Argentinian Silverside (*Odontesthes bonariensis*)
Ecological Risk Screening Summary

U.S. Fish and Wildlife Service, November 2023
Revised, February 2024
Web Version, 5/6/2026

Organism Type: Fish
Overall Risk Assessment Category: High

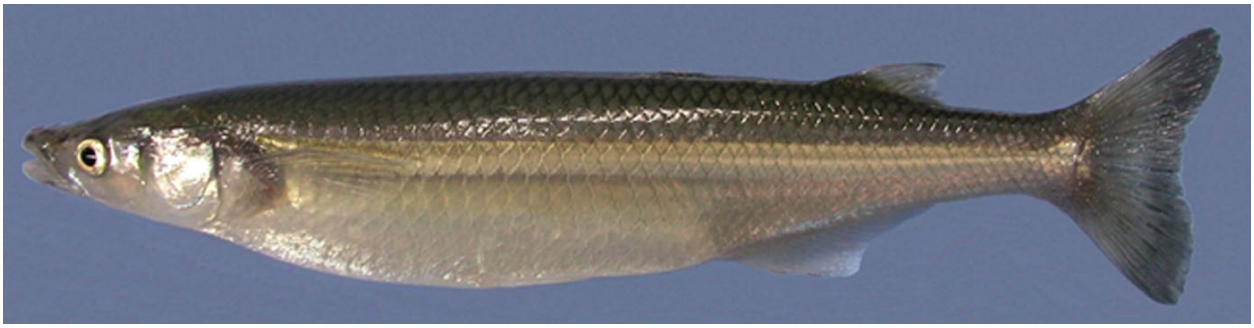


Photo: Adapted from Majhi et al. (2009). Licensed under Creative Commons Attribution 4.0 International.

1 Native Range and Status in the United States

Native Range

From Vila-Pinto (2011):

"*O. bonariensis* is native to the lower La Plata Basin (Río de La Plata) and the Pampean lakes in Buenos Aíres Province."

According to Vila-Pinto (2011), *Odontesthes bonariensis* is native to Argentina, Brazil, and Uruguay.

From Frederico (2020):

"This species is native to Argentina and Uruguay, occurring in rivers draining into the south-western Atlantic (Fricke et al. 2020)."

Status in the United States

No records of *Odontesthes bonariensis* in the wild or in trade in the United States were found.

Regulations
No species-specific regulations on possession or trade were found within the United States.

Means of Introductions within the United States
No records of *Odontesthes bonariensis* in the wild in the United States were found.

Remarks
This ERSS was previously published in July 2014. Revisions were completed to incorporate new information and conform to updated standards.

O. bonariensis is also known by the common name Pejerrey (Vila-Pinto 2011).

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing
From ITIS (2023):

Kingdom Animalia
Subkingdom Bilateria
Infrakingdom Deuterostomia
Phylum Chordata
Subphylum Vertebrata
Infraphylum Gnathostomata
Superclass Actinopterygii
Class Teleostei
Superorder Acanthopterygii
Order Atheriniformes
Family Atherinopsidae
Subfamily Atherinopsinae
Genus *Odontesthes*
Species *Odontesthes bonariensis* (Valenciennes in Cuvier and Valenciennes, 1835)

According to Fricke et al. (2023), *Odontesthes bonariensis* (Valenciennes 1835) is the current valid name for this species.

Size, Weight, and Age Range
From Vila-Pinto (2011):

"[…] average length from one to five years of age correspond to 138 mm (year 1), 243 mm (year 2), 349 mm (year 3), 430 mm (year 4) and 498 mm (year 5) (Freyre, 1976; Vila and Soto, 1981)."

"Other studies suggests [sic] seven age groups, the range for each age fluctuates between 97 to 145 mm for one year, 193 to 243 mm for two years, 270 to 349 mm for three years, 370 to 450

mm for four years, 465 to 474 mm for five years, 488 to 526 mm for six years and over 520 mm for seven years (Vila and Soto, 1986; Reartes, 1995). In the La Plata River, the total length is >60 cm (E Avigliano, Universidad de Buenos Aires, Argentina, personal communication, 2011)."

From Froese and Pauly (2026):

"[…] max. reported age: 4 years [Kottelat and Freyhof 2007]."

Environment

From Froese and Pauly (2026):

"Marine; freshwater; brackish; pelagic-neritic […]"

From Vila-Pinto (2011):

"*O. bonariensis* tolerates a wide range of water temperature and salinity as is shown by its present distribution, ranging from 7 to 30°C. The optimum temperature range is between 15 and 29°C."

From González-Castro et al. (2022):

"*Odontesthes bonariensis* is restricted to fresh water or slightly brackish water habitats (salinity 1–2 ppt) […]."

Climate

From Froese and Pauly (2026):

"Subtropical […]"

From Vila-Pinto (2011):

"*O. bonariensis* tolerates a wide variation in temperature from typical temperate systems to tropical ones […]"

From Rueda et al. (2017):

"*Odontesthes bonariensis* has been able to establish populations in environments where the mean summer air temperature is higher than 20°C (Cussac et al. 2009) […]"

Distribution Outside the United States

Native

From Vila-Pinto (2011):

"*O. bonariensis* is native to the lower La Plata Basin (Río de La Plata) and the Pampean lakes in Buenos Aíres Province."

According to Vila-Pinto (2011), *Odontesthes bonariensis* is native to Argentina, Brazil, and Uruguay.

From Frederico (2020):

"This species is native to Argentina and Uruguay, occurring in rivers draining into the south-western Atlantic (Fricke et al. 2020)."

Introduced

From Frederico (2020):

"This species has been introduced in Brazil, where it occurs in in [sic] Tramandaí River, Patos Lagoon and Uruguay River, Rio Grande do Sul and Santa Catarina states (ICMBio 2018). It has also been introduced elsewhere, including Chile, Italy and in Asia, for sports fishing in lakes and reservoirs (Dyer 2000)."

According to Vila-Pinto (2011) and Froese and Pauly (2026), *Odontesthes bonariensis* is established in the wild in Chile.

Bianco and Ketmaier (2001) report that *O. bonariensis* was introduced to Italy in 1974 but that it is now "Probably extinct."

From Vila et al. (2007):

"It was reported to have been introduced into Lake Poopó [southwest Bolivia] in 1946 by sport fishermen (Bustamante and Treviño, 1980), and by ascending in Desaguadero River successfully colonized Lake Titicaca [on the border of Bolivia and Peru]."

From Daga et al. (2016):

"[…] for *O. bonariensis*, the multiple size classes of the individuals caught were a strong indication of the establishment of this species in the Salto Santiago reservoir [Paraná, Brazil] (Santa Fé 2015)."

