Green Swordtail (*Xiphophorus hellerii*)
Ecological Risk Screening Summary

U.S. Fish and Wildlife Service, February 2011
Revised, March 2018
Web Version, 11/7/2019

Photo: Usien. Licensed under Creative Commons (CC0 1.0). Available: https://commons.wikimedia.org/wiki/File:Xiphophorus_helleri_Annanasschwerttaeger_Maennchen.JPG. (March 2018).

1 Native Range and Status in the United States

Native Range

From Nico et al. (2018):

"Middle America from Rio Nautla (= Rio Nantla), Veracruz, Mexico, to northwestern Honduras (Rosen 1960, 1979; Page and Burr 1991; Greenfield and Thomerson 1997; Miller et al. 2005)."

From Eschmeyer et al. (2018):

"Central America: Belize, Guatemala, Honduras, Mexico"

Status in the United States

From Nico et al. (2018):

"This species has been recorded from Rock Spring in Maricopa County, Arizona (Minckley 1973); several counties in California (Coots 1956; St. Amant and Hoover 1969; St. Amant 1970; Mearns 1975; Courtenay et al. 1984, 1986, 1991; Swift et al. 1993; Dill and Cordone 1997); Conejos and Sagauche counties in Colorado (Woodling 1985, Zuckerman and Behnke 1986; S. Platania, personal communication); several counties in Florida (Courtenay and Robins 1973; Courtenay et al. 1974; Courtenay and Hensley 1979; Dial and Wainright 1983; museum specimens); Hawaii (Brock 1960; Maciolek 1984; Devick 1991; Mundy 2005); several geothermal waters in Idaho (Courtenay 1985; Courtenay et al. 1987; Idaho Fish and Game 1996); St. Tammany Parish, Louisiana (K. Piller, pers. comm.); Madison County, Montana (Brown 1971; Courtenay 1985; Courtenay and Meffe 1989; Holton 1990); Indian Spring and Rogers Spring, Clark County, Nevada (La Rivers 1962; Deacon et al. 1964; Minckley 1973; Courtenay and Deacon 1982; Deacon and Williams 1984; Vinyard 2001); the Verdigris River near Catoosa, Oklahoma (Pigg et al. 1996); Bexar County, Texas (Howells 1992); and Teton County, Wyoming (Courtenay et al. 1987; Hubert 1994; Stone 1995; Tilmant 1999). Also collected in several locations throughout Puerto Rico (Erdsman 1984; Lee et al 1980 et seq), and in the Tarzan River, Guam (S. Walsh, pers. communication)."

"It is locally established, or possibly so, in Colorado (Zuckerman and Behnke 1986), Florida (Nico, personal communication), Hawaii (Devick 1991), Idaho (Courtenay and Meffe 1989), Montana (Courtenay and Meffe 1989), Nevada (Courtenay and Meffe 1989), Texas (Howells 1992), and Wyoming (Stone 1995). A breeding population existed in Arizona at Rock Spring, but it disappeared after a flood in 1965 (Minckley 1973). It has been reported from several sites in California (Dill and Cordone 1997) and a single locality in Oklahoma (Pigg et al. 1996)."

Chapman et al. (1997) report that 150,053 individual *X. hellerii* were imported in the United States in October 1992, accounting for 1.0% of all ornamental fishes imported into the country in that month. Rixon et al. (2005) found *X. hellerii* in 17 of 20 pet and aquarium stores surveyed in the U.S. and Canada.

Means of Introductions in the United States

From Nico et al. (2018):

"Most introductions probably due to aquarium releases. Its origin in the Westminster flood control channel in California was believed to be a goldfish farm (St. Amant and Hoover 1969). Florida records may also be fish farm escapes or aquarium releases."

Remarks

From Nico et al. (2018):

"This species exhibits a wide natural range of body form and color patterns (Rosen 1960, 1979; Dawes 1991; Wischnath 1993). It has long been popular as an ornamental fish, and has been used in genetics research. Many ornamental swordtails are hybrids of *X. hellerii* with the either *X. maculatus* or *X. variatus*."

"The green swordtail was recorded from Indian Spring, Clark County, Nevada, as early as 1975 (Courtenay and Deacon 1982). However, the *Xiphophorus* taken from Indian Spring during later collections were identified as hybrids of *X. hellerii* x *X. maculatus* (Courtenay and Deacon 1982; Deacon and Williams 1984; Page and Burr 1991). That conclusion apparently was based on the fact that the live fish were yellow to pale orange (Courtenay and Deacon 1982). In 1989, Rauchenberger (personal communication) examined the preserved voucher material (UF 91919) and determined that all specimens were *X. hellerii*. Nevertheless, some of the other above records actually may represent hybrids rather than pure *X. hellerii*. Myers (1940) mentioned an unconfirmed report of *X. hellerii* breeding in the Florida Everglades; however, no *Xiphophorus* spp. are known to have established there (Loftus, personal communication)."

From Seriously Fish (2019):

"This species is among the world's most recognisable aquarium fishes and ubiquitous in the ornamental trade, although its name is often misspelled *X. helleri* (with only a single *i*, vs. correct spelling *X. hellerii*) in both scientific and hobbyist literature."

Fricke et al. (2019) list *Xiphophorus brevis*, *Xiphophorus guntheri*, *Xiphophorus jalapae*, *Xiphophorus rachovii*, and *Xiphophorus strigatus* as synonyms for *Xiphophorus hellerii*. All names were used in searching for information about this species.

