U.S. Fish & Wildlife Service

Southern Platyfish (*Xiphophorus maculatus*)

Ecological Risk Screening Summary

U.S. Fish and Wildlife Service, May 2014
Revised, March 2018
Web Version, 11/17/2019

Photo: M. Korzeniec. Licensed under Creative Commons (CC BY-SA 3.0). Available: https://commons.wikimedia.org/wiki/File:18_marca_06_r._015.jpg. (March 2018).

1 Native Range and Status in the United States

Native Range

From Froese and Pauly (2018):

"North and Central America: Ciudad Veracruz, Mexico to northern Belize."

From Fricke et al. (2019):

"Atlantic slope of Central America: Mexico, Belize and Guatemala […]"

From CABI (2018):

"*X. maculatus* is native to Mexico, Belize, Guatemala and Honduras."

Status in the United States

From Nico et al. (2018):

"This species has been recorded from Orange County, California, near Westminster (St. Amant and Hoover 1969; Courtenay et al. 1984, 1991; Swift et al. 1993); near a fish farm in Conejos County and the South Platte drainage, Colorado (Woodling 1985; Zuckerman and Behnke 1986; Rasmussen 1998); several counties in Florida (Courtenay et al. 1974; Courtenay and Hensley [1979]; Dial and Wainright 1983; museum specimens); Hawaii (Brock 1960; Maciolek 1984; Devick [1991]; Mundy 2005); an unnamed tributary to Big Branch Bayou in Lacombe, Louisiana (K. Piller, pers. comm.); Beaverhead Rock Pond (Madison County), Montana (Page and Burr 1991); Clark County, Nevada (La Rivers 1962; Bradley and Deacon 1967; Courtenay and Deacon 1982; Courtenay et al. 1984, 1991; Deacon and Williams 1984; Vinyard 2001); several drainages around Puerto Rico (Erdsman 1984; Lee et al 1983); South Carolina (museum record), and Texas (Hubbs 1982; Courtenay et al. 1984, 1991)."

"It is locally established, or possibly established locally, in several states, including Florida (Courtenay and Meffe 1989; Nico, personal communication), Colorado (Zuckerman and Behnke 1986), Hawaii (Kanayama 1968; Devick [1991]), and Montana (Page and Burr 1991). It was reported from Texas (Courtenay et al. 1984, 1991). The species was mentioned as being extirpated from California (Swift et al. 1993), but there is no evidence that it was ever established in that state (Courtenay and Meffe 1989). Uncertain in Louisiana. The species was introduced into Blue Point Springs near Lake Mead, in Nevada (Deacon and Williams 1984); the status of that population is assumed to be established locally."

"This species has long been a popular ornamental fish and exhibits a wide range of color patterns (Rosen 1960, 1979; Dawes 1991; Wischnath 1993). […] Aquaculturists have hybridized it with related species to create a variety of forms and colors, and Florida fish farms raise tremendous numbers of these each year for the aquarium trade."

Means of Introductions in the United States

From Nico et al. (2018):

"Probably the result of fish farm or aquarium releases. Specimens in Louisiana were collected near a tropical fish farm."

Remarks

From Nico et al. (2018):

"A second population, inhabiting Indian Springs, Clark County, Nevada, was considered to be a hybrid with *X. hellerii* (Deacon and Williams 1984; Courtenay and Meffe 1989); however, in

1989 M. Rauchenberger examined specimens (UF 91919) taken from Indian Spring[s] and determined that they represented *X. hellerii* and not a hybrid."

"Myers (1940) received unconfirmed reports that *X. maculatus*, along with several other introduced species, had breeding populations in the Florida Everglades but the location of unspecific [sic]; no specimens have ever been taken in the Everglades wetlands (Loftus and Kushlan 1987, Shafland 2008). There is some confusion surrounding the positive identification of a Nevada population (see account for *X. hellerii*). Courtenay and Meffe (1989) indicated that the Nevada record of Courtenay and Deacon (1982) and Deacon and Williams (1984) was actually a hybrid with *X. hellerii*. As such, the listing of pure *X. maculatus* for Nevada is obviously tentative."

"Formerly known as *Platypoecilus maculatus*."

Both the former scientific name and the current, valid scientific name were used in searching for information on this species.

From CABI (2018):

"*Xiphophorus* spp. commonly hybridise (Dawes, 1995; Bailey and Sandford, 1999; Balon, 2004), and most ornamental varieties have resulted from hybridisation and artificial selection of three species; i.e. *X. hellerii*, *X. maculatus* and *X. variatus* (Dawes, 1995; Balon, 2004)."

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 Acanthopterygii
Order Cyprinodontiformes
Suborder Cyprinodontoidei
Family Poeciliidae
Subfamily Poeciliinae
Genus *Xiphophorus*
Species *Xiphophorus maculatus* (Günther, 1866)"

From Fricke et al. (2019):

"**Current status:** Valid as *Xiphophorus maculatus* (Günther 1866). Poeciliidae: Poeciliinae."

Size, Weight, and Age Range

From Nico et al. (2018):

"Females to about 6 cm TL; males to 4 cm TL."

From Froese and Pauly (2018):

"Max length : 4.0 cm TL male/unsexed; [Keith et al. 2006]; 6.0 cm TL (female); common length : 2.3 cm TL male/unsexed; [Hugg 1996]"

Environment

From CABI (2018):

"*X. maculatus* has fairly broad environmental tolerances and, as it is common as an introduced species in many countries, occurs in many different habitats. […] *X. maculatus* has been observed to survive winter in outdoor ponds at a latitude of 32°S, in Perth, Western Australia (M Maddern, University of Western Australia, personal communication, 2010)."

"Milton and Arthington (1983) noted that reproduction was influenced by temperature and occurred between approximately15°C [*sic*] and 30°C, though no published data of the species within its native range is available for comparison."