From Rueda et al. (2017):

"*Odontesthes bonariensis* has been able to establish populations [in central and southern Argentina] […] most successfully in the northern areas (Cuyo), extending southward into

Patagonia up to the Reservoir Ezequiel Ramos Mexía on the Limay river (39°30'S, 69°00'W), the southernmost locality reported for *O. bonariensis* (Aigo et al. 2008)."

From NIES (2020):

"Range in Japan: Tanzawako (Kanagawa), Kasumigaura and Kitaura (Ibaraki) Lakes."

From Froese and Pauly (2026):

"[…] stocked in the Baruch Reservoir [Israel] where it established a flourishing population. In 1993, the reservoir was dried, the population died and was never restocked."

Additionally, Vila-Pinto (2011) reports that *O. bonariensis* was introduced but is not established in the wild in France. Froese and Pauly (2026) report that *O. bonariensis* was introduced but is probably not established in the wild in Morocco.

Means of Introduction Outside the United States

From Vila-Pinto (2011):

"*O. bonariensis* was introduced from the Buenos Aíres lakes (Chascomus Lake) to the Peñuelas reservoir near Valparaiso, Chile, for sport fishing by the Fishing and Game Department (Riegel, 1960). Eggs and fry have been sent to Japan since 1966 for experimental culture (Zama in Dyer, 2000; Ohashi, 2004). Tortonese (1985) and Sola et al. (1988) have reported the introduction of fertilized eggs from the Chascomus Lake (Buenos Aíres Province) to Lake Nemi, central Italy in November and December 1974."

"Fertilized eggs and fry have been sent to Tokyo, Japan, from the Pampean lakes near Buenos Aires for temperature acclimation, the production of triploids, and hybridization with the atherinopsid *Odontesthes hatcheri* (Strüssmann et al., 1993; 1996a,b,c; 1997a,b)."

Short Description

From Vila-Pinto (2011):

"Eggs: When spawned *O. bonariensis* eggs are transparent, yellowish and vary between 1.6 and 1.8 mm. They possess three to five sticky filaments joined as a cluster which is fixed to the vegetation."

"Larvae: At eclosion the transparent larvae measure between 6.5 and 7.0 mm and have a few dorsal stellar pigment cells or melanophores (15-20). They only have pectoral fins. […] Slender and very active, the larvae are recognized by their silvery colour, median dorsal melanophores and scarce pigmentation."

"Post-larvae and Juveniles: The slender and silvery shape is maintained. From one to four months, it grows up to 60 mm in length with a small number of star-shaped pigmented areas on the head and dorsal region. By its first spring it may reach from 10 to 12 cm total length and matures for its first spawning."

“Adults: Characterized by an elongate and fusiform body that is more or less compressed. Silvery white with less pigmentation dorsally and laterally and a wide silver lateral band along the body. Head smooth dorsally; terminal mouth obliquely cleaved. Protractile premaxilla. Two to three rows of small premaxillary teeth. Maxilla excluded from the superior border. Branchial apparatus with operculum rounded without spines and scaled. Dorsal fins separated. The anterior dorsal fin presents five to eight thin and flexible spines, the posterior one being membranous. Ventral fins are small and distant from the pectoral fins. Pectoral fins inserted behind the postero-superior angle of the operculum. Anal fin with a soft spine. Caudal fin forked. Dorsal, pectoral and caudal fins blackish. Wide cycloid scales, with 6-7 dorsal rows over pectoral fin. Gill rakers on lower branch between 32-38 in specimens over 100 mm SL. Largest registered size is 52 cm SL. No sexual dimorphism present.”

“It has been described by Martty (1992) that the specimens populating La Plata River are silvery and with blue iridizations; with a lateral brilliant white band and lacking ventral pigmentation. In Paraná River they are creamy yellow similar to the sand on the river bottom. Specimens coming from eutrophic lakes such as Chascomús in Argentina, and the Peñuelas and Rapel reservoirs in Chile are tainted white.”

Biology

From Vila-Pinto (2011):

“*O. bonariensis* is an oviparous non-migratory fish that does not present sexual differences except during reproduction when females have a higher maximum abdominal depth than males. Studies show that *O. bonariensis* has a naturally high reproductive rate (Calvo and Dadone, 1972; Burbidge et al., 1974; Freyre, 1976; Luchini et al., 1983; Vila and Soto, 1986). Calvo and Dadone report that *O. bonariensis* starts reproducing between 12 and 20 cm of total length. In Argentina minimum size at maturity was reported as 14 cm total length. In Chilean temperate reservoirs maturity is found after the first winter from 10 cm total length (Vila and Soto, 1981).”

“Spawning period extends from August through to November in southern South America, during the spring of temperate ecosystems when water temperatures reach 13°C. There is a shorter second spawning period during autumn (March, April). The optimum spawning temperature is around 17°C. This species has a wide range of tolerance for spawning since it has reproduced naturally from tropical systems in Brazil to cold high Andean ones in Peru and Bolivia (Godoi, 1946; Loubens and Osorio, 1988; Reartes, 1995). Paiva and Schaeffer (1978) report that in lakes Quadros and Itapeva the spawning climax is observed during May and June.”

“Schools, grouped by sex, approach shallower waters generally covered by aquatic plants such as *Elodea* and *Potamogeton*. Fecundity follows an exponential increase that shows females from one year (10 to 14 cm of total length) spawning 2000 oocytes. Females older than three years may spawn up to 45,000 oocytes per season.”

“Eggs are round and transparent with an average size of 1.8 mm with oil drops between 25 and 300 mm and three to four sticky chorionic filaments which form egg clusters adhering to

shallower waters vegetation. Embryonic development takes 285 hours at 20°C, five to fifteen days at 18°C and ten days at 27°C. Larvae measure between 6.5 to 7 mm at eclosion."

"*O. bonariensis* moves from deeper waters to shallower areas in river [sic] and lakes when ready to spawn."

"*O. bonariensis* has a wide diet that includes planktonic microalgae, zooplankton, insects, snails and small fish."

"*O. bonariensis* shares habitat with other atherinopsids, trout, killifish and catfishes."

Human Uses

From Vila-Pinto (2011):

"It is mostly appreciated by sport fishermen and for semi-intensive culture due to the quality of its meat and its rapid growth (see Somoza et al., 2008)."

"[…] fished and cultured since the beginning of last century […]. Since the last century it has been also commercially fished with the use of gill nets in rivers and fished for sport in shallow lakes."

Diseases

***Odontesthes bonariensis* has been documented as a carrier of *Gyrodactylus* sp. (exact species unknown). *Gyrodactylus salaris* is a disease listed by the World Organisation for Animal Health (2023).**

From Vila-Pinto (2011):

"Parasites: Cestodes and nematodes have been found in the anterior part of the intestine of *O. bonariensis* in Lake Titicaca (Rivas and Llanos, 1989), *Mysosoma cerebralis* has been found in fish in central Argentina (Reartes, 1995). Hephert and Pruginin (1981) report that *O. bonariensis* cultured in tanks in Israel were infected by the crustacean *Lernaea*. In Argentina, fish were found to be infected by *Argulus violaceus* (Martty, 1992)."