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 hellerii*"

From Fricke et al. (2019):

"**Current status:** Valid as *Xiphophorus hellerii* Heckel 1848. Poeciliidae: Poeciliinae."

Size, Weight, and Age Range

From Froese and Pauly (2018):

"Max length : 14.0 cm TL male/unsexed; [Wischnath 1993]; 16.0 cm TL (female); common length : 2.8 cm TL male/unsexed; [Hugg 1996]"

Environment

From Nico et al. (2018):

"Inhabits fast-flowing streams and rivers around vegetation, and also lives in warm springs, ponds, and ditches (Miller et al. 2005)."

From Froese and Pauly (2018):

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

Climate/Range

From Froese and Pauly (2018):

"Tropical; 22°C - 28°C [Adelaide Aquariums 2004]; 26°N - 12°N"

Distribution Outside the United States

Native

From Nico et al. (2018):

"Middle America from Rio Nautla (= Rio Nantla), Veracruz, Mexico, to northwestern Honduras (Rosen 1960, 1979; Page and Burr 1991; Greenfield and Thomerson 1997; Miller et al. 2005)."

From Eschmeyer et al. (2018):

"Central America: Belize, Guatemala, Honduras, Mexico"

Introduced

From Nico et al. (2018):

"Widely introduced in locations worldwide, including Africa and Australia (Welcomme 1988)."

CABI (2018) list Australia, Canada, Hungary, Israel, Papua New Guinea, Puerto Rico, Singapore, South Africa, Sri Lanka, Hong Kong, Indonesia, Japan, Taiwan, Madagascar, Namibia, Zambia, Bahamas, Jamaica, Puerto Rico, Fiji, Guam, New Caledonia, and New

Zealand as places where *X. hellerii* has been introduced and is present. The source further lists Australia, Canada, Hungary, Israel, Papua New Guinea, Singapore, South Africa, and Sri Lanka as countries where it is established in the wild through natural reproduction.

Froese and Pauly (2019) report *X. hellerii* as established in Hong Kong, Jamaica, Japan, Madagascar, Martinique, Namibia, New Caledonia, New Zealand, Reunion, Guam, Fiji, Colombia, Taiwan, Bahamas, Israel, Sri Lanka, Papua New Guinea, Australia, and South Africa. Froese and Pauly (2019) report *X. hellerii* as probably established in India, Indonesia, Mauritius, Slovakia, Czech Republic, and Singapore.

According to Lincoln Barroso de Magalhães and Jacobi (2010), *X. hellerii* is established in Brazil.

Means of Introduction Outside the United States

CABI (2018) list biological control, intentional release, pet trade, and flooding as potential vectors for introduction.

Short Description

From Froese and Pauly (2018):

"Dorsal spines (total): 0; Dorsal soft rays (total): 11-14; Anal spines: 0; Anal soft rays: 8 - 10. This species is distinguished by having a medium to large swordtail with a long straight caudal appendage; midlateral stripe may be dusky or brownish (northern populations) or red; 2 additional reddish stripes may be present above midlateral line and one beneath; terminal segment of gonopodial ray 3 produced into a crescent-shaped hook and blade pointed distally; ray 4a curves strongly backward over the blade at an angle greater than 90°; distal serrae of ray 4p reduced in size and number and proximal serrae rather slender; terminal segment of ray 5a produced into a claw, several times larger than the distal serrae of ray 4p [Kallman et al. 2004]."

Biology

From Froese and Pauly (2018):

"Adults are found mainly in rapidly flowing streams and rivers, preferring heavily vegetated habitats [Wischnath 1993]. They occur in warm springs and their effluents, weedy canals and ponds [Page and Burr 1991] They feed on worms, crustaceans, insects and plant matter [Mills and Vevers 1989]. Used for genetics research [Robins et al. 1991]. Especially the red varieties are very popular aquarium fishes [Riehl and Baensch 1991]. Aquarium keeping: the males aggressive towards each other; minimum aquarium size 80 cm [BMELF 1999]."

Human Uses

From Froese and Pauly (2018):

"Fisheries: of no interest; aquarium: highly commercial"

Chapman et al. (1997) report that 150,053 individual *X. hellerii* were imported in the United States in October 1992, accounting for 1.0% of all ornamental fishes imported into the country in that month. Rixon et al. (2005) found *X. hellerii* in 17 of 20 pet and aquarium stores surveyed in the U.S. and Canada.

Diseases
From Froese and Pauly (2018):

"Fin-rot Disease (late stage), Bacterial diseases
Costia Disease, Parasitic infestations (protozoa, worms, etc.)
Dactylogyrus Gill Flukes Disease, Parasitic infestations (protozoa, worms, etc.)
Skin Flukes, Parasitic infestations (protozoa, worms, etc.)
Fin Rot (early stage), Bacterial diseases
Columnaris Disease (e.), Bacterial diseases
Skin Fungi (Saprolegnia sp.), Fungal diseases
Pseudomonas infection, Bacterial diseases
Bacterial Infections (general), Bacterial diseases
Aeromonosis, Bacterial diseases
Velvet Disease, Parasitic infestations (protozoa, worms, etc.)
Cryptobia Infestation, Parasitic infestations (protozoa, worms, etc.)
Metacercaria Infection (Flatworms), Parasitic infestations (protozoa, worms, etc.)
Fungal Infection (general), Fungal diseases
Viral Diseases (general), Viral diseases
Mexiconema Infestation, Parasitic infestations (protozoa, worms, etc.)"

