

Arawana (*Osteoglossum bicirrhosum*)

Ecological Risk Screening Summary

U.S. Fish & Wildlife Service, November 2020

Revised, November 2020

Web Version, 9/16/2021

Organism Type: Fish

Overall Risk Assessment Category: Low



Photo: User:Qwertzy2. Licensed under CC BY-SA 3.0 Unported. Available: <https://commons.wikimedia.org/w/index.php?curid=226294>. (November 2020).

1 Native Range and Status in the United States

Native Range

From Schofield et al. (2020):

“Tropical America; northern South America including the Amazon basin and the Guianas (Robins et al. 1991).”

From Froese and Pauly (2020):

“South America: Amazon River basin, Rupununi and Oyapock Rivers [Brazil, Colombia, Ecuador, French Guiana, Guyana, and Peru].”

Status in the United States

From Schofield et al. (2020):

“**Nonindigenous Occurrences:** Three specimens have been recorded from **California**. The first was a single fish taken from Lake Berryessa, Napa County, by an angler ca. 1972 (Shapovalov et al. 1981; Courtenay et al. 1991); a second specimen was netted from Lake Merced, San Francisco County, by anglers in August 1994 (Dill and Cordone 1997); a third specimen was collected from Adobe Creek in Petaluma in July 2000 (D. Logan, personal communication). A single fish was collected from the Denver, **Colorado** area in 2004 (Walker, pers. comm.). A fish was photographed at Blue Hole on Big Pine Key, **Florida** in 2003 (Loftus, pers. comm.); a single individual was collected by an angler from a retention pond adjacent to East Lake Tohopekaliga (K. McDaniel, Florida Fish and Wildlife Conservation Commission, pers. comm.). An *Osteoglossum* species was reported from a freshwater reservoir in O'ahu, **Hawai'i** in 1988-1989, but no specimen was collected and the species was not identified. That sighting is provisionally allocated to *O. bicirrhosum* as it is more frequently imported than *O. ferreirai* (Mundy 2005). One individual was taken in Lake George, **Indiana** in October 2000 (Keller, pers. comm.). The species was unsuccessfully introduced at Forest Spring in Ash Meadows, Nye County, **Nevada**, during the early 1960s (Soltz and Naiman 1978; Deacon and Williams 1984; Vinyard 2001). One individual was taken in a small pond in Bensalem, **Pennsylvania** in July 2005 (DeVicar, personal communication). A specimen in a Chicago, **Illinois** canal was electrofished in 2013 (A. Plauck, personal communication).”

“**Status:** All reported introductions of arawana have failed to establish viable populations.”

From Aqua Imports (2020):

“Silver Arowana (*Osteoglossum bicirrhosum*)
\$22.99 – \$159.99”

From Moreau and Coomes (2006):

“In North America, based on an October 2005 internet search of aquarium fish retailer and hobbyist sites, silver arawana [*O. bicirrhosum*] larvae with yolk sacs retail for 10–20 USD, 10–20 cm juveniles for 25–65 USD, and adults for 100 USD or more, depending on size.”

Osteoglossum bicirrhosum is on Hawaii's Conditional Animal List (Hawaii Department of Agriculture 2019).

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. [...]

Bony-tongue fishes Family Osteoglossidae ****[all species]”

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:
[...]

(3) Boney-tongue group: *Osteoglossum* spp., and *Arapaima* spp.”

Means of Introductions in the United States

From Schofield et al. (2020):

“Aquarium releases in most locations. Juveniles and small adults are found in the ornamental fish trade. They quickly reach sizes too large for most hobbyists. Introduced by an illegal ornamental fish-farming operation in Nevada (Soltz and Naiman 1978).”

Remarks

This ERSS was previously published in September 2017. Revisions were completed to incorporate new information and conform to updated standards.

Database and literature searches were done using the valid scientific name *Osteoglossum bicirrhosum* and the senior synonym *Ischnosoma bicirrhosum*.

From Schofield et al. (2020):

“Conventionally, most arawanas (especially in the aquarium trade) have been referred to as *O. bicirrhosum*. Some of these (including our own records) may have actually been *O. ferreirai*; however, this is unlikely because *O. bicirrhosum* is most commonly imported and sold in the U.S. and is easily distinguishable as juveniles/subadults [sic] [...]

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

According to Fricke et al. (2020), *Osteoglossum bicirrhosum* (Cuvier 1829) is the current valid name of this species. The original name of this species is *Ischnosoma bicirrhosum* (Cuvier

1829). The following names are synonyms of this species: *Osteoglossum arowana*, and *Osteoglossum vandellii*.