According to Froese and Pauly (2023), *O. bonariensis* is a host to the following additional parasites: *Austrodiplostomum mordax*, *Caligus rogercresseyi*, *Camallanus (Zeylanema) corderoi*, *Cangatiella macdonaghi*, *Diplostomum mordax*, *Lernaea cyprinacea*, *Steganoderma macrophallus*, *Tylodelphys cardiophilus*, and *Wolffhugelia matercula*.

According to Poelen et al. (2014), *O. bonariensis* is a host to the parasite *Ficopomatus enigmaticus*.

According to Mancini et al. (2006), *O. bonariensis* is a host to the following additional parasites: *Aeromonas hydrophila*, *Dactylogyrus* sp., *Gyrodactylus* sp., *Trichodina* sp., *Saprolegnia* sp., and *Trematoda* and *Heterophyidae*.

Threat to Humans

No information was found on threats to humans from *Odontesthes bonariensis*.

3 Impacts of Introductions

From Rueda et al. (2017):

"In several areas [in Argentina and Chile], introductions [of *O. bonariensis*] resulted in extensive hybridization [with native *Odontesthes hatcheri*], with high frequencies of F2 and backcrossed hybrids in natural populations, and in some cases *O. bonariensis* has completely displaced the native populations."

From Vila-Pinto (2011):

"*O. bonariensis* has had a positive economic impact in places where it has been introduced as is the case with Bolivia and Peru where it is today the principal fish in artisan fisheries producing 1700 tons a year (Loubens and Osorio, 1991); similarly in Italy (Sola et al., 1988)."

"There are no negative impacts on habitats reported. [...] Alfaro et al. (1982) reported that *O. bonariensis* predates on the small killifish *Orestias ispi* and the catfish *Trichomycterus* in Lake Titicaca."

"*O. bonariensis* is an important sport fish and has had a positive impact on tourism in all places where it has been introduced."

From Froese and Pauly (2026):

"Established [in Chile] and contributes to fishery but may have eliminated the local *Orestias* and *Trichomycterus* species."

"Has damaged populations of local *Orestias* species [in Peru]."

4 History of Invasiveness

Odontesthes bonariensis has a long history of introduction for its aquaculture appeal and sport fish attributes. Peer-reviewed studies and reliable databases provide evidence that introductions have led to species establishment outside its native range. In its introduced range, *O. bonariensis* has had negative impacts on native fish populations through hybridization with closely related species or displacement of the native populations. Therefore, the History of Invasiveness for *Odontesthes bonariensis* is classified as High.

5 Global Distribution



Figure 1. Reported global distribution of *Odontesthes bonariensis*. Map from GBIF Secretariat (2023). Observations are reported from Argentina, Bolivia, Brazil, Chile, Israel, Italy, Japan, and Uruguay. The observations in Israel and Italy were not included as source points in the climate matching analysis because these populations have been extirpated. The observations in eastern Brazil were not included as source points because they are outside the known established range of *O. bonariensis* in Paraná, Rio Grande do Sul, and Santa Catarina states.

No georeferenced occurrences were available representing the established range of *O. bonariensis* in Peru.

Additional georeferenced occurrences in Bolivia were available from Sarmiento et al. (2014).

6 Distribution Within the United States

No records of *Odontesthes bonariensis* in the wild in the United States were found.

7 Climate Matching

Summary of Climate Matching Analysis

The climate match for *Odontesthes bonariensis* to the contiguous United States was highest in an area of the Southwest centered on southwestern Texas. Other high climate matches were found primarily along the Pacific Coast and in the Great Basin, Gulf Coast, Mid-Atlantic, Southeast, and Southern Plains regions. Low climate matches were found in northern New England and in the Western Mountains. The overall Climate 6 score (Sanders et al. 2023; 16 climate variables; Euclidean distance) for the contiguous United States was 0.782, indicating that Yes, there is establishment concern for this species. The Climate 6 score is calculated as: (count of target points with scores ≥ 6)/(count of all target points). Establishment concern is warranted for Climate 6 scores greater than or equal to 0.002 based on an analysis of the establishment success of 356 nonnative aquatic species introduced to the United States (USFWS 2024).