No reported OIE-listed diseases.

Threat to Humans
From Froese and Pauly (2018):

"Potential pest"

3 Impacts of Introductions
From Nico et al. (2018):

"Largely unknown. The green swordtail has been implicated in the decline of the Utah sucker *Catostomus ardens* in a thermal spring in Wyoming (Courtenay et al. 1988). Green swordtails, 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):

"Several countries report adverse ecological impact after introduction."

From CABI (2018):

"Although much literature has considered the invasive potential and ecological impacts of *X. hellerii* (e.g. McKay, 1978; Arthington, 1991; Arthington et al., 1999; Bomford and Glover, 2004; Corfield et al., 2007), the ecological impacts are poorly understood (Arthington and Lloyd, 1989; Arthington, 1991) and specific mechanisms have not been clearly defined. An example is the difficulty of dissociating the effects of habitat and hydrological changes compared with the effects of *X. hellerii* on indigenous fauna in Queensland (Milton and Arthington, 1983; Arthington et al., 1990)."

"While the specific ecological impacts of *X. hellerii* may be unclear, research from locations including Australia (McKay, 1978; Arthington et al., 1983), Hawaii (Englund, 1999), Hong Kong (Dudgeon and Corlett, 1994), Israel (Goren and Galil, 2005) and the USA (Courtenay et al., 1988) suggests that when *X. hellerii* occurs in high numbers, and particularly in sympatry with other introduced poeciliids (*Gambusia*, *Poecilia* or *Xiphophorus spp.*), impacts are observed on aquatic ecosystems."

"A negative synergistic effect may exist between introduced *X. hellerii* and *G. holbrooki* in Queensland, as where both species co-exist in large numbers native fishes are rare of absent, particularly surface-dwelling species (McKay, 1978, 1984; Arthington et al., 1983; Arthington, 1989a, 1991). Similar observations have been made in Israel where *X. hellerii* and *Gambusia affinis* co-occur and indigenous fish are depressed (Goren and Galil, 2005). Similarly, Courtenay et al. (1988) implicated *P. reticulata* and *X. hellerii* in the decline of the Utah sucker (*Catostomus arden*) in a thermal Spring in northwestern Wyoming. Controlled laboratory trials with *X. hellerii*, *G. holbrooki* and two small, Australian native fishes demonstrated increased aggression and resource competition with both poeciliids present (Warburton and Madden, 2003)."

"Other potential ecological impacts of *X. hellerii* may include the consumption fish eggs and/or juveniles of indigenous fishes (Mackenzie et al., 2001) and predation upon invertebrate communities, which may also indirectly affect the food resources of native fishes (Arthington and McKenzie, 1997), and therefore the aquatic food web as a whole."

From GISD (2018):

"*Xiphophorus helleri* is native to Central America. A very popular aquarium fish, it has been introduced to many countries around the world. Although *Xiphophorus hellerii* is rarely documented, its introduction into the natural environment has probably resulted in ecological consequences on native fish species."