From Froese and Pauly (2018):

"Freshwater; benthopelagic; pH range: 7.0 - 8.0; dH range: 9 - 19; non-migratory."

Climate/Range

From Froese and Pauly (2018):

"Tropical; […] 23°N - 17°N, 99°W - 86°W"

From CABI (2018):

"The species has a "native" latitude of 17-23°N though has exists [*sic*] outside of this range as an introduced species in some states of USA. Based on this [*sic*] data and the fact that other introduced *X. maculatus* populations occur only in tropical/subtropical locales it appears that the species tolerance of low water temperatures is less than that of the closely related *Xiphophorus hellerii*."

Distribution Outside the United States

Native

From Froese and Pauly (2018):

"North and Central America: Ciudad Veracruz, Mexico to northern Belize."

From Fricke et al. (2019):

"Atlantic slope of Central America: Mexico, Belize and Guatemala […]"

From CABI (2018):

"*X. maculatus* is native to Mexico, Belize, Guatemala and Honduras."

Introduced

From CABI (2018):

"The southern platyfish *X. maculatus* […] occurs as an introduced species in the aquatic habitats of at least 18 countries, principally because of human-mediated translocation and release."

According to CABI (2018), *X. maculatus* has been introduced to India, Indonesia, Japan, Saudi Arabia, Singapore, Sri Lanka, Madagascar, Mauritius, Nigeria, Bahamas, Honduras, Jamaica, Réunion, Canada, Brazil, Colombia, Australia, and Palau.

According to Froese and Pauly (2019), *X. maculatus* is established outside its native range in Jamaica, Japan, Madagascar, Palau, Saudi Arabia, India, Colombia, Sri Lanka, Brazil, Bahamas, and Australia; and probably established outside its native range in Nigeria, Indonesia, and Singapore. Its status is unknown in Spain, Mauritius, Reunion, and Canada.

Means of Introduction Outside the United States

From CABI (2018):

"**Natural Dispersal (Non-Biotic)**
Further spread of *X. maculatus* by natural dispersal may occur (e.g. flooding), though is most likely in areas with substantial populations, i.e. Queensland, Australia."

"**Intentional Introduction**
X. maculatus may be intentionally introduced to aquatic habitats as unwanted ornamental fishes, and possibly as mosquito biocontrol agents."

Short Description

From Nico et al. (2018):

"Distinguishing characteristics were given by Rosen (1960, 1979) and Page and Burr (1991). It is included in identification keys of Rosen (1960, 1979) and Greenfield and Thomerson (1997).

Photographs or illustrations appeared in Rosen (1960), Mills and Vevers (1982), Petrovicky (1988), Dawes (1991), Sakurai et al. (1993), and Wischnath (1993)."

From Froese and Pauly (2018):

"Dorsal soft rays (total): 8-10. Distinct line of black pigment midventrally on caudal peduncle absent. Greatest body depth about 2 times in SL. Ventral rays of caudal fin of males not elongated into a sword. Male gonopodium falling short of caudal fin base, without a membranous protuberance, third ray with a strong hook [Greenfield and Thomerson 1997]."

Biology

From Froese and Pauly (2018):

"Feed on worms, crustaceans, insects and plant matter [Mills and Vevers 1989; Yamamoto and Tagawa 2000]."

"[…] attain sexual maturity after 3-4 months and reproduce easily [Riehl and Baensch 1991]."

From CABI (2018):

"*X. maculatus* is omnivorous and the diet of introduced populations in Queensland included plant material, aquatic and terrestrial insects and Crustacea (atyid and caridian shrimps) (Arthington, 1989). The diet in an Indonesian lake was predominantly detritus and lesser quantities of chironomid larvae and cyclopoid copepods (Green et al., 1978)."

"*X. maculatus* is ovoviviparous (i.e. livebearing), with insemination occurring by the males' gonopodium. Like many poeciliids, *X. maculatus* has fairly large brood sizes, short gestation periods and multiple broods per year (Milton and Arthington, 1983). Males do not perform a courtship display (Farr, 1989) though complex male dominance hierarchies are established (Sontirat, 1984). Little peer-reviewed research has been conducted on the reproductive biology of *X. maculatus*. *X. maculatus* can reach maturity at approximately 20 mm (Kallman and Borowski, 1978; Milton and Arthington, 1983), and 8-10 weeks of age (Travolga and Rugh, 1947). The gestation period may be between 26-90 days (Travolga, 1949). Large females in southern Queensland exhibited a maximum fecundity of approximately 90 offspring (Milton and Arthington, 1983). Favourable water temperatures in subtropical and tropical areas lead to almost continuous reproduction (Travolga and Rugh, 1947; Milton and Arthington, 1983)."

Human Uses

From CABI (2018):

"*X. maculatus* is a very popular ornamental species worldwide (Froese and Pauly, 2007), and accounts for 5.4% of the total number of ornamental fish imported into the USA (Chapman et al., 1997). It is considered of "high" importance as an ornamental fish in Australia (Corfield et al., 2007)."

According to CABI (2018), other uses of *X. maculatus* include biological control, laboratory use, and research model.

Diseases

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

From Froese and Pauly (2018):

"Fin-rot Disease (late stage), Bacterial diseases
White spot Disease, Parasitic infestations (protozoa, worms, etc.)
Costia Disease, Parasitic infestations (protozoa, worms, etc.)
Fin Rot (early stage), Bacterial diseases
Skin Fungi (Saprolegnia sp.), Fungal diseases
Fish tuberculosis, Bacterial diseases
Turbidity of the Skin (Freshwater fish), Parasitic infestations (protozoa, worms, etc.)
Bacterial Infections (general), Bacterial diseases
Fish louse Infestation 1, Parasitic infestations (protozoa, worms, etc.)
Malnutriton, Nutritional deficiencies
Fish tuberculosis (FishMB), Bacterial diseases"

From Nolan et al. (2014):

"Members of the genus *Megalocytivirus* cause severe systemic disease with characteristic inclusion bodies seen in both freshwater and marine fish (Hyatt & Chinchar 2008). *Megalocytivirus* is a genus within the family Iridoviridae which also includes the genera *Iridovirus*, *Chloriridovirus*, *Lymphocystivirus* and *Ranavirus* (Chinchar et al. 2005)."