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

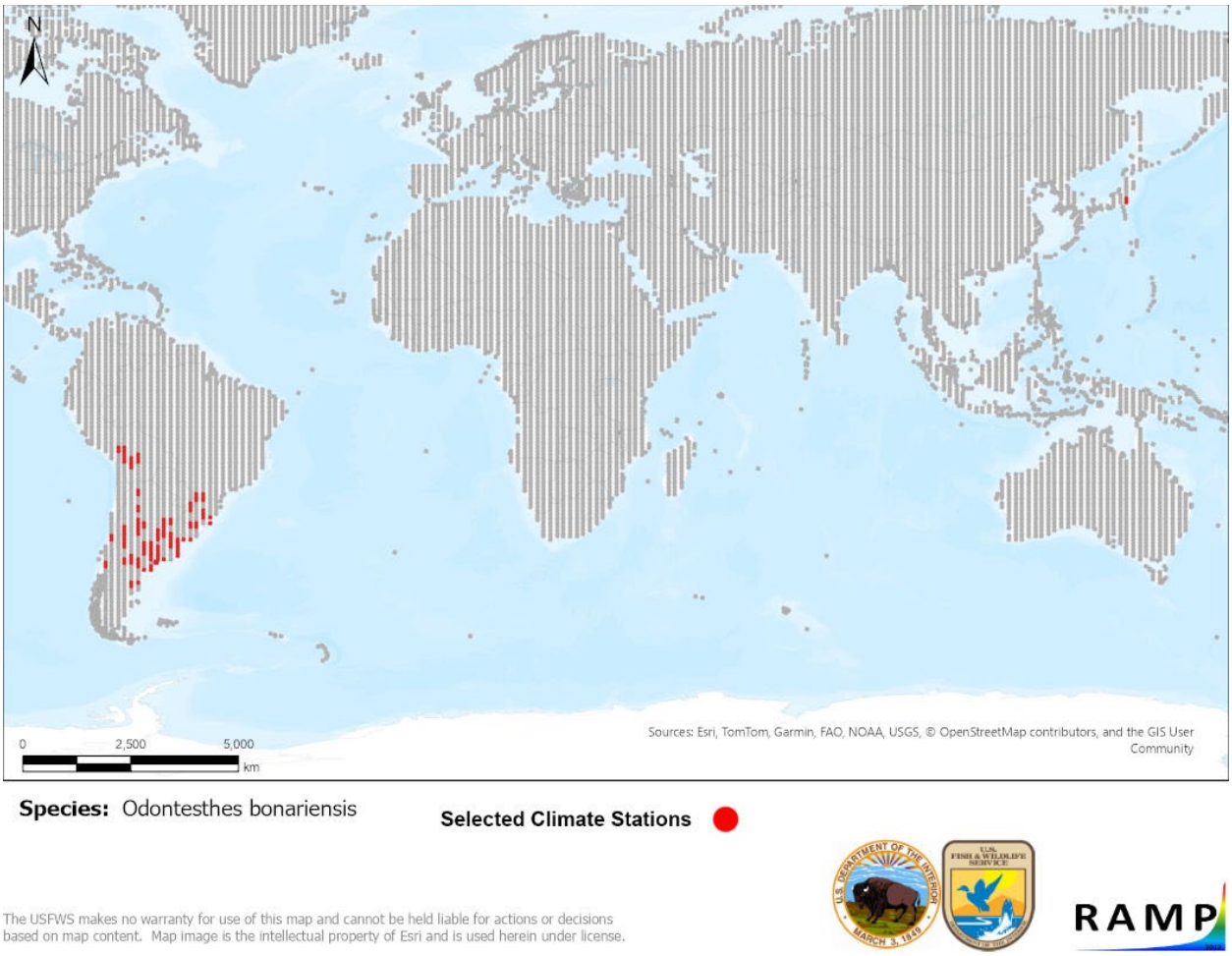


Figure 2. RAMP (Sanders et al. 2023) source map showing global weather stations selected as source locations (red; Argentina, Bolivia, Brazil, Chile, Japan, Peru, Uruguay) and non-source locations (gray) for *Odontesthes bonariensis* climate matching. Source locations from GBIF Secretariat (2023) and Sarmiento et al. (2014). Selected source locations are within 100 km of one or more species occurrences, and do not necessarily represent the locations of occurrences themselves.

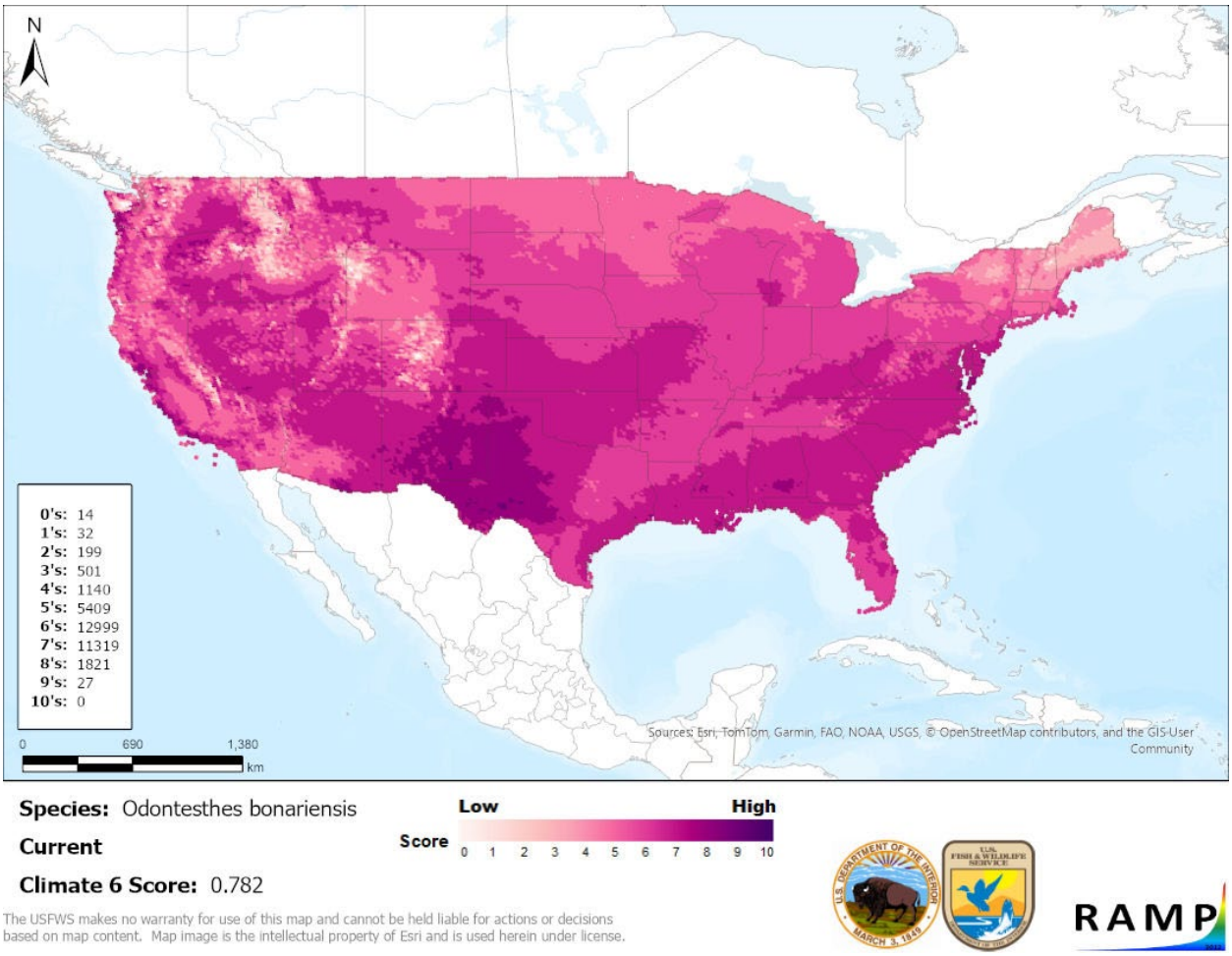


Figure 3. Map of RAMP (Sanders et al. 2023) climate matches for *Odontesthes bonariensis* in the contiguous United States based on source locations reported by GBIF Secretariat (2023) and Sarmiento et al. (2014). Counts of climate match scores are tabulated on the left. 0/Pale Pink = Lowest match, 10/Dark Purple = Highest match.

8 Certainty of Assessment

The Certainty of Assessment for *Odontesthes bonariensis* is classified as High. Information is available on the biology, ecology, and distribution of this species. Information regarding history of invasiveness was found from reliable sources.

9 Risk Assessment

Summary of Risk to the Contiguous United States

Odontesthes bonariensis, Argentinian Silverside, is a fish native to southwestern Atlantic drainages of South America. *O. bonariensis* has a long history of introduction for its aquaculture appeal and sport fish attributes, although there is no evidence to suggest there is trade of this species within the United States. The species has a high tolerance of a wide range of water temperatures and salinity. Established nonnative populations of *O. bonariensis* in other parts of South America have depleted native populations of fish species and hybridized with native

congeners. The History of Invasiveness for *Odontesthes bonariensis* is classified as High. The climate matching analysis for the contiguous United States indicates establishment concern. The highest climate matches were found in the south-central and southwestern United States, centered on western Texas. The Certainty of Assessment for this ERSS is classified as High based on the availability of clear and reliable sources of information on its distribution and impacts of introduction. The Overall Risk Assessment Category for *Odontesthes bonariensis* in the contiguous United States is High.