4 Global Distribution

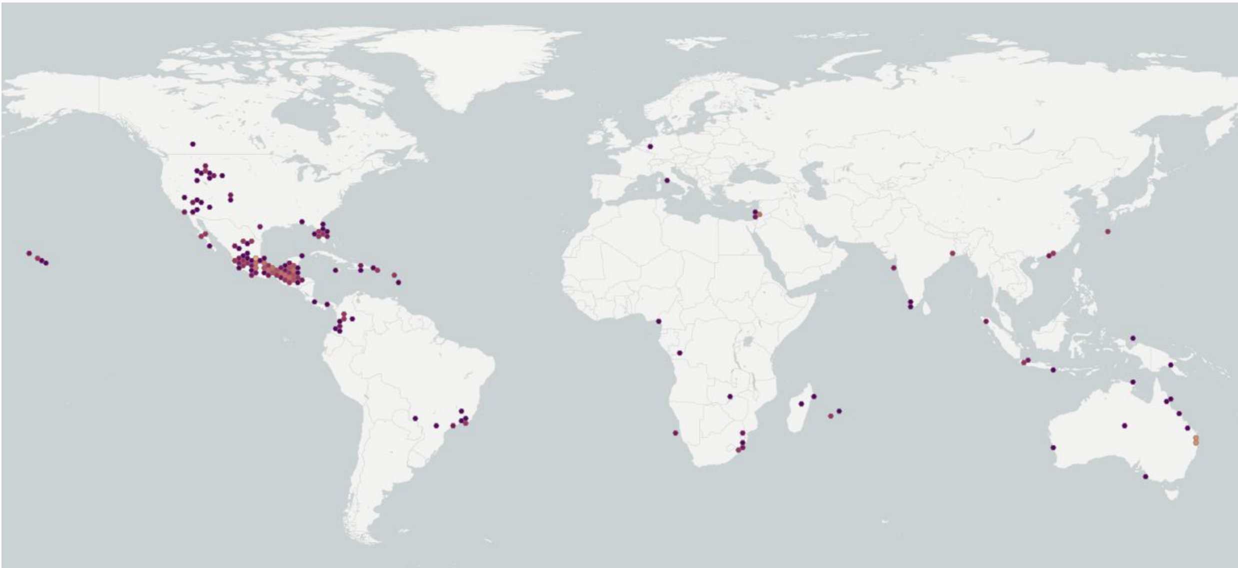

Figure 1. Known global distribution of *Xiphophorus hellerii*. Map from GBIF Secretariat (2019). Occurrences reported in the Dominican Republic, Guadeloupe, Martinique, Costa Rica, Panama, Germany, Italy, Cameroon, Democratic Republic of the Congo, and Zambia were excluded from the climate matching analysis because these countries have not been reported as having one or more established populations of *X. hellerii*. The occurrence reported in Canada was excluded from the climate matching analysis because it is located within a hot spring, where climatic conditions are not representative of the local climate overall. No georeferenced occurrences are available for portions of the species established range in Bahamas, Czech Republic, Fiji, Guam, Hungary, New Caledonia, New Zealand, Singapore, Slovakia, Sri Lanka, and Taiwan.

5 Distribution Within the United States

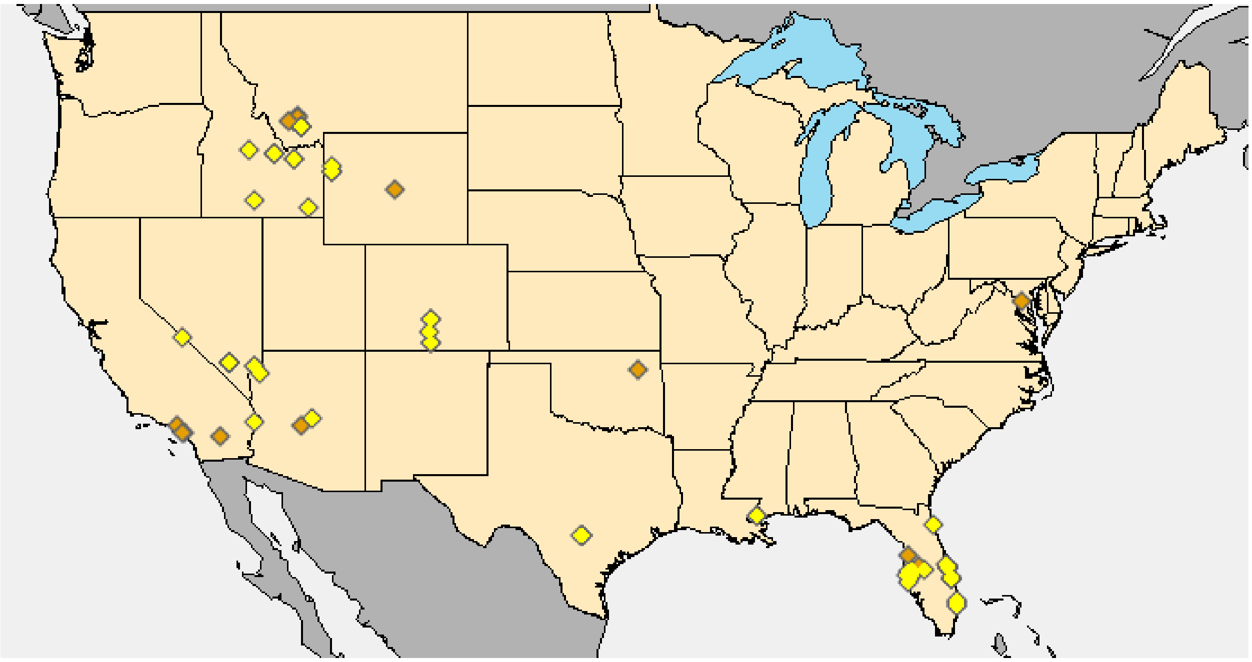

Figure 2. Distribution of *Xiphophorus hellerii* in the United States. Map from GBIF Secretariat (2018). The yellow diamonds represent established populations, while orange diamonds represent introductions. Only established populations are included in the climate match analysis.

6 Climate Matching

Summary of Climate Matching Analysis

The climate match (Sanders et al. 2018; 16 climate variables; Euclidean Distance) for *Xiphophorus hellerii* was high overall. The Climate 6 score for this species was 0.598. Scores of 0.103 and greater are classified as high. Locally, high matches exist in the coastal Southeast and Interior West, with medium matches in the Upper Midwest and Great Plains, and low matches in the Northeast, Appalachian Mountain range, and coastal Pacific Northwest.