From ITIS (2020):

Kingdom Animalia
Subkingdom Bilateria
Infrakingdom Deuterostomia
Phylum Chordata
Subphylum Vertebrata
Infraphylum Gnathostomata
Superclass Actinopterygii
Class Teleostei
Superorder Osteoglossomorpha
Order Osteoglossiformes
Suborder Osteoglossoidei
Family Osteoglossidae
Subfamily Osteoglossinae
Genus *Osteoglossum*
Species *Osteoglossum bicirrhosum* (Cuvier, 1829)

Size, Weight, and Age Range

From Froese and Pauly (2020):

“Max length: 90.0 cm TL male/unsexed; [Ferraris 2003]; max. published weight: 6.0 kg [Machacek 2007]”

From Moreau and Coomes (2006):

“Silver arowana are thought to reach sexual maturity after 2 years (Lowe-McConnell, 1975), with hobbyist web sites reporting that the fish can live for up to 20 years in captivity”

Environment

From Froese and Pauly (2020):

“Freshwater; benthopelagic. [...] 24°C - 30°C [Riehl and Baensch 1991; assumed to be recommended aquarium temperature]”

“It [*O. bicirrhosum*] is capable of adapting to environments with low oxygen levels [Planquette et al. 1996].”

From Armando et al. (2018):

“The highest survival of silver arowana fish seeds was obtained at a treatment temperature of 26°C at 78%[survival rate] and the lowest was obtained at 30°C temperature treatment by 20% [survival rate] [...]”

Climate

From Froese and Pauly (2020):

“Tropical; [...]”

Distribution Outside the United States

Native

From Schofield et al. (2020):

“Tropical America; northern South America including the Amazon basin and the Guianas (Robins et al. 1991).”

From Froese and Pauly (2020):

“South America: Amazon River basin, Rupununi and Oyapock Rivers [Brazil, Colombia, Ecuador, French Guiana, Guyana, and Peru].”

Introduced

Froese and Pauly (2020) lists introductions of *Osteoglossum bicirrhosum* to the Philippines at an unknown time and to China in 1990. It is unknown if either introduction resulted in an established population, however this species is listed as questionable in the Philippines.

From Maciaszek and Sosnowski (2019):

“In this contribution we present first data of confirmed presence of the Silver arowana (*Osteoglossum bicirrhosum*) in water ecosystem [Powsinkowskie Lake] in Poland.”

“It can be assumed that this was a single case of uncontrolled introduction, which resulted in the death of the fish as a result of excessive hypothermia and resulting damage.”

Means of Introduction Outside the United States

From Froese and Pauly (2020):

“Reason: ornamental [...] Assumed to be introduced for aquaria. [Chen 2002]”

Short Description

From Froese and Pauly (2020):

“Body covered with very big scales; dorsal and anal fins almost fused with the caudal fin; 2 barbels at the extremity of the lower jaw; adult silvery, juvenile with blue glints and a yellow-orange bar [Planquette et al. 1996].”

Biology

From Froese and Pauly (2020):

“Is an omnivore with a tendency to feed on fish at the surface. The superior position of the mouth allows it to capture its prey while swimming from below. Also jumps out of the water to feed on large insects (Coleoptera; [Ferreira et al. 1998]).”

“The male carries eggs, larvae and early juveniles (alevinos) in his mouth [Riehl and Baensch 1991], which lasts for nearly six weeks [Verba et al. 2014].”

From Moreau and Coomes (2006):

“Only once the alevinos [juveniles] are 25– 40 mm long and have absorbed their yolk-sac are they released from the male’s mouth for occasional feeding, returning at the first sign of danger (Schaller & Dorn, 1971; Goulding, 1990). At 4–6 weeks young are left to fend for themselves (Goulding, 1990). Silver arowana are thought to reach sexual maturity after 2 years (Lowe-McConnell, 1975), [...]”

From Tavares-Dias et al. (2014):

“A benthopelagic fish with a sedentary life-style, it can jump out of water to catch prey in nearby branches, which allows this species exploring a variety of arboreal preys, such as insects, arachnids and other small vertebrates. A small portion of its diet consists of small fish; it is an omnivorous species and also feeds on crustaceans and mollusks, showing no variations in the type of food from a hydrological period to another (SANTOS et al., 2006; AGUDELO-ZAMORA et al., 2007; SOARES et al., 2008). All these characteristics indicate that this is a carnivore-insectivore fish. Reproduction occurs between the end of the dry season (December) and the beginning of the flooding season (January). The females begin the process of sexual maturity at 55 cm out of standard length (SOARES et al., 2008).”