Assessment Elements

- **History of Invasiveness (see Section 4): High**
- **Establishment Concern (see Section 7): Yes**
- **Certainty of Assessment (see Section 8): High**
- **Remarks, Important additional information: None**
- **Overall Risk Assessment Category: High**

10 Literature Cited

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

Bianco PG, Ketmaier V. 2001. Anthropogenic changes in the freshwater fish fauna of Italy, with reference to the central region and *Barbus graellsii*, a newly established alien species of Iberian origin. Journal of Fish Biology 59(Supplement A):190–208.

Daga VS, Debona T, Abilhoa V, Gubiani EA, Vitule JRS. 2016. Non-native fish invasions of a Neotropical ecoregion with high endemism: a review of the Iguaçu River. Aquatic Invasions 11:209–223.

Frederico RG. 2022. *Odontesthes bonariensis*. The IUCN Red List of Threatened Species: e.T186711A1817222. Available: https://dx.doi.org/10.2305/IUCN.UK.2022-2.RLTS.T186711A1817222.en (February 2024).

Fricke R, Eschmeyer W, van der Laan R, editors. 2023. Eschmeyer's catalog of fishes: genera, species, references. California Academy of Science. Available: https://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp (November 2023).

Froese R, Pauly D. 2023. *Odontesthes bonariensis* (Valenciennes, 1835). World Register of Marine Species. Available: https://www.marinespecies.org/aphia.php?p=taxdetails&id=281825#attributes (November 2023).

Froese R, Pauly D, editors. 2026. *Odontesthes bonariensis* (Valenciennes, 1835). FishBase. Available: https://fishbase.org/summary/Odontesthes_bonariensis.html (April 2026).

GBIF Secretariat. 2023. GBIF backbone taxonomy: *Odontesthes bonariensis* (Valenciennes, 1835). Copenhagen: Global Biodiversity Information Facility. Available: https://www.gbif.org/species/2412370 (November 2023).

González-Castro M, Cardoso YP, Hughes LC, Ortí G. 2022. Hybridization is strongly constrained by salinity during secondary contact between silverside fishes (*Odontesthes,* Atheriniformes). Heredity 129:233–243.

[ITIS] Integrated Taxonomic Information System. 2023. *Odontesthes bonariensis* (Valenciennes in Cuvier and Valenciennes, 1835). Reston, Virginia: Integrated Taxonomic Information System. Available: https://itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=630684#null (November 2023).

Mancini M, Rodriguez C, Prosperi C, Salinas V, Bucco C. 2006. Main diseases of pejerrey (*Odontesthes bonariensis*) in central Argentina. Brazilian Journal of Veterinary Research 26(4):205–210.

[NIES] National Institute for Environmental Studies. 2020. *Odontesthes bonariensis*. Invasive species of Japan. Tsukuba, Japan: National Research and Development Agency, National Institute for Environmental Studies. Available: https://www.nies.go.jp/biodiversity/invasive/DB/detail/50220e.html (January 2020).

Poelen JH, Simons JD, Mungall CJ. 2014. Global Biotic Interactions: an open infrastructure to share and analyze species-interaction datasets. Ecological Informatics 24:148–159.

Rueda EC, Mullaney KA, Conte-Grand C, Habit EM, Cussac V, Ortí G. 2017. Displacement of native Patagonian freshwater silverside populations (*Odontesthes hatcheri*, Atherinopsidae) by introgressive hybridization with introduced *O. bonariensis*. Biological Invasions 19:971–988.

Sanders S, Castiglione C, Hoff M. 2023. Risk Assessment Mapping Program: RAMP. Version 5.0. U.S. Fish and Wildlife Service.

Sarmiento J, Bigorne R, Carvajal-Vallejos FM, Maldonado M, Leciak E, Oberdorff T, editors. 2014. Bolivian fishes. La Paz, Bolivia: IRD-BioFresh (EU). Available: https://horizon.documentation.ird.fr/exl-doc/pleins_textes/divers20-06/010062802.pdf (April 2026).

[USFWS] U.S. Fish and Wildlife Service. 2024. Standard operating procedures: how to prepare an “Ecological Risk Screening Summary.” Version 3. Available: https://www.fws.gov/media/standard-operating-procedures-how-prepare-ecological-risk-screening-summary-2024 (April 2026).

Vila I, Pardo R, Scott S. 2007. Freshwater fishes of the Altiplano. Aquatic Ecosystem Health & Management 10:201–211.

Vila-Pinto I. 2011. *Odontesthes bonariensis* (pejerrey). In CABI Compendium. Wallingford, United Kingdom: CAB International. Available: https://www.cabidigitallibrary.org/doi/10.1079/cabicompendium.72773 (November 2023).

World Organisation for Animal Health. 2023. Animal diseases. Paris: World Organisation for Animal Health. Available: https://www.woah.org/en/what-we-do/animal-health-and-welfare/animal-diseases/ (November 2023).

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.

Aigo JC, Cussac VE, Peris S, Ortubay S, Gómez S, López H, Gross M, Barriga J, Battini M. 2008. Distribution of introduced and native fish in Patagonia (Argentina): patterns and changes in fish assemblages. Reviews in Fish Biology and Fisheries 18:387–408.

Alfaro, Bustamante, Torres, Treviño. 1982. La Pesquería en el Lago Titicaca (Perú), presente y futuro. Rome, Italy: Fisheries and Agriculture Organization of the United Nations. [Source did not provide full citation for this reference.]

Burbidge RG, Carrasco MC, Brown PA. 1974. Age, growth, length–weight relationship, sex ratio and food habits of the Argentine pejerrey, *Basilichthys bonariensis* (Cuv. and Val.), from Lake Peñuelas, Valparaíso, Chile. Journal of Fish Biology 6:299–305.

Bustamante E, Treviño H. 1980. Descripcíon de las pesquerías en el lago Titicaca 1975–1979. [Description of the fisheries of Lake Titicaca 1975–1979.] Puno, Peru: Instituto del Mar del Perú. (In Spanish.)

Calvo J, Dadone LA. 1972. Fenómenos reproductivos en el pejerrey, I. Escala y tabla de Madurez. Revista del Museo de La Plata 11(102):153–163.

Cussac VE, Fernández DA, Gómez SE, López HL. 2009. Fishes of southern South America: a story driven by temperature. Fish Physiology and Biochemistry 35:29–42.