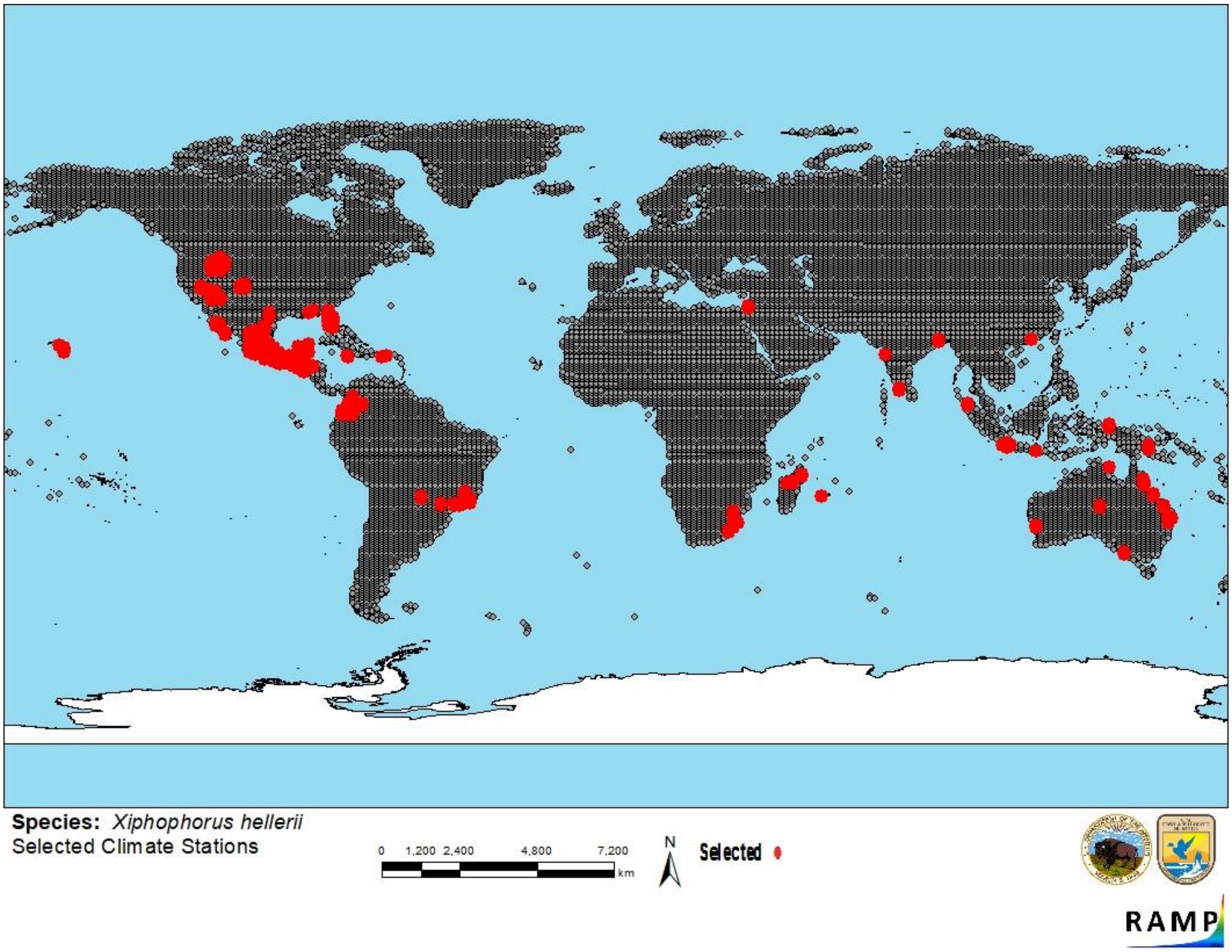

Figure 3. RAMP (Sanders et al. 2018) source map showing weather stations across the world selected as source locations (red; Canada, United States, Mexico, Belize, Honduras, El Salvador, Guatemala, Colombia, Jamaica, Israel, South Africa, Madagascar, India, China, Indonesia, Papua New Guinea, Australia) and non-source locations (gray) for *Xiphophorus hellerii* climate matching. Source locations from GBIF Secretariat (2019).