"The presence of *Megalocytivirus* was confirmed by PCR in all 3 species of freshwater ornamental livebearer fish examined which included platys *Xiphophorus maculatus* […]"

Threat to Humans

From Mehrdana et al. (2014):

"A popular and frequently exported fish *Xiphophorus maculatus*, also known as platy fish (family Poecilidae), is susceptible to a number of parasite species, including digenetic trematodes in their metacercarial stage, which use the fish as their second intermediate host (Thilakaratne et al. 2003, Piazza et al. 2006, Garcia et al. 2009). […] Some of these parasites have also a zoonotic potential and may be considered a public health threat, if inadequately processed fish are consumed (WHO 1995, Chai and Lee 2002, Keiser and Utzinger 2005, Rim et al. 2013)."

3 Impacts of Introductions

From Nico et al. (2018):

"Southern platys, and other introduced poeciliids, have been implicated in the decline of native damselflies on Oahu, Hawaii. Often the distributions of the damselflies and introduced fishes

were found to be mutually exclusive, probably resulting from predation by the fish on the insects (Englund 1999)."

From Froese and Pauly (2018):

"At least one country reports adverse ecological impact after introduction."

From CABI (2018):

"Little information is available on specific deleterious ecological impacts though *X. maculatus* and other poeciliids are considered responsible for the decline of indigenous aquatic invertebrates in Hawaii. Furthermore, research has suggested that impacts on aquatic ecosystems are increased when multiple poeciliid species are present. Ecological impacts may include resource competition and predation, and predation of aquatic invertebrate communities as a whole."

From Krishnakumar et al. (2009):

"The insectivorous feeding habit of platy, *Xiphophorus maculatus* makes them potential competitors for indigenous barbs like *Puntius fasciatus, Puntius ticto, Puntius vittatus* and Killi fishes like *A*[*plocheilus*] *lineatus, A. panchax* and *A. dayi*."

4 Global Distribution

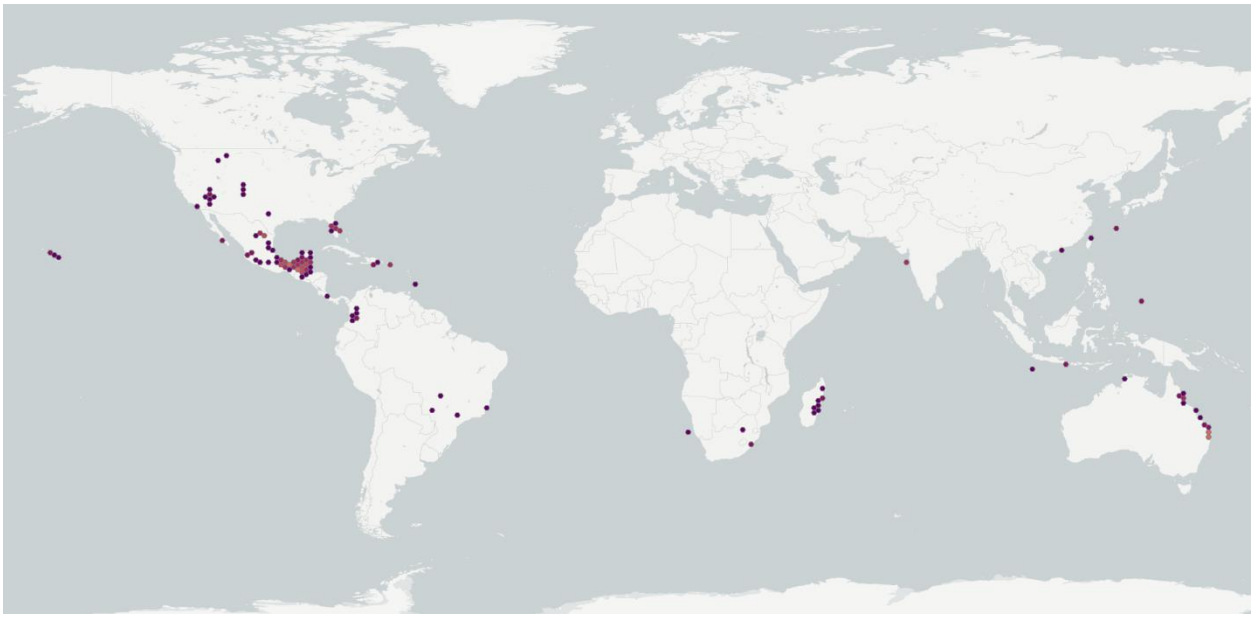

Figure 1. Known global distribution locations of *Xiphophorus maculatus*. Map from GBIF Secretariat (2019). Occurrences reported from the Dominican Republic, Barbados, South Africa, Hong Kong, and Taiwan were excluded from the climate matching analysis because no established populations of *X. maculatus* have been confirmed in these locations. See Section 5 for occurrences within the United States used or excluded from the climate matching analysis. No georeferenced occurrences were available for parts of the species established range located in Jamaica, Saudi Arabia, Sri Lanka, Bahamas, Nigeria, or Singapore.