From Orlov et al. (2015):

“Sporadic weak electric discharges were recorded from the [...] South American silver arowana (*Osteoglossum bicirrhosum*). [...] All discharges recorded from the silver arowana *Osteoglossum bicirrhosum* [...] were similar to those of *Heterotis niloticus* [...], but their waveform was less stable. Maximum peak-to-peak amplitude was around 1.5 mV. Polarity of phases was not determined because only five spontaneous discharges were recorded from a pair of individuals left for 19.5 hours in the experimental tank.”

Human Uses

From Froese and Pauly (2020):

“Fisheries: commercial; gamefish: yes; aquarium: commercial”

From Moreau and Coomes (2006):

“The Peruvian Amazon is a key supply region of *O. bicirrhosum* to international aquarium markets, with silver arowana also exported (probably in smaller quantities) from Brazil (64,750 individuals exported from Manaus in 2003; N.L. Chao, pers. comm), Colombia and Guyana.”

“In 2001 aquarium export firms in Iquitos officially sold just over one million arowana juveniles to international clients [...]. Actual trade volumes and values are probably higher (by at least 20%, [...]). Arowana is the most commercially important species to the Peruvian Amazon aquarium trade, representing 42% of declared total international export value in 2001. [...] Arowana is also the second most important species in the trade by total export volume, after the small armoured catfish *Otocinclus* sp. (29% of volume).”

“The practice of killing reproductive adults and taking all their juveniles for the trade, as reported by informants on the Río Tapiche, is probably more common in the Peruvian Amazon than the catch-and release method described by informants living within the Pacaya-Samiria National Reserve. [...] The killing of reproductive males for the aquarium trade may threaten the fishery’s long-term sustainability.”

From De Jesus Da Silva et al. (2009):

“*Osteoglossum bicirrhosum* (silver arowana) is an important fish for the economy of the Amazon region, both as an ornamental fish and as a food fish.”

From Aqua Imports (2020):

“Silver Arowana (*Osteoglossum bicirrhosum*)
\$22.99 – \$159.99”

Diseases

No records of OIE-reportable diseases (OIE 2020) were found in association with *Osteoglossum bicirrhosum*.

From Froese and Pauly (2020):

“*Camallanus* Infection 14, Parasitic infestations (protozoa, worms, etc.)”

From Mood et al. (2010):

“[...] metacercariae of the heterophyid trematode *Centrocestus formosanus* were found encysted in the gills of [...] Arowana (*Osteoglossum bicirrhosum*). [...] *C. formosanus* is a trematode that produces severe alterations in the gills of many freshwater fishes, most notably cartilage proliferation around the encysted trematode in the branchial tissues. It has caused significant losses among cichlids, characids, and cyprinids.”

From Kritsky et al. (1996):

“*Telethecium nasalis* sp. n. [...] HOST AND LOCALITY: Nasal cavity of *Osteoglossum bicirrhosum* Vandelli (Osteoglossidae); Furo do Catalao, near Manaus, Amazonas, Brazil (10 January 1989).”

From Mehdizadeh Mood and Rassouli (2016):

“In this research, 35 *O. bicirrhosum* [...] with clinical signs were collected from different ornamental fish markets in Semnan, Iran and transferred alive to the Lab. Fish skin and gills were examined for monogenean infestations. No monogenea was observed on the skin specimens, but *Gonocleithrum cursitans* and *Unilatus unilatus* infested 54.28% and 74% of gills in *O. bicirrhosum* and *H. plecostomus*, respectively. This is the first report of both *G. cursitans* and *U. unilatus* in Iran.”

From Tavares-Dias et al. (2014):

“From the examined arowana *O. bicirrhosum*, 87.5% had their gills parasitized by *Gonocleithrum aruanae* Kristy & Thatcher, 1983 (Monogeneoidea, Dactylogyridae), but no other parasite was found.”

Threat to Humans

From Froese and Pauly (2020):

“Harmless”

3 Impacts of Introductions

Osteoglossum bicirrhosum has been introduced in multiple countries including the United States, Poland, China, and the Philippines. Despite multiple introductions, this species has yet to become established outside of its native range. No impacts of introductions have been reported.