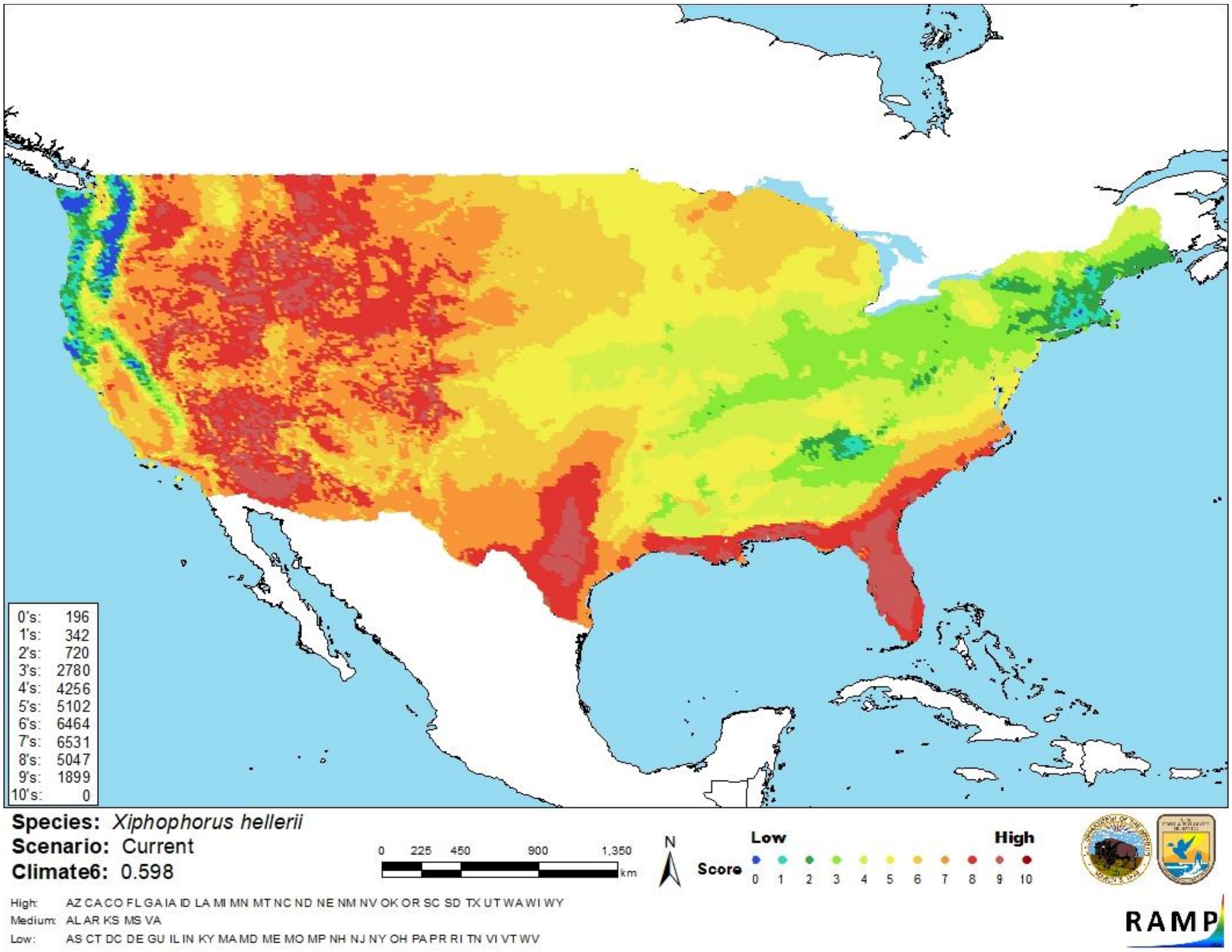

Figure 4. Map of RAMP (Sanders et al. 2018) climate matches for *Xiphophorus hellerii* in the contiguous United States based on source locations reported by GBIF Secretariat (2019). Counts of climate match scores are tabulated on the left. 0=Lowest match, 10=Highest match.

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 hellerii* is readily available for review. However, information on impacts from introduction of *X. hellerii* 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 *Xiphophorus hellerii* is low.

8 Risk Assessment

Summary of Risk to the Contiguous United States

Xiphophorus hellerii, Green Swordtail, is a fish native to Central America, including the countries of Belize, Guatemala, Honduras, and Mexico. It inhabits fast-flowing streams and rivers around vegetation, but can also thrive in warm springs, ponds, and ditches. This species has a wide distribution beyond its native range, with established populations in Asian, African, European, Caribbean, Oceanic, and North American countries. Within the United States, it is established, or possibly so, in Colorado, Florida, Hawaii, Idaho, Montana, Nevada, Texas, Wyoming, California, and Oklahoma. Many introductions have occurred through intentional release or escape from captivity, as this is a popular aquarium fish globally. The species has been associated with negative impacts in many locations where introduced, although its direct influence relative to other factors is unclear. It has been implicated in the decline of the Utah sucker *Catostomus ardens* in a thermal spring in Wyoming and the decline of native damselflies on Oahu, Hawaii. Some of these records may actually represent hybrids rather than pure *X. hellerii*. *X. hellerii* is also a carrier of numerous parasites and diseases that could negatively influence native species in nonnative waters where it is established. History of invasiveness is classified as “none documented.” The climate match to the contiguous United States was high overall. Due to the lack of clear and convincing evidence on impacts of introductions, the overall risk assessment category for *Xiphophorus hellerii* is uncertain.

Assessment Elements

- **History of Invasiveness (Sec. 3): None Documented**
- **Climate Match (Sec. 6): High**
- **Certainty of Assessment (Sec. 7): Low**
- **Remarks/Important additional information: Carrier of numerous bacterial infections, viruses, and parasitic infestations**
- **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 hellerii* [original text by Mark Maddern]. In Invasive Species Compendium. CAB International, Wallingford, UK. Available: https://www.cabi.org/isc/datasheet/59751. (March 2018).

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.

Fricke, R., W. N. Eschmeyer, and R. van der Laan, editors. 2019. Catalog of Fishes: genera, species, references. Available: http://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp. (November 2019).

Froese, R., and D. Pauly, editors. 2018, 2019. *Xiphophorus hellerii* Heckel, 1848. FishBase. Available: http://www.fishbase.se/summary/Xiphophorus-hellerii.html. (March 2018, November 2019).

GBIF Secretariat. 2019. GBIF backbone taxonomy: *Xiphophorus hellerii* Heckel, 1848. Global Biodiversity Information Facility, Copenhagen. Available: https://www.gbif.org/species/8246728. (November 2019).

GISD (Global Invasive Species Database). 2018. Species profile: *Xiphophorus hellerii*. IUCN Invasive Species Specialist Group, Gland, Switzerland. Available: http://www.iucngisd.org/gisd/speciesname/Xiphophorus+hellerii. (March 2018).

ITIS (Integrated Taxonomic Information System). 2018. *Xiphophorus hellerii* Heckel, 1848. Integrated Taxonomic Information System, Reston, Virginia. Available: https://www.itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=647013#null. (March 2018).

Lincoln Barroso de Magalhães, A., and C. M. Jacobi. 2010. E-commerce of freshwater aquarium fishes: potential disseminator of exotic species in Brazil. Acta Scientiarum. Biological Sciences 32(3):243-248.