5 Distribution Within the United States

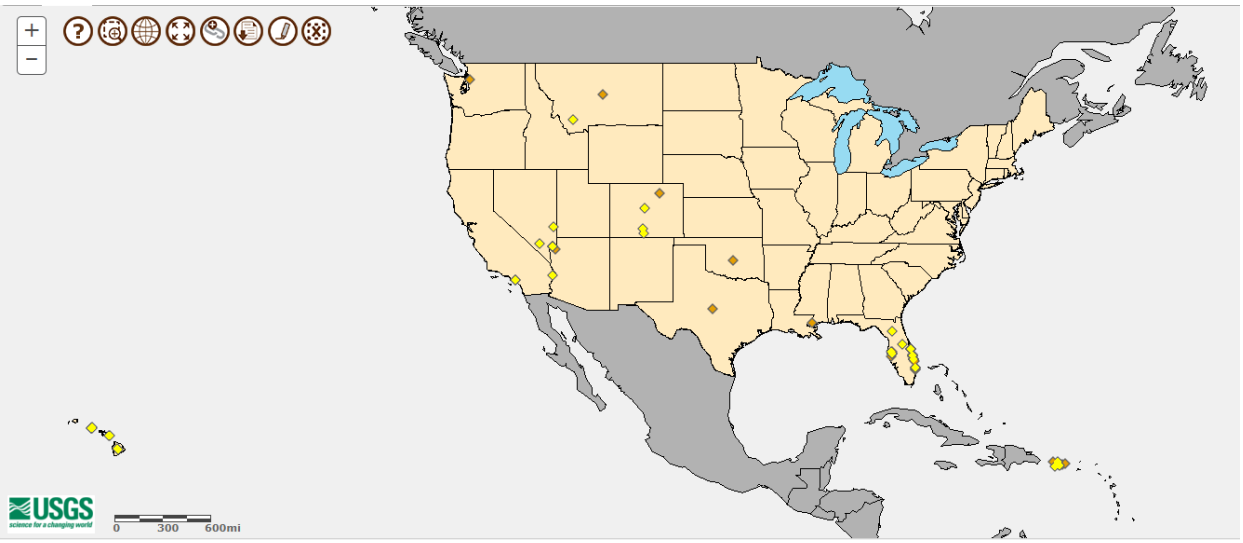

Figure 2. Known distribution of *Xiphophorus maculatus* in the United States. Map from Nico et al. (2019). The yellow diamonds represent established populations, while orange diamonds represent introductions that failed or for which the status is unknown. Only established populations were included in the climate matching analysis.

6 Climate Matching

Summary of Climate Matching Analysis

The climate match (Sanders et al. 2018; 16 climate variables; Euclidean Distance) for *Xiphophorus maculatus* was high overall, with a Climate 6 score of 0.506. Scores of 0.103 and greater are classified as high match. Locally, there were high matches in Florida, southern Georgia, southern Texas, and much of the western United States. Other coastal areas of the Southeast had medium matches, along with the Upper Midwest and Great Plains. There were low matches across the remainder of the eastern half of the contiguous United States, as well as in the Pacific Northwest.