O. bicirrhosum is regulated in Hawaii, Mississippi, and Oklahoma.

4 History of Invasiveness

Osteoglossum bicirrhosum is a highly valued aquarium fish and is subject to substantial trade. Trade for this species is considered to be substantial because of large documented trade quantities in 2001 (Moreau and Coomes 2006) and the fact that it is still present in the aquarium trade today (Aqua Imports 2020). Likely as a result of such trade, *O. bicirrhosum* has been introduced in multiple countries including the United States, Poland, China, and the Philippines. Despite multiple introductions this species has yet to become established outside of its native range and impacts of said introductions are unknown. The history of invasiveness is classified as Low.

5 Global Distribution



Figure 1. Known global distribution of *Osteoglossum bicirrhosum*. Observations are reported mainly from South America, with scattered locations in North America and southern Asia. Map from GBIF Secretariat (2020). Locations in North America and Asia will not be included in the climate match as they represent either individual specimen captured or museum specimen, and not established populations. The most southern and most eastern locations in Brazil will not be included in the climate match as they represent a confiscated animal and a museum specimen, respectively.

6 Distribution Within the United States

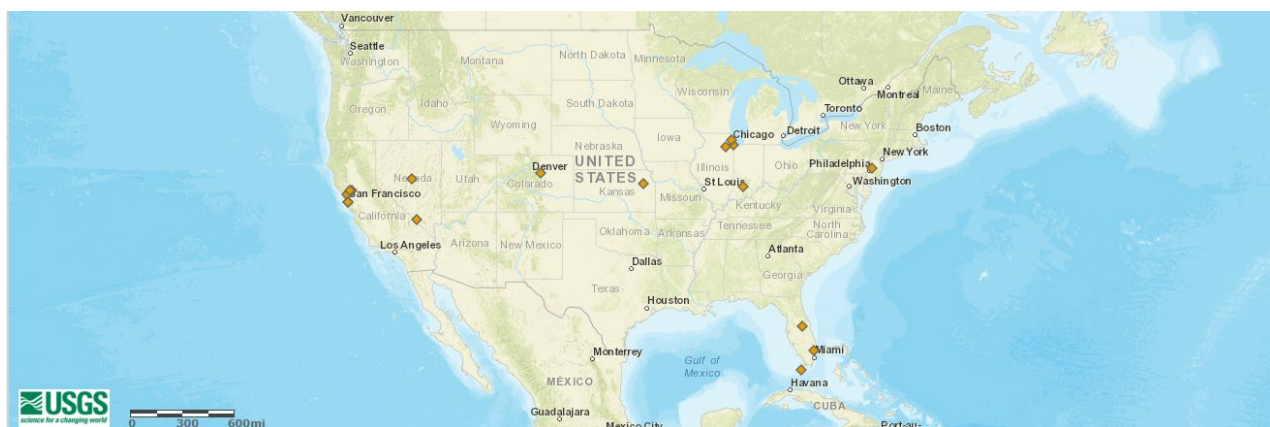


Figure 2. Known distribution of *Osteoglossum bicirrhosum* in the United States. Map from Schofield et al. (2020). All points represent individual specimens collected and do not represent established populations.

7 Climate Matching

Summary of Climate Matching Analysis

The climate match for the contiguous United States was generally low. Small patches of medium and medium-high match were found in Florida and along the Gulf Coast. The overall Climate 6 score (Sanders et al. 2018; 16 climate variables; Euclidean distance) for the contiguous United States was 0.001, low (scores between 0.000 and 0.005, inclusive, are classified as low). All States had a low individual Climate 6 score except for Florida, which had a medium individual Climate 6 score.

