

# Oriental Weatherfish (*Misgurnus anguillicaudatus*) Ecological Risk Screening Summary

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Photo: W. Aguirre

## 1 Native Range and Nonindigenous Occurrences

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### Native Range

From Nico et al. (2012):

“Eastern Asia (Berg 1949; Masuda et al. 1984; Talwar and Jhingran 1992).”

### Nonindigenous Occurrences

From Nico et al. (2012):

“Recently collected from Porthouse Branch, a tributary of the Coosa River in Talladega County, **Alabama** (B. Kuhajda, personal communication). Specimens were collected from a three-mile reach of the Westminster flood control channel in Orange County, **California**, in 1968 (St. Amant and Hoover 1969). Additional established populations were discovered upstream from the original collection sites in 1977 and in the adjacent Bolsa Chica Channel in 1979 (Shapovalov et al. 1981). It has also been recorded for Huntington Beach, Orange County, and in tributaries to the Salton Sea, Riverside County, California (e.g., Courtenay et al. 1986; Page and Burr 1991). In **Florida**, this species has been found in the Little Manatee River drainage since about 1988 (L. G. Nico, unpublished data); and more recently in other areas in the Peace drainage (Charlotte Harbor NEP 2004); and in the Myakka River in 2003 (Lemon, personal communication). The species was introduced into **Hawaii** prior to 1900 (Brock 1960); it now occupies primarily stream habitats in Kauai, Maui, and Oahu (Maciolek 1984; Devick 1991a, 1991b). Specimens have been found in the Harton Davis Canal, in an irrigation ditch at Eagle State Park, in the

Boise River system, Ada County, **Idaho**, since the mid 1980s (Courtenay et al. 1986; Idaho Fish and Game 1990). It has been found in the North Shore Channel, Cook County, Lake Michigan drainage, **Illinois**, since 1987, and in the Chicago Sanitary and Ship Canal in 1994 (Page and Laird 1993; Burr et al. 1996; Laird and Page 1996; Thiel, personal communication). Recently found in the Grand Calumet River and the Indiana Harbor Canal near Hammond, **Indiana** (Simon et al. 2006). Several specimens including YOY were collected near Lacombe, **Louisiana**, just downstream of a fish farm (K. Piller, pers. comm. 2005). Recently (2007-2009) collected in Gwynns Falls and the Patapsco River, **Maryland** (Ashton and Ciccotto 