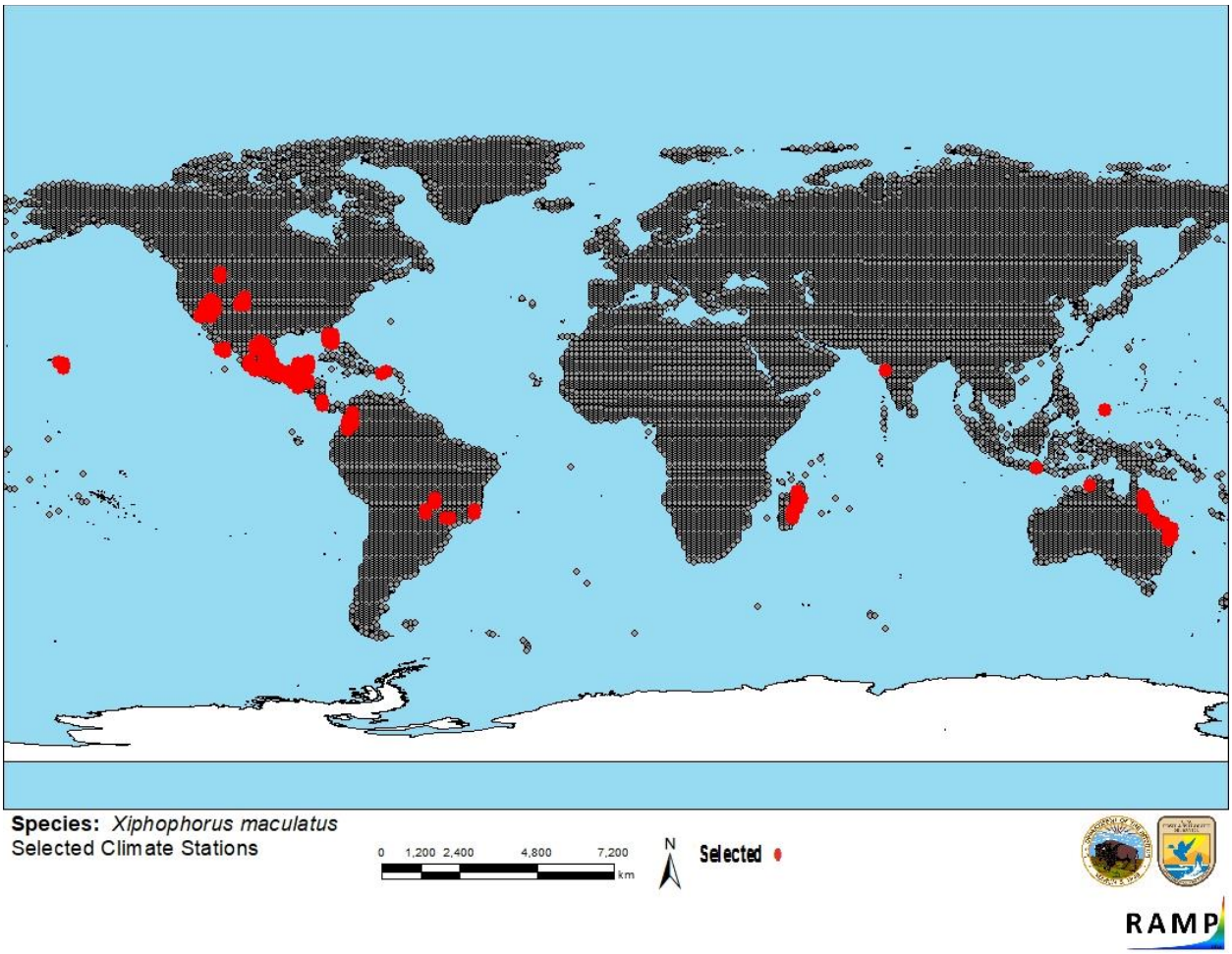

Figure 3. RAMP (Sanders et al. 2018) source map showing weather stations across the globe selected as source locations (red; United States, Mexico, Belize, Guatemala, Honduras, Colombia, Brazil, Madagascar, India, Palau, Indonesia, Australia) and non-source locations (gray) for *Xiphophorus maculatus* climate matching. Source locations from GBIF Secretariat (2019).

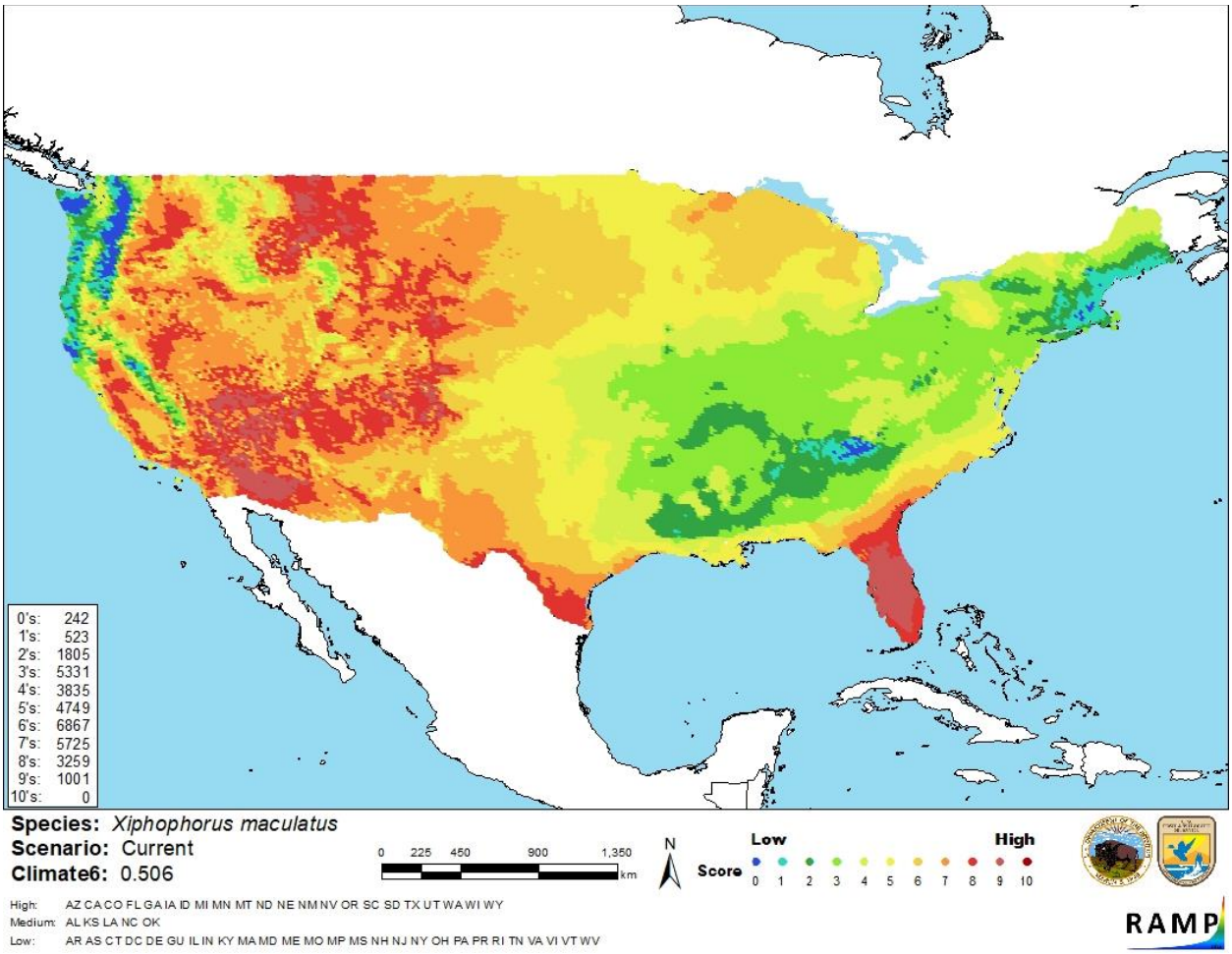

Figure 4. Map of RAMP (Sanders et al. 2018) climate matches for *Xiphophorus maculatus* in the contiguous United States based on source locations reported by GBIF Secretariat (2019). Counts of climate match scores are tabulated on the left. 0=Lowest match, 10=Highest match.

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≤X≤0.005	Low
0.005<X<0.103	Medium
≥0.103	High

7 Certainty of Assessment

Information on the biology, ecology, and distribution of *Xiphophorus maculatus* was readily available upon review. However, information on impacts from introduction of *X. maculatus* are poorly understood. A fair amount of scientific literature suggests negative impacts, but further research is needed to reach definitive conclusions. Certainty of assessment for *X. maculatus* is low.