Dyer BS. 2000. Systematic review and biogeography of the freshwater fishes of Chile. Estudios Oceanológicos 19:77–98.

Freyre LR. 1976. La población de pejerrey de la laguna de Lobos. Limnobios 1(4):105–128.

Fricke R, Eschmeyer W, van der Laan R, editors. 2020. Eschmeyer's catalog of fishes: genera, species, references. California Academy of Science. Available: http://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp.

Godoi MP. 1946. Contribuicao a Biología do Peixe-Rei "*Odonthestes bonariensis*". Revista Brasileira de Biologia 6:373–384.

Hephert B, Pruginin Y. 1981. Commercial fish farming. New York: Wiley Interscience.

[ICMBio] Instituto Chico Mendes de Conservação da Biodiversidade. 2018. Livro Vermelho da Fauna Brasileira Ameaçada de Extinção: Volume VI - Peixes. Brasília, Brazil: ICMBio.

Kottelat M, Freyhof J. 2007. Handbook of European freshwater fishes. Cornol, Switzerland: Publications Kottelat and Berlin: Freyhof.

Loubens G, Osorio F. 1988. Observations sur les poissons de la partie bolivienne du lac Titicaca. III. *Basilichthys bonariensis* (Valenciennes, 1835) (Pisces, Atherinidae). Revue d'hydrobiologie tropicale 21:153–177.

Loubens G, Osorio F. 1991. *Basilichthys bonariensis* (pejerrey). Pages 431–449 in Dejoux C, Iltis A. El lago Titicaca. Síntesis del conocimiento limnológico actual. Paris: ORSTOM, and La Paz: HISBOL.

Luchini L, Quiroz R, Avendaño T. 1983. Cultivo del pejerrey en estanques. Valdivia, Chile: Reunión Asociación Latinoamericana de Acuicultura 7.

Martty H. 1992. Manual del Pejerrey. Nomenclatura, reproducción, pesca. Buenos Aires, Argentina: Albatros.

Ohashi M. 2004. The culture of pejerrey in Japan. Chascomús, Argentina: Jornadas del Pejerrey: aspectos básicos y acuicultura 14.

Paiva MP, Scheffer AC. 1978. Incubacao artificial e aproveitamento de desovas do peixe-rei (*O. bonariensis*). Ciência e Cultura 30:208–211.

Reartes JL. 1995. El pejerrey (*Odonthestes bonariensis*): métodos de cría y cultivo masivo. Organización de las Naciones Unidas para la Agricultura y la Alimentación.

Riegel H. 1960. Observaciones sobre la fauna ictiológica de las aguas dulces chilenas. Actas y Trabajos, Primer Congreso Sudamericano Zoología 1:141–144.

Rivas P, Llanos U. 1989. El pejerrey de la cuenca del lago Titicaca. Centro de Investigación y desarrollo Agro Pesquero (CEIDAP). Lima, Peru: CEIDAP.

Santa Fé UMG. 2015. Estimativas de parâmetros de crescimento individual para *Odontesthes bonariensis* (Valenciennes, 1835), peixe introduzido em um reservatório Neotropical. Masters dissertation. Toledo, Brazil: Universidade Estadual do Oeste do Paraná.

Sola L, Natili GL, Cataudella S. 1988. Cytogenetical characterization of *Odontesthes bonariensis* (Pisces, Atherinidae), an Argentine species introduced in Italy. Genetica 77:217–224.

Somoza GM, Miranda LA, Berasain GE, Colautti D, Remes Lenicov M, Strüssmann CA. 2008. Historical aspects, current status and prospects of pejerrey aquaculture in South America. Aquaculture Research 39:784–793.

Strüssmann CA, Akaba T, Ijima K, Yamaguchi K, Yoshizaki G, Takashima F. 1997a. Spontaneous hybridization in the laboratory and genetic markers for the identification of hybrids between two atherinid species, *Odontesthes bonariensis* (Valenciennes, 1835) and *Patagonina hatcheri* (Eigenmann, 1909). Aquaculture Research 28:291–300.

Strüssmann CA, Calsina Cota JC, Phonlor G, Higuchi H, Takashima F. 1996a. Temperature effects on sex differentiation of two South American atherinids, *Odontesthes argentinensis* and *Patagonina hatcheri*. Environmental Biology of Fishes 47:143–154.

Strüssmann CA, Choon NB, Takashima F, Oshiro T. 1993. Triploidy induction in an atherinid fish, the pejerrey (*Odontesthes bonariensis*). The Progressive Fish-Culturist 55(2):83–89.

Strüssmann CA, Moriyama S, Hanke EF, Cota JCC, Takashima F. 1996b. Evidence of thermolabile sex determination in pejerrey. Journal of Fish Biology 48:643–651.

Strüssmann CA, Saito T, Usui M, Yamada H, Takashima F. 1997b. Thermal thresholds and critical period of thermolabile sex determination in two atherinid fishes, *Odontesthes bonariensis* and *Patagonina hatcheri*. Journal of Experimental Zoology 278(3):167–177.

Strüssmann CA, Takashima F, Toda K. 1996c. Sex differentiation and hormonal feminization in pejerrey *Odontesthes bonariensis*. Aquaculture 139:31–45.

Tortonese E. 1985. Interesse scientifico e pratico di una famiglia di Pesci ossei: gli aterinidi. Ente tutela pesca del Friuli Venezia Giulia. Revista di Limnolgia 10:1–40.

Vila I, Soto D. 1981. Atherinidae (Pisces) of Rapel Reservoir, Chile. SIL Proceedings, 1922-2010. Verhandlungen Internationale Vereinigung Limnologie 21:1334–1338.

Vila I, Soto D. 1986. *Odontesthes bonariensis* “pejerrey argentino”, una especie para cultivo extensivo. FAO Documento técnico 4:224–228.

Appendix

Summary of Future Climate Matching Analysis

Future climate projections represent two Shared Socioeconomic Pathways (SSP) developed by the Intergovernmental Panel on Climate Change (IPCC 2021): SSP5, in which emissions triple by the end of the century; and SSP3, in which emissions double by the end of the century. Future climate matches were based on source locations reported by GBIF Secretariat (2023) and Sarmiento et al. (2014).