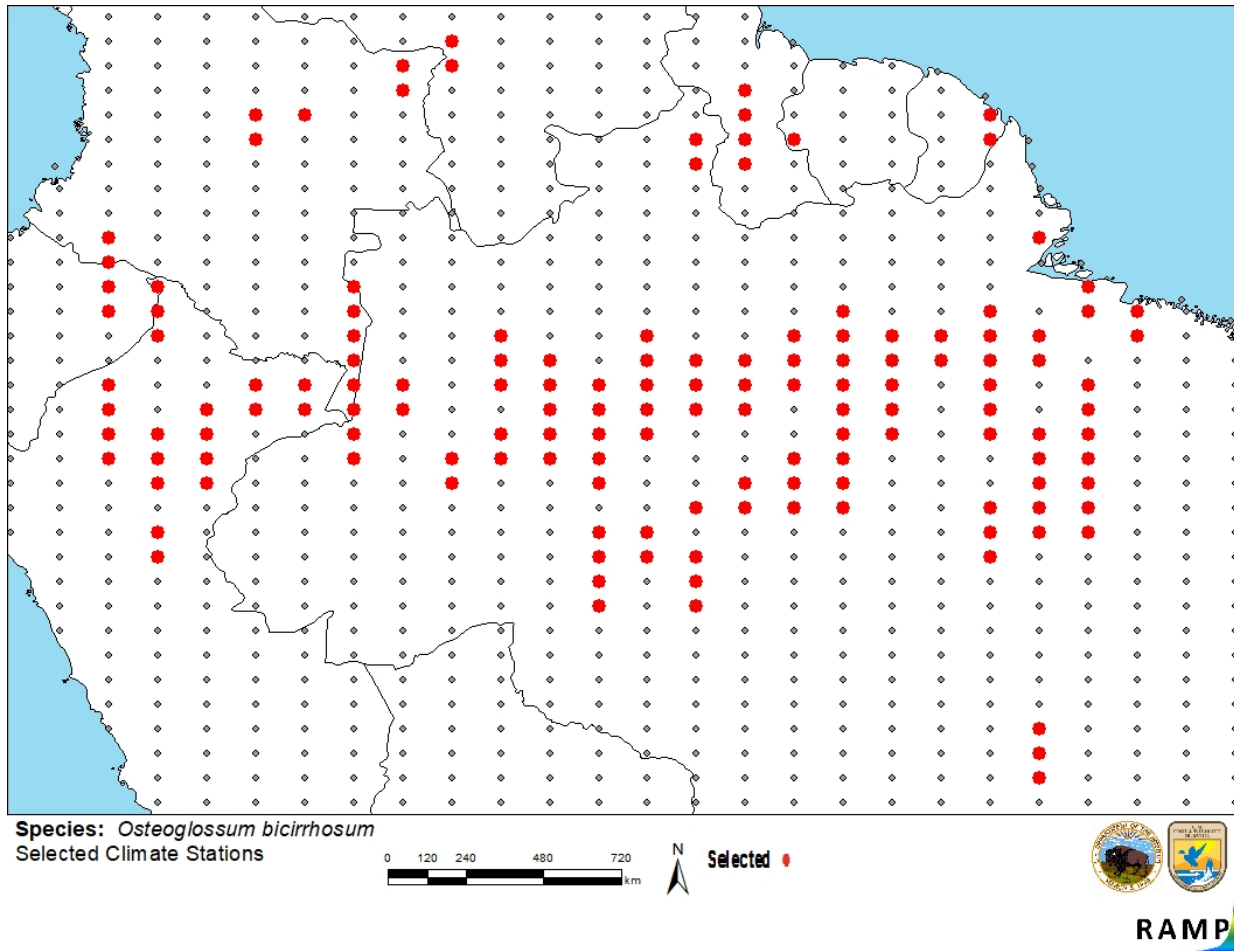


Figure 3. RAMP (Sanders et al. 2018) source map showing weather stations in northern South America as source locations (red; Brazil, Peru, Ecuador, Colombia, Venezuela, Guyana, and French Guiana) and non-source locations (gray) for *Osteoglossum bicirrhosum* climate matching. Source locations from GBIF Secretariat (2020). Selected source locations are within 100 km of one or more species occurrences, and do not necessarily represent the locations of occurrences themselves.