8 Risk Assessment

Summary of Risk to the Contiguous United States

Xiphophorus maculatus, Southern Platyfish, is a fish species native to northern Central America. The omnivorous *X. maculatus* feeds on worms, crustaceans, insects and plants, and is a livebearer that attains sexual maturity after 3-4 months. A popular ornamental fish in the United States and internationally, this species has a wide distribution beyond its native range, with established populations in Asian, African, Caribbean, Oceanic, South American, and North American countries. The species has been associated with potential negative impacts in some of these locations, although the direct influence of *X. maculatus* relative to other introduced species is unclear and more research is needed in this area. The history of invasiveness is classified as "none documented" based on currently available information. *X. maculatus* is currently established in several States within the contiguous United States, including Hawaii, Florida, Colorado, Montana, California, and Nevada, as well as the Commonwealth of Puerto Rico. There is a high overall climate match with the contiguous United States. The certainty is low for this assessment because of the lack of clear and convincing evidence on impacts of *X. maculatus* introduction or the lack thereof. The overall risk posed by *X. maculatus* to the contiguous United States is uncertain.

Assessment Elements

- **History of Invasiveness (Sec. 3): None Documented**
- **Climate Match (Sec. 6): High**
- **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.

CABI. 2018. *Xiphophorus maculatus* [original text by M. Maddern]. *In* Invasive Species Compendium. CAB International, Wallingford, UK. Available: https://www.cabi.org/isc/datasheet/59752. (March 2018).

Froese, R., and D. Pauly, editors. 2018, 2019. *Xiphophorus maculatus* Günther, 1866. FishBase. Available: http://www.fishbase.org/summary/Xiphophorus-maculatus.html. (March 2018, November 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. (November 2019).

GBIF Secretariat. 2019. GBIF backbone taxonomy: *Xiphophorus maculatus* Günther, 1866. Global Biodiversity Information Facility, Copenhagen. Available: https://www.gbif.org/species/2350164. (November 2019).

ITIS (Integrated Taxonomic Information System). 2018. *Xiphophorus maculatus* Günther, 1866. Integrated Taxonomic Information System, Reston, Virginia. Available: https://itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=165922#null. (March 2018).

Krishnakumar, K., R. Raghavan, G. Prasad, A. Bijukumar, M. Sekharan, B. Pereira, and A. Ali. 2009. When pets become pests – exotic aquarium fishes and biological invasions in Kerala, India. Current Science 97:474-476.

Mehrdana, F., H. M. Jensen, P. W. Kania, and K. Buchmann. 2014. Import of exotic and zoonotic trematodes (Heterophyidae: *Centrocestus* sp.) in *Xiphophorus maculatus*: implications for ornamental fish import control in Europe. Acta Parasitologica 59(2):276-283.

Nico, L., P. Fuller, M. Neilson, and B. Loftus. 2018. *Xiphophorus maculatus* Günther, 1866. U.S. Geological Survey, Nonindigenous Aquatic Species Database, Gainesville, Florida. Available: https://nas.er.usgs.gov/queries/FactSheet.aspx?SpeciesID=872. (March 2018).

Nolan, D., F. Stephens, M. Crockford, J. B. Jones, and M. Snow. 2015. Detection and characterization of viruses of the genus *Megalocytivirus* in ornamental fish imported into an Australian border quarantine premises: an emerging risk to national biosecurity. Journal of Fish Diseases 38:187-195.

OIE (World Organisation for Animal Health). 2019. OIE-listed diseases, infections and infestations in force in 2019. World Organisation for Animal Health, Paris. Available: http://www.oie.int/animal-health-in-the-world/oie-listed-diseases-2019/. (August 2019).

Sanders, S., C. Castiglione, and M. H. Hoff. 2018. Risk Assessment Mapping Program: RAMP, version 3.1. U.S. Fish and Wildlife Service.

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.

Arthington, A. H. 1989. Diet of *Gambusia affinis holbrooki*, *Xiphophorus helleri*, *X. maculatus* and *Poecilia reticulata* (Pisces: Poeciliidae) in streams of southeastern Queensland, Australia. Asian Fisheries Science 2:193-212.

Bailey, M., and G. Sandford. 1999. Aquarium fish: a comprehensive and authoritative guide to tropical freshwater, brackish, and marine fishes. Sebastian Kelly, Oxford, U.K.

Balon, E. K. 2004. About the oldest domesticates among fishes. Journal of Fish Biology 65(Suppl. 1):1-27.

Bradley, W. G., and J. E. Deacon. 1967. The biotic communities of southern Nevada. Nevada State Museum Anthropological Papers 13(4):201-273.

Brock, V. E. 1960. The introduction of aquatic animals into Hawaiian waters. Internationale Revue der gesamten Hydrobiologie 45(4):463-480.

Chai, J. Y., and S. H. Lee. 2002. Food-borne intestinal trematode infections in the Republic of Korea. Parasitology International 51:129-154.

Chapman, F. A., S. A. Fitz-Coy, E. M. Thunberg, and C. M. Adams. 1997. United States of America trade in ornamental fish. Journal of the World Aquaculture Society 28(1):1-10.

Chinchar, V. G., S. Essbauer, J. G. He, A. Hyatt, T. Miyazaki, V. Seligy, and T. Williams, editors. 2005. Family Iridoviridae. Virus taxonomy. Classification and nomenclature of viruses. Eighth report of the International Committee on the Taxonomy of Viruses. Academic Press, San Diego, California.