Under the future climate scenarios (figure A1), parts of the southwestern contiguous United States, centered on the Rio Grande Basin, were projected to have a high climate match for *Odontesthes bonariensis*. At the 2055 time step, there were additional areas of high match in the Great Basin, Great Lakes, Gulf Coast, and Mid-Atlantic regions and along the Pacific Coast, although most of these areas did not show high match at the 2085 time step, especially under SSP5. The Climate 6 scores for the individual future scenario models (figure A2) ranged from a low of 0.390 (model: UKESM1-0-LL, SSP5, 2085) to a high of 0.835 (model: IPSL-CM6A-LR, SSP5, 2055). All future scenario Climate 6 scores were above the Establishment Concern threshold, indicating that Yes, there is establishment concern for this species under future scenarios. The Climate 6 score for the current climate match (0.782, figure 3) falls within the range of scores for future projections. The time step and climate scenario with the most change relative to current conditions was SSP5, 2085, the most extreme climate change scenario. Areas within the Northeast saw a large increase in the climate match relative to current conditions at the 2085 time step and a moderate increase at the 2055 time step. Additionally, areas within the Colorado Plateau and Western Mountains saw a moderate increase in the climate match relative to current conditions at the 2085 time step. Primarily at the 2085 time step and especially under SSP5, areas within California, the Great Basin, Gulf Coast, Mid-Atlantic, Northern Pacific Coast, Southeast, Southern Atlantic Coast, Southern Florida, Southern Plains, Southwest, and Western Mountains saw a moderate decrease in the climate match relative to current conditions. No large decreases were observed regardless of time step and climate scenarios. Additional very small areas of large or moderate change may be visible on the maps (figure A3).

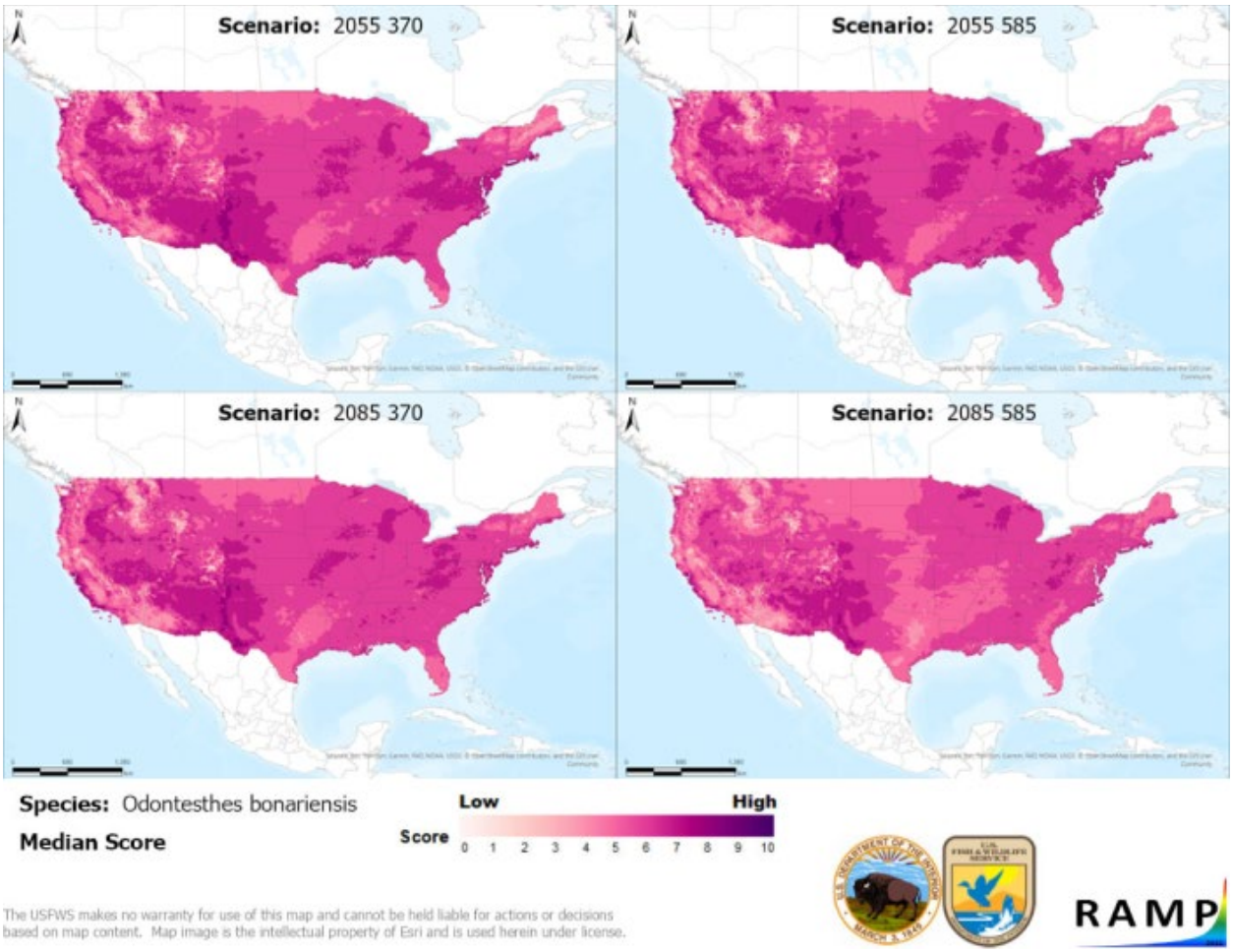


Figure A1. Maps of median RAMP (Sanders et al. 2023) climate matches projected under potential future climate conditions using five global climate models for *Odontesthes bonariensis* in the contiguous United States. Climate matching is based on source locations reported by GBIF Secretariat (2023) and Sarmiento et al. (2014). Shared Socioeconomic Pathways (SSPs) used (from left to right): SSP3, SSP5 (IPCC 2021). Time steps: 2055 (top row) and 2085 (bottom row). Climate source data from CHELSA (Karger et al. 2017, 2018); global climate models used: GFDL-ESM4, UKESM1-0-LL, MPI-ESM1-2-HR, IPSL-CM6A-LR, and MRI-ESM2-0. 0/Pale Pink = Lowest match, 10/Dark Purple = Highest match.

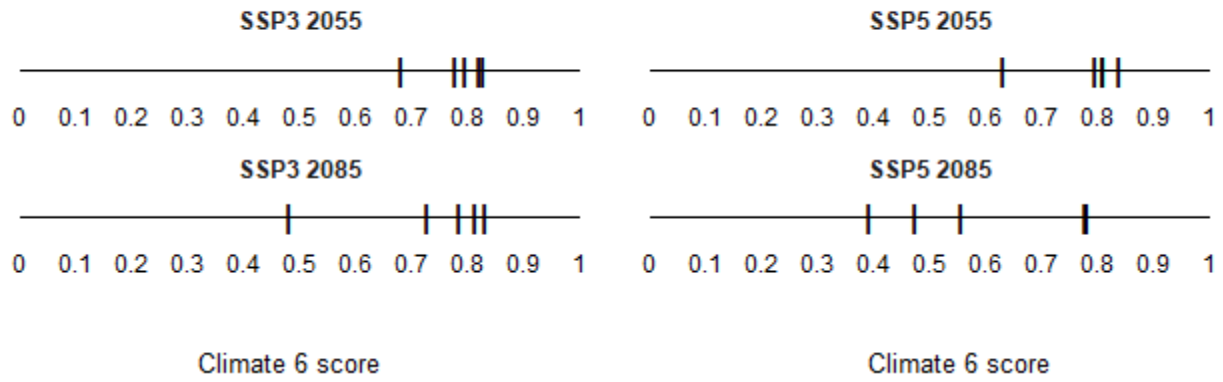


Figure A2. Comparison of projected future Climate 6 scores for *Odontesthes bonariensis* in the contiguous United States for each of five global climate models under four combinations of Shared Socioeconomic Pathway (SSP) and time step. SSPs used (from left to right): SSP3, SSP5 (Karger et al. 2017,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