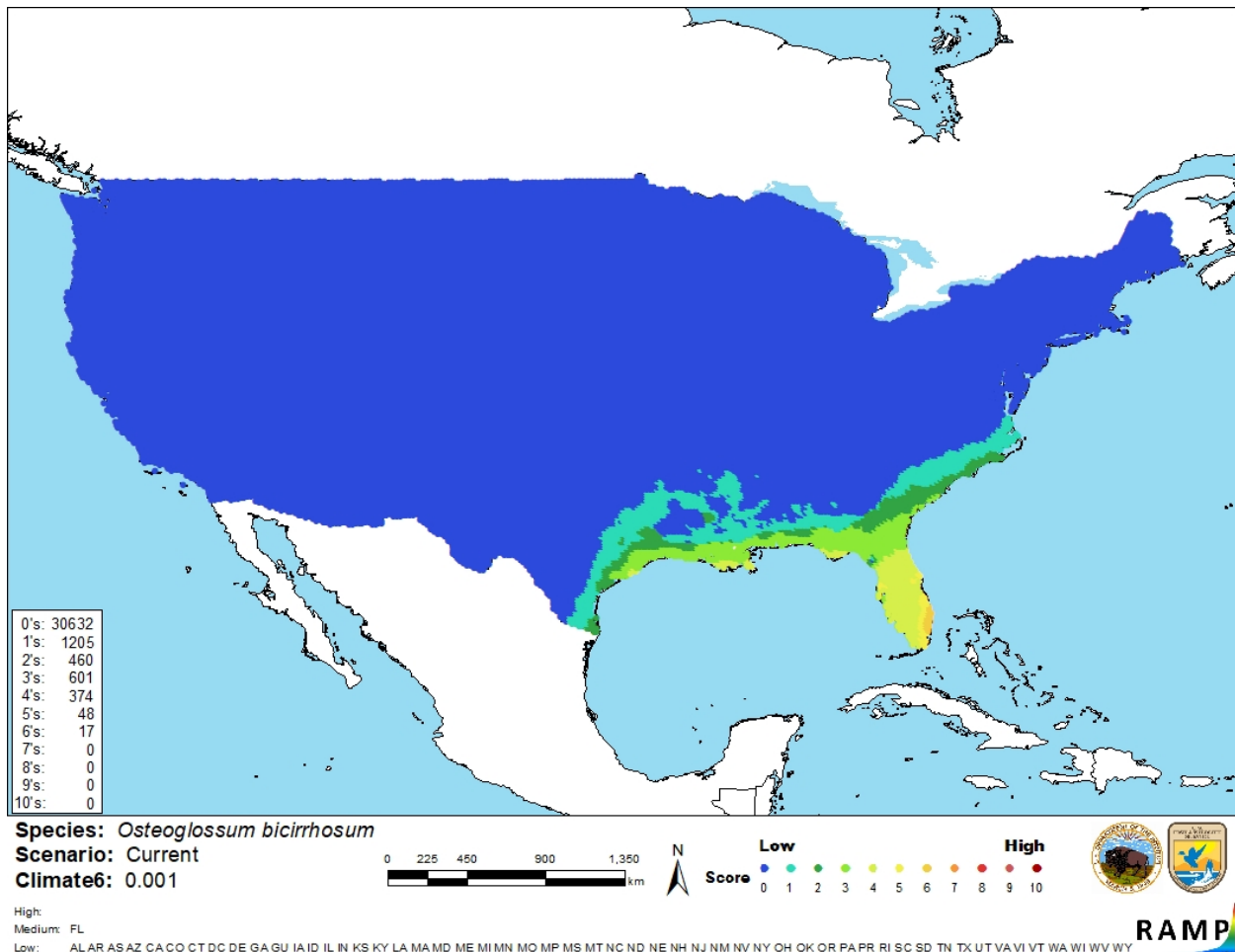


Figure 4. Map of RAMP (Sanders et al. 2018) climate matches for *Osteoglossum bicirrhosum* in the contiguous United States based on source locations reported by GBIF Secretariat (2020). Counts of climate match scores are tabulated on the left. 0/Blue = Lowest match, 10/Red = Highest match.

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

General information regarding the biology, ecology, and distribution of *Osteoglossum bicirrhosum* was available in online databases and peer-reviewed literature. Although impacts of introductions are unknown, the substantial trade presence combined with the lack of non-native

establishment for this species lends some degree of certainty to this assessment. The certainty of this assessment is Medium.

9 Risk Assessment

Summary of Risk to the Contiguous United States

Osteoglossum bicirrhosum, the Arawana, is a freshwater fish native to northern South America (Brazil, Colombia, Ecuador, French Guiana, Guyana, and Peru). This species is heavily traded in the aquarium industry, which is likely what led to multiple introductions in the United States, Poland, China, and the Philippines. *O. bicirrhosum* is regulated in Hawaii, Mississippi, and Oklahoma. Impacts of these introductions are unknown. Despite the multiple introductions, *O. bicirrhosum* has yet to become established outside of its native range. The history of invasiveness is therefore classified as Low. Overall climate match with the contiguous United States was Low with small patches of medium match in the Southeast. Adequate information was available pertaining to the biology, distribution, and trade status of this species resulting in a Medium level of certainty for this assessment. The overall risk assessment category for *Osteoglossum bicirrhosum* is Low.

Assessment Elements

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

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.

Aqua Imports. 2020. Silver arowana. Available: <https://www.aqua-imports.com/product/silver-arowana-osteoglossum-bicirrhosum/> (November 2020).

Armando E, Widodo MS, Fadholi MR. 2018. The effect of different temperature towards the survival rate and specific growth rate of the silver arowana fish (*Osteoglossum bicirrhosum*). Journal of Aquaculture Development and Environment 1:31–34.