Corfield, J., B. Diggles, C. Jubb, R. M. McDowall, A. Moore, A. Richards, and D. K. Rowe. 2007. Review of the impacts of introduced aquarium fish species that have established wild populations in Australia. Australian Government Department of the Environment and Water Resources, Canberra, Australia.

Courtenay, W. R., Jr., and J. E. Deacon. 1982. Status of introduced fishes in certain spring systems in southern Nevada. Great Basin Naturalist 42(3):361-366.

Courtenay, W. R., Jr., and D. A. Hensley. 1979. Survey of introduced non-native fishes. Phase I report. Introduced exotic fishes in North America: status 1979. Report submitted to National Fishery Research Laboratory, U.S. Fish and Wildlife Service, Gainesville, Florida.

Courtenay, W. R., Jr., and G. K. Meffe. 1989. Small fishes in strange places: a review of introduced poeciliids. Pages 319-331 *in* G. K. Meffe, and F. F. Snelson, Jr., editors. Ecology and evolution of livebearing fishes (Poeciliidae). Prentice Hall, Englewood Cliffs, New Jersey.

Courtenay, W. R., Jr., D. A. Hensley, J. N. Taylor, and J. A. McCann. 1984. Distribution of exotic fishes in the continental United States. Pages 41-77 *in* W. R. Courtenay, Jr., and J. R. Stauffer, Jr., editors. Distribution, biology and management of exotic fishes. Johns Hopkins University Press, Baltimore, Maryland.

Courtenay, W. R., Jr., D. P. Jennings, and J. D. Williams. 1991. Appendix 2: exotic fishes. Pages 97-107 *in* C. R. Robins, R. M. Bailey, C. E. Bond, J. R. Brooker, E. A. Lachner, R. N. Lea, and W. B. Scott, editors. Common and scientific names of fishes from the United

States and Canada, 5th edition. American Fisheries Society Special Publication 20. American Fisheries Society, Bethesda, Maryland.

Courtenay, W. R., Jr., H. F. Sahlman, W. W. Miley, II, and D. J. Herrema. 1974. Exotic fishes in fresh and brackish waters of Florida. Biological Conservation 6(4):292-302.

Dawes, J. A. 1991. Livebearing fishes. A guide to their aquarium care, biology and classification. Blandforn, London.

Dawes, J. A. 1995. Livebearing fishes: a guide to their aquarium care, biology and classification. Blandford, London.

Deacon, J. E., and J. E. Williams. 1984. Annotated list of the fishes of Nevada. Proceedings of the Biological Society of Washington 97(1):103-118.

Devick, W. S. 1991. Patterns of introductions of aquatic organisms to Hawaiian freshwater habitats. Pages 189-213 *in* New directions in research, management and conservation of Hawaiian freshwater stream ecosystems. Proceedings of the 1990 symposium on freshwater stream biology and fisheries management. Division of Aquatic Resources, Hawaii Department of Land and Natural Resources, Honolulu, Hawaii.

Dial, R. S., and S. C. Wainright. 1983. New distributional records for non-native fishes in Florida. Florida Scientist 46(1):8-15.

Englund, R. A. 1999. The impacts of introduced poeciliid fish and Odonata on the endemic *Megalagrion* (Odonata) damselflies of Oahu Island, Hawaii. Journal of Insect Conservation 3:225-243.

Erdsman, D. S. 1984. Exotic fishes in Puerto Rico. Pages 162-176 *in* W. R. Courtenay, Jr., and J. R. Stauffer, Jr., editors. Distribution, biology, and management of exotic fishes. John Hopkins, Baltimore and London.

Farr, J. A. 1989. Sexual selection and secondary sexual differentiation in poeciliids: determinants of male mating success and the evolution of female mating choice. *In* G. K. Meffe, and F. F. Snelson, Jr, editors. Ecology and evolution of livebearing fishes. Prentice Hall, New Jersey.

Froese, R., and D. Pauly. 2007. FishBase. Available: http://www.fishbase.org.

Garcia, F., R. Y. Fujimoto, M. L. Martins, and F. R. Moraes. 2009. Protozoan parasites of *Xiphophorus* spp. (Poeciliidae) and their relation with water characteristics. Arquivo Brasileiro de Medicina Veterinaria e Zootecnia, 61:156-162.

Green, J., S. A. Corbet, E. Watts, and O. B. Lan. 1978. Ecological studies in Indonesian lakes: the Montne Lake of Bali. Journal of Zoology 186:15-38.

Greenfield, D. W. and J. E. Thomerson. 1997. Fishes of the continental waters of Belize. University Press of Florida, Florida.

Hubbs 1982 [Source did not provide full citation for this reference.]

Hugg, D. O. 1996. MAPFISH georeferenced mapping database. Freshwater and estuarine fishes of North America. Life Science Software, Edgewater, Maryland.

Hyatt, A. D., and V. G. Chinchar. 2008. Iridoviruses of vertebrates. Pages 155-160 *in* B. W. J. Mahy, and M. H. V. Van Regenmortel, editors. Encyclopedia of virology, 3rd edition. Academic Press, Boston.

Kallman, K. D., and R. Borowski. 1978. A sex-linked gene controlling the onset of sexual maturity in female and male platyfish (*Xiphophorus maculatus*), fecundity in females and adult size in males. Genetics 89:79-119.

Kanayama 1968 [Source did not provide full citation for this reference.]

Keiser, J., and J. Utzinger. 2005. Emerging foodborne trematodiasis. Emerging Infectious Diseases 11:1507-1514.

Keith, P., G. Marquet, P. Valade, P. Bosc, and E. Vigneux. 2006. Atlas des poissons et des crustacés d'eau douce des Comores. Mascareignes et Seychelles, MNHN, Paris.

La Rivers, I. 1962. Fishes and fisheries of Nevada. Nevada State Print Office, Carson City, Nevada.