Nico, L., P. Fuller, and M. Neilson. 2018. *Xiphophorus hellerii* Heckel, 1848: U.S. Geological Survey, Nonindigenous Aquatic Species Database, Gainesville, FL, https://nas.er.usgs.gov/queries/FactSheet.aspx?SpeciesID=869. (March 2018).

Rixon, C. A. M., I. C. Duggan, N. M. N. Bergeron, A. Ricciardi, and H. J. MacIsaac. 2005. Invasion risks posed by the aquarium trade and live fish markets on the Laurentian Great Lakes. Biodiversity and Conservation 14:1365-1381.

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

Seriously Fish. 2019. *Xiphophorus hellerii* – green swordtail. Available: https://www.seriouslyfish.com/species/xiphophorus-hellerii/. (November 2019).

10 References Quoted But Not Accessed

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

Adelaide Aquariums. 2004. Sword tail. Available: http://www.adelaideaquariums.com.au/Faqs/freshwater/fish/toothcarps/sword.html. (August 2004).

Arthington, A. H. 1989. Diet of *Gambusia affinis holbrooki*, *Xiphophorus helleri*, *X. maculatus* and *P. reticulata* (Pisces: Poeciliidae) in streams of south-eastern Queensland, Australia. Asian Fisheries Science 2:192-212.

Arthington, A. H. 1991. Ecological and genetic impacts of introduced and translocated freshwater fishes in Australia. Canadian Journal of Fisheries and Aquatic Sciences 48(1):33-43.

Arthington, A. H., S. Hamlet, and D. R. Bluhdorn. 1990. The role of habitat disturbance in the establishment of introduced warm-water fishes in Australia. Pages 61-66 *in* D. A. Pollard, editor. Introduced and translocated fishes and their ecological effects. Bureau of Rural Resources Proceedings No. 8. Australian Govt. Pub. Service, Canberra, Australia.

Arthington, A. H, P. J. Kailola, D. J. Woodland, J. M. Zalucki. 1999. Baseline environmental data relevant to an evaluation of quarantine risk potentially associated with the importation to Australia of ornamental finfish. Report to the Australian Quarantine and Inspection Service, Department of Agriculture, Fisheries and Forestry, Canberra, Australia. Available: http://www.aqis.gov.au/docs/qdu/Environmental-report.pdf

Arthington, A. H., and F. Mackenzie. 1997. Review of impacts of displaced/introduced fauna associated with inland waters. State of the Environment Technical Paper Series (Inland Waters). Department of the Environment, Canberra, Australia.

Arthington, A. H., D. A. Milton, and R. J. McKay. 1983. Effects of urban development and habitat alterations on the distribution and abundance of native and exotic freshwater fish in the Brisbane region, Queensland. Australian Journal of Ecology 8:87-101.

Axelrod, H. R., W. E. Burgess, N. Pronek, and J. G. Walls. 1985. Dr. Axelrod's atlas of freshwater aquarium fishes. Tropical Fish Hobbyist Publications, Inc., Neptune City, New Jersey.

Bomford, M., and J. Glover. 2004. Risk assessment model for the import and keeping of exotic freshwater and estuarine finfish. Bureau of Rural Sciences, Canberra, Australia.

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

Brown, C. J. D. 1971. Fishes of Montana. Montana State University, Bozeman, Montana.

BMELF (Bundesministerium für Ernährung, Landwirtschaft und Forsten). 1999. Gutachten über Mindestanforderungen an die Haltung von Zierfischen (Süßwasser). Bundesministerium für Ernährung, Landwirtschaft und Forsten (BMELF), Bonn, Germany.

Coots, M. 1956. The yellow perch, *Perca flavescens* (Mitchill), in the Klamath River. California Fish and Game 47(7):219-228.

Courtenay, W. R., Jr. 1985. Florida Atlantic University Quarterly Reports for 1985 to the U.S. Fish and Wildlife Service, Gainesville, Florida.

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., 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. John Hopkins University Press, Baltimore, Maryland.

Courtenay, W. R., Jr., D. A. Hensley, J. N. Taylor, and J. A. McCann. 1986. Distribution of exotic fishes in North America. Pages 675-698 *in* C. H. Hocutt, and E. O. Wiley, editors. The zoogeography of North American freshwater fishes. John Wiley and Sons, New York.

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., and C. R. Robins. 1973. Exotic aquatic organisms in Florida with emphasis on fishes: a review and recommendations. Transactions of the American Fisheries Society 102:1–12.

Courtenay, W. R., Jr., C. R. Robins, R. M. Bailey, and J. E. Deacon. 1988. Records of exotic fishes from Idaho and Wyoming. Great Basin Naturalist 47(4):523-526.

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.

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.

Deacon, J. E., C. Hubbs, and B. J. Zahuranec. 1964. Some effects of introduced fishes on the native fish fauna of southern Nevada. Copeia 1964(2):384-388.

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.

Dill, W. A., and A. J. Cordone. 1997. History and status of introduced fishes in California, 1871-1996. California Department of Fish and Game, Fish Bulletin 178:1-414.

Dudgeon, D., and R. Corlett. 1994. Hills and streams: an ecology of Hong Kong. Hong Kong University Press, Hong Kong.

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. The Johns Hopkins University Press, Baltimore, Maryland.