De Jesus Da Silva TH, Hrbek T, Farias IP. 2009. Microsatellite markers for the silver arowana (*Osteoglossum bicirrhosum*, Osteoglossidae, Osteoglossiformes). Molecular Ecology Resources 9(3):1019–1022.

Fricke R, Eschmeyer WN, van der Laan R, editors. 2020. Catalog of fishes: genera, species, references. California Academy of Science. Available: <http://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp> (November 2020).

- Froese R, Pauly D, editors. 2020. *Osteoglossum bicirrhosum* (Cuvier, 1829). FishBase. Available: <https://www.fishbase.se/summary/Osteoglossum-bicirrhosum.html> (November 2020).
- GBIF Secretariat. 2020. GBIF backbone taxonomy: *Osteoglossum bicirrhosum* Spix & Agassiz, 1829. Copenhagen: Global Biodiversity Information Facility. Available: <https://www.gbif.org/species/7812454> (November 2020).
- Hawaii Department of Agriculture. 2019. Amendment and compilation of chapter 4-71, Hawaii Administrative Rules. Honolulu: Hawaii Department of Agriculture, Plant Industry Division. Available: <http://hdoa.hawaii.gov/pi/pq/import-program/pq-non-domestic-animal-and-microorganism-lists/> (February 2021).
- [ITIS] Integrated Taxonomic Information System. 2020. *Osteoglossum bicirrhosum* (Cuvier, 1829). Reston, Virginia: Integrated Taxonomic Information System. Available: https://www.itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=161894#null (November 2020)
- Kritsky DC, Van Every LR, Boeger WA. 1996. Neotropical Monogeneoidea. 27. Two new species of *Telethecium* gen. n. from the nasal cavities of Central Amazonian fishes and a redescription of *Kritskyia moravecii* Kohn, 1990 (Dactylogyridae, Ancyrocephalinae). Journal of the Helminthological Society of Washington 63:35–41.
- Maciaszek R, Sosnowski W. 2019. First record of silver arowana *Osteoglossum bicirrhosum* Cuvier, 1928 (Osteoglossidae) from Central Poland. World Scientific News 117:189–195.
- Mehdizadeh Mood S, Rassouli M. 2016. Monogenean infestations of arowana (*Osteoglossum bicirrhosum*) and cat fish (*Hypostomus plecostomus*). Iranian Journal of Fisheries Sciences 15(2):606–612.
- Mississippi Secretary of State. 2019. Guidelines for aquaculture activities. Mississippi Administrative Code, Title 2, Part 1, Subpart 4, Chapter 11. Jackson: Office of the Mississippi Secretary of State, Regulatory and Enforcement Division.
- Mood SM, Ebrahimzadeh Mousavi HA, Mokhayer B, Ahmadi M, Soltani M, Sharifpour I. 2010. *Centrocestus formosanus* metacercarial infection of four ornamental fish species imported into Iran. Bulletin of the European Association of Fish Pathologists 30(4):146–149.
- Moreau M-A, Coomes OT. 2006. Potential threat of the international aquarium fish trade to silver arowana *Osteoglossum bicirrhosum* in the Peruvian Amazon. Oryx 40(2):152–160.

- [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/> (October 2020).
- Oklahoma Secretary of State. 2019. List of restricted exotic species. Oklahoma Administrative Code, Title 800, Chapter 20-1-2.
- Orlov AA, Golubtsov AS, Baron VD, Pavlov DS. 2015. Bioelectric fields of the Africa marbled lungfish *Protopterus aethiopicus* (Sarcopterygii: Protopteridae), African (*Heterotis niloticus*) and South American silver (*Osteoglossum bicirrhosum*) arowanas (Actinopterygii: Osteoglossidae): primitive electrogenesis? *Journal of Ichthyology* 55(6):874–879.
- Sanders S, Castiglione C, Hoff M. 2018. Risk Assessment Mapping Program: RAMP. Version 3.1. U.S. Fish and Wildlife Service.
- Schofield PJ, Nico LG, Fuller PL, Loftus WF, Neilson M. 2020. *Osteoglossum bicirrhosum* (Cuvier, 1829). Gainesville, Florida: U.S. Geological Survey, Nonindigenous Aquatic Species Database. Available: <https://nas.er.usgs.gov/queries/FactSheet.aspx?SpeciesID=799> (November 2020).
- Tavares-Dias M, Sousa TJSM, Neves LR. 2014. Parasitic infections in two benthopelagic fish from Amazon: the arowana *Osteoglossum bicirrhosum* (Osteoglossidae) and oscar *Astronotus ocellatus* (Cichlidae). *Bioscience Journal* 30(2):546–555.

