History Museum of Los Angeles County 409:1–75.
- Garcia-Ayala, J. R., E. M. Brambilla, F. A. Travassos, E. D. Carvalho, and G. S. David. 2014. Length-weight relationships of 29 fish species from the Tucuruí Reservoir (Tocantins/Araguaia Basin, Brazil). Journal of Applied Ichthyology 30:1092–1095.

- Guzmán, H. M., V. L. Obando, R. C. Brusca, and P. M. Delane. 1988. Aspects of the population biology of the marine isopod *Excorallana tricornis occidentalis* Richardson, 1905 (Crustacea: Isopoda: Corallanidae) at Cano Island, Pacific Costa Rica. *Bulletin of Marine Science* 43:77–87.
- Santos, G. M., E. J. G. Ferreira, and J. A. S. Zuanon. 2006. Peixes comerciais de Manaus. Ibama/AM, ProVárzea, Manaus, Brazil.
- Schotte, M. 2014. *Excorallana* Stebbing, 1904. In M. Schotte, C. B. Boyko, N. L. Bruce, G. C. B. Poore, S. Taiti, and G. D. F. Wilson, editors. World marine, freshwater and terrestrial isopod crustaceans database. Available: <http://www.marinespecies.org/aphia.php?p=taxedtails&id=248749>. (February 2015).