Lee, D. S., S. P. Platania, and G. H. Burgess. 1983. Atlas of North American freshwater fishes, 1983 supplement. Occasional Papers of the North Carolina Biological Survey number 1983-6. North Carolina State Museum of Natural History, Raleigh, North Carolina.

Loftus, W. F., and J. A. Kushlan. 1987. Freshwater fishes of southern Florida. Bulletin of the Florida State Museum, Biological Sciences 31:147-344.

Maciolek, J. A. 1984. Exotic fishes in Hawaii and other islands of Oceania. Pages 131-161 *in* W. R. Courtenay, Jr., and J. R. Stauffer, Jr., editors. Distribution, biology, and management of exotic fishes. The Johns Hopkins University Press, Baltimore, Maryland.

Mills and Vevers 1982 [Source did not provide full citation for this reference.]

Mills, D., and G. Vevers. 1989. The Tetra encyclopedia of freshwater tropical aquarium fishes. Tetra Press, New Jersey.

Milton, D. A., and A. H. Arthington. 1983. Reproductive biology of *Gambusia affinis holbrooki* Baird and Girard, *Xiphophorus helleri* (Gunther) and *X. maculatus* (Heckel) (Pisces; Poeciliidae) in Queensland, Australia. Journal of Fish Biology 23(1):23-41.

Mundy 2005 [Source did not provide full citation for this reference.]

Myers, G. S. 1940. An American cyprinodont fish, *Jordanella floridae*, reported from Borneo, with notes on the possible widespread introduction of foreign aquarium fishes. Copeia 1940:267-268.

Page, L. M., and B. M. Burr. 1991. A field guide to freshwater fishes of North America north of Mexico. The Peterson Field Guide Series, volume 42. Houghton Mifflin Company, Boston.

Petrovicky, I. 1988. Aquarium fish of the world. Hamlyn, London.

Piazza, R.S., M. L. Martins, L. Guiraldelli, and M. M. Yamashita. 2006. Parasitic diseases of freshwater ornamental fishes commercialized in Florianópolis, Santa Catarina, Brazil. Boletim do Instituto de Pesca, São Paulo 32:51-57.

Rasmussen, J. L. 1998. Aquatic nuisance species of the Mississippi River basin. 60th Midwest Fish and Wildlife Conference, Aquatic Nuisance Species Symposium, Cincinnati, Ohio.

Riehl, R., and H. A. Baensch. 1991. Aquarien Atlas, volume 1. Mergus, Verlag für Natur-und Heimtierkunde, Melle, Germany.

Rim, H. J., W. M. Sohn, T. S. Yong, K. S. Eom, J. Y. Chai, D. Y. Min, S. H. Lee, E. H. Hoang, B. Phommasack, and S. Insisiengmay. 2013. Fish-borne trematode metacercariae in Luang Prabang, Khammouane, and Saravane province, Lao PDR. Korean Journal of Parasitology 51:107-114.

Rosen, D. E. 1960. Middle-American Poeciliid fishes of the genus *Xiphophorus*. Bulletin of the Florida State Museum Biological Sciences 5(4):57-242.

Rosen, D. E. 1979. Fishes from the uplands and intermontane basins of Guatemala: revisionary studies and comparative geography. Bulletin of the American Museum of Natural History 162:267-376.

Sakurai, A., Y. Sakamoto, and F. Mori. 1993. Aquarium fish of the world: the comprehensive guide to 650 species. Chronicle Books, San Francisco.

Sontirat, S. 1984. Aggressive behaviour in the male platy, *Xiphophorus maculatus* (Günther). Kasetsart Journal (Natural Sciences) 18:99-107.

Shafland, P. L., K. B. Gestring, and M. S. Stanford. 2008. Florida's exotic freshwater fishes - 2007. Florida Scientist 71:220-245.

St. Amant, J. A., and F. G. Hoover. 1969. Addition of *Misgurnus anguillicaudatus* (Cantor) to the California fauna. California Fish and Game 57(2):330-331.

Swift, C. C., T. R. Haglund, M. Ruiz, and R. N. Fisher. 1993. The status and distribution of the freshwater fishes of southern California. Bulletin of the Southern California Academy of Science 92(3):101-167.

Thilakaratne, I. D. S. I. P., G. Rajapaksha, A. Hewakopara, R. P. V. J. Rajapakse, and A. C. M. Faizal. 2003. Parasitic infections in freshwater ornamental fish in Sri Lanka. Diseases of Aquatic Organisms 54:157-162.

Travolga, W. N. 1949. Embryonic development of the platyfish *Platypoecilius*, the Swordtail *Xiphophorus* and their hybrids. Bulletin of the American Museum of Natural History 94:167-227.

Travolga, W. N., and R. Rugh. 1947. Development of the platyfish, *Platypoecilus maculatus*. Zoologica 32:1-15.

Vinyard 2001 [Source did not provide full citation for this reference.]

WHO (World Health Organization). 1995. Control of food-borne trematode infections: report of a WHO Study Group. Technical Report Series issue 849.

Wischnath, L. 1993. Atlas of livebearers of the world. TFH Publications, New Jersey.

Woodling, J. 1985. Colorado's little fish: a guide to the minnows and other lesser known fishes in the state of Colorado. Colorado Division of Wildlife, Denver, Colorado.

Yamamoto, M. N., and A. W. Tagawa. 2000. Hawai'i's native and exotic freshwater animals. Mutual Publishing, Honolulu, Hawaii.

Zuckerman, L. D., and R. J. Behnke. 1986. Introduced fishes in the San Luis Valley, Colorado. Pages 435-452 *in* R. H. Stroud, editor. Fish culture in fisheries management. Proceedings of a symposium on the role of fish culture in fisheries management at Lake Ozark, Missouri, March 31-April 3, 1985. American Fisheries Society, Bethesda, Maryland.