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.

- Agudelo-Zamora HD, López-Macias JN, Sánchez-Páez CL. 2007. Hábitos alimentarios de la arawana (*Osteoglossum bicirrhosum* Vandelli, 1829) (Pisces: Osteoglossidae) en el alto Río Putumayo, área del Parque Nacional Natural La Paya, Putumayo, Colombia. *Acta Biológica Paranaense, Curitiba* 36:91–101.
- Chen S. 2002. Fauna Sinica, Osteichthyes. Myctophiformes, Cetomimiformes, Osteoglossiformes. Fauna Sinica series. Beijing: Science Press.
- Courtenay WR Jr, Jennings DP, Williams JD. 1991. Appendix 2: exotic fishes. Pages 97–107 in Robins CR, Bailey RM, Bond CE, Brooker JR, Lachner EA, Lea RN, Scott WB. Common and scientific names of fishes from the United States and Canada, 5th edition. Bethesda, Maryland: American Fisheries Society. American Fisheries Society Special Publication 20.
- Deacon JE, Williams JE. 1984. Annotated list of the fishes of Nevada. *Proceedings of the Biological Society of Washington* 97:103–118.

- Dill WA, Cordone AJ. 1997. History and status of introduced fishes in California, 1871–1996. California Department of Fish and Game Fish Bulletin 178.
- Ferraris CJ Jr. 2003. Osteoglossidae (arowanas). Page 30 in Reis RE, Kullander SO, Ferraris CJ Jr, editors. Checklist of the freshwater fishes of South and Central America. Porto Alegre, Brazil: EDIPUCRS.
- Ferreira EJG, Zuanon JAS, dos Santos GM. 1998. Peixes comerciais do médio Amazonas. Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis.
- Goulding M. 1980. The fishes and the forest, explorations in Amazonian natural history. Berkeley: University of California Press.
- Lowe-McConnell RH. 1975. Fish communities in tropical freshwaters. London: Longman.
- Machacek H, editor. 2007. World records freshwater fishing. Available: <http://www.fishing-worldrecords.com> (November 2007).
- Mundy BC. 2005. Checklist of the fishes of the Hawaiian Archipelago. Bishop Museum Bulletins in Zoology Number 6.
- Planquette P, Keith P, Le Bail P-Y. 1996. Atlas des poissons d'eau douce de Guyane, volume 1. Collection du Patrimoine Naturel, volume 22. Paris: Muséum national d'Histoire naturelle.
- Robins CR, Bailey RM, Bond CE, Brooker JR, Lachner EA, Lea RN, Scott WB. 1991. World fishes important to North Americans exclusive of species from the continental waters of the United States and Canada. Bethesda, Maryland: American Fisheries Society. American Fisheries Society Special Publication 21.
- Riehl R, Baensch HA. 1991. Aquarien atlas, volume 1. Melle, Germany: Mergus, Verlag für Natur- und Heimtierkunde.
- Santos GM, Ferreira EJG, Zuanon JAS. 2006. Peixes comerciais de Manaus. Manaus, Brazil: Ibama/ProVárzea.
- Schaller F, Dorn E. 1971. Maulbrüten beim Aruaná, *Osteoglossum bicirrhosum* und *Osteoglossum ferreirai*. Die Naturwissenschaften 58:573.
- Shapovalov L, Cordone AJ, Dill WA. 1981. A list of freshwater and anadromous fishes of California. California Fish and Game 67:4–38.
- Soares MGM, Costa EI, Siqueira-Souza FK, Anjos HDB, Yamamoto KC, Freitas CEC. 2008. Peixes de lagos do médio Rio Solimões. Manaus, Brazil: Instituto Piatam.

- Stoltz DL, Naiman RJ. 1978. The natural history of the native fishes in the Death Valley system. Natural History Museum of Los Angeles County, Science Series 30:1–76.
- Verba JT, Neto JGR, Zuanon J, Farias I. 2014. Evidence of multiple paternity and cooperative parental care in the so called monogamous silver arowana *Osteoglossum bicirrhosum* (Osteoglossiformes: Osteoglossidae). Neotropical Ichthyology 12:145–151.
- Vinyard GL. 2001. Fish species recorded from Nevada. Reno: University of Nevada, Biological Research Center.