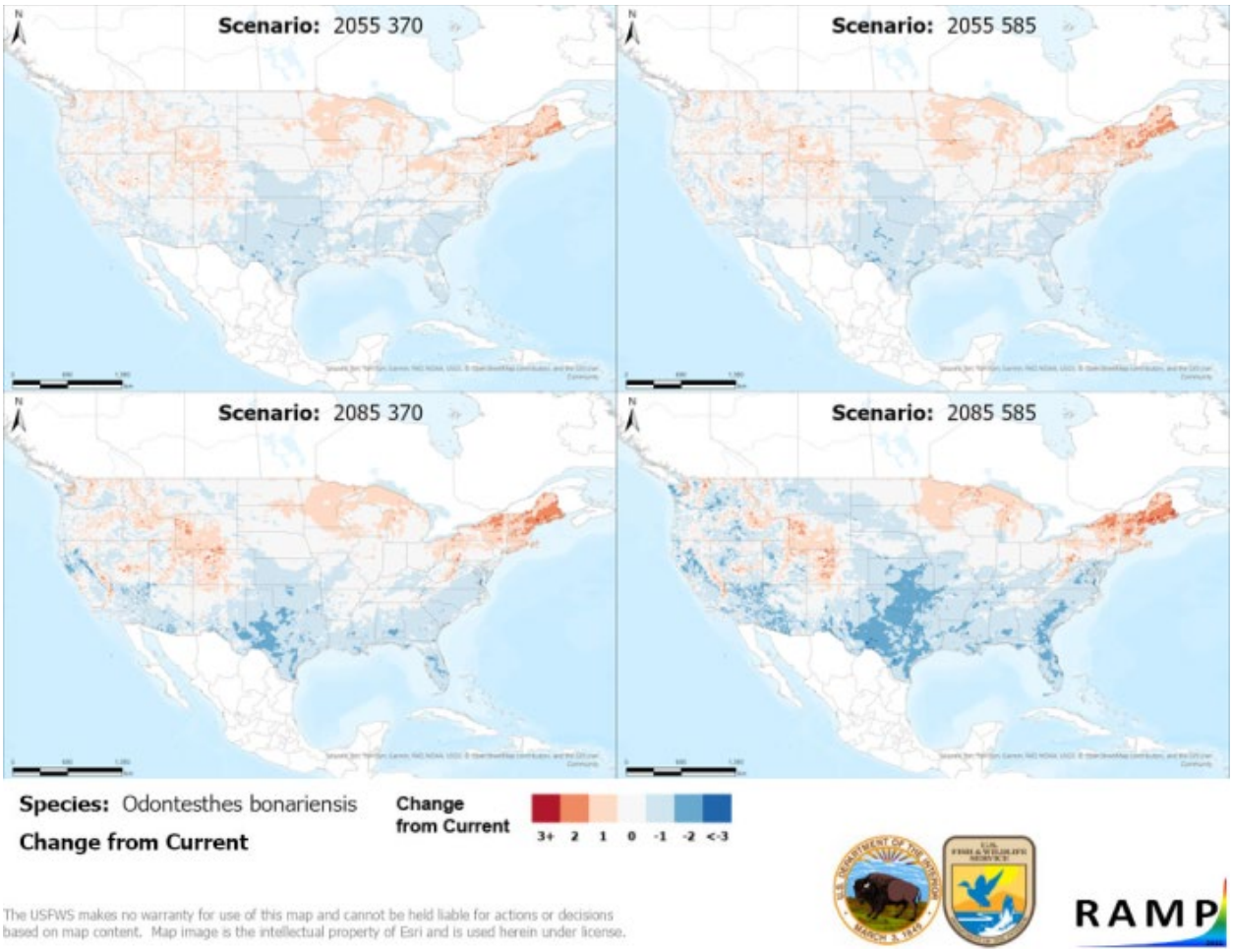


Figure A3. RAMP (Sanders et al. 2023) maps of the contiguous United States showing the difference between the current climate match target point score (figure 3) and the median target point score for future climate scenarios (figure A1) for *Odontesthes bonariensis* based on source locations reported by GBIF Secretariat (2023) and Sarmiento et al. (2014). Shared Socioeconomic Pathways (SSPs) used (from left to right): SSP3, SSP5 (IPCC 2021). Time steps: 2055 (top row) and 2085 (bottom row). Climate source data from CHELSA (Karger et al. 2017, 2018); global models used: GFDL-ESM4, UKESM1-0-LL, MPI-ESM1-2-HR, IPSL-CM6A-LR, and MRI-ESM2-0. Shades of blue indicate a lower target point score under future scenarios than under current conditions. Shades of red indicate a higher target point score under future scenarios than under current conditions. Darker shades indicate greater change.

Literature Cited

GBIF Secretariat. 2023. GBIF backbone taxonomy: *Odontesthes bonariensis* (Valenciennes, 1835). Copenhagen: Global Biodiversity Information Facility. Available: https://www.gbif.org/species/2412370 (November 2023).

[IPCC] Intergovernmental Panel on Climate Change. 2021. Climate change 2021: the physical science basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press.

Karger DN, Conrad O, Böhner J, Kawohl T, Kreft H, Soria-Auza RW, Zimmermann NE, Linder HP, Kessler M. 2018. Data from: Climatologies at high resolution for the earth's land surface areas. EnviDat. Available: https://doi.org/10.16904/envidat.228.v2.1.

Karger DN, Conrad O, Böhner J, Kawohl T, Kreft H, Soria-Auza RW, Zimmermann NE, Linder P, Kessler M. 2017. Climatologies at high resolution for the Earth land surface areas. Scientific Data 4:170122.

Sanders S, Castiglione C, Hoff M. 2023. Risk Assessment Mapping Program: RAMP. Version 5.0. U.S. Fish and Wildlife Service.

Sarmiento J, Bigorne R, Carvajal-Vallejos FM, Maldonado M, Leciak E, Oberdorff T, editors. 2014. Bolivian fishes. La Paz, Bolivia: IRD-BioFresh (EU). Available: https://horizon.documentation.ird.fr/exl-doc/pleins_textes/divers20-06/010062802.pdf (April 2026).