Goren, M., and B. S. Galil. 2005. A review of changes in the fish assemblages of Levantine inland and marine ecosystems following the introduction of non-native fishes. Journal of Applied Ichthyology 21:364-370.

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

Holton, G. D. 1990. A field guide to Montana fishes. Montana Department of Fish, Wildlife and Parks, Helena, Montana.

Howells, R. G. 1992. Annotated list of introduced non-native fishes, mollusks, crustaceans and aquatic plants in Texas waters. Texas Parks and Wildlife Department, Management Data Series 78, Austin, Texas.

Hubert, W. 1994. Exotic fish. Pages 158-174 *in* T.L. Parrish, and S.H. Anderson, editors. Exotic species manual. Wyoming Game and Fish Department, Laramie, Wyoming.

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

Idaho Department Fish and Game. 1990. Fisheries Management Plan 1991-1995. Appendix I: a list of Idaho fishes and their distribution by drainage. Idaho Fish and Game, Boise, Idaho.

Idaho Department of Fish and Game. 1996. Fisheries Management Plan 1996-2000. Idaho Department of Fish and Game, Boise, Idaho.

Kallman, K. D., R. B. Walter, D. C. Morizot and S. Kazianis, 2004. Two new species of *Xiphophorus* (Poeciliidae) from the Isthmus of Tehuantepec, Oaxaca, Mexico, with a discussion of the distribution of the *X. clemenciae* clade. American Museum Novitates 3441:1-34.

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

Lee, D. S., C. R. Gilbert, C. H. Hocutt, R. E. Jenkins, D. E. McAllister, and J. R. Stauffer, Jr. 1980 et seq. Atlas of North American freshwater fishes. North Carolina State Museum of Natural History, Raleigh, North Carolina.

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.

Mackenzie, R., P. Jackson, and E. Cotterell. 2001. Control of exotic pest fishes - an operation strategy for Qld [Queensland] freshwaters 2002-2005. Department of Primary Industries, Queensland, Australia.

McKay, R. J. 1978. The exotic freshwater fishes of Queensland. Australian National Parks and Wildlife Service, Canberra, Australia.

McKay, R. J. 1984. Introductions of exotic fishes in Australia. Pages 177-199 *in* W. R. Courtney Jr and J. R. Stauffer Jr, editors. Distribution, biology and management of exotic fishes. John Hopkins University Press, Baltimore, Maryland.

Mearns, A. J. 1975. *Poeciliopsis gracilis* (Hackel), a newly introduced poeciliid fish in California. California Fish and Game 61(4):251-253.

Miller, R. R., W. L. Minckley, and S. M. Norris. 2005. Freshwater fishes of Mexico. The University of Chicago Press.

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

Minckley, W. L. 1973. Fishes of Arizona. Arizona Fish and Game Department. Sims Printing Company, Inc., Phoenix, Arizona.

Moyle, P. B. 1976. Inland fishes of California. University of California Press, Berkeley, California.

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.

Nelson, J. S., E. J. Crossman, H. Espinosa-Perez, L. T. Findley, C. R. Gilbert, R. N. Lea, and J. D. Williams. 2004. Common and scientific names of fishes from the United States, Canada and Mexico, sixth edition. American Fisheries Society Special Publication 29. Bethesda, Maryland.

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, England.

Pigg, J., R. Gibbs, and T. Beard. 1996. Observations on two exotic fish species in Oklahoma. Proceedings of the Oklahoma Academy of Sciences 1996:90.

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

Robins, C. R., R. M. Bailey, C. E. Bond, J. R. Brooker, E. A. Lachner, R. N. Lea and W. B. Scott. 1991. World fishes important to North Americans. Exclusive of species from the continental waters of the United States and Canada. American Fisheries Society Special Publication 21:243.

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.

St. Amant, J. A. 1970. Addition of Hart's rivulus, *Rivulus harti* (Boulenger), to the California fauna. California Fish and Game 56(2):138.

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.

Stone, M. D. 1995. Fish stocking programs in Wyoming: a balanced perspective. Pages 47-51 *in* H.L. Schramm, Jr., and R.G. Piper, editors. Uses and effects of cultured fishes in aquatic ecosystems. American Fisheries Society Symposium 15.

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.

Tilmant, J. T. 1999. Management of nonindigenous aquatic fish in the U.S. National Park System. National Park Service.

Vinyard, G. L. 2001. Fish species recorded from Nevada. Biological Resources Research Center, University of Nevada, Reno, Nevada.

Warburton, K., and C. Madden. 2003. Behavioural responses of two native Australian fish species (*Melanotaenia duboulayi* and *Pseudomugil signifer*) to introduced poeciliids (*Gambusia holbrooki* and *Xiphophorus helleri*) in controlled conditions. Proceedings of the Linnean Society of New South Wales 124:115-123.

Watters, T. G., and S. H. O'Dee. 1998. Metamorphosis of freshwater mussel glochidia (Bivalvia: Unionidae) on amphibians and exotic fishes. American Midland Naturalist 139:49-57.

Welcomme, R. L. 1988. International introductions of inland aquatic species. FAO Fisheries Technical Paper 294. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.

Wischnath, L. 1993. Atlas of livebearers of the world. T.F.H. Publications, Inc., New Jersey.

Williams, J. D., D. P. Jennings, and D. C. Haney. 1992. Exotics in the Indian River Lagoon system. National Biological Survey, Gainesville, Florida. Unpublished manuscript.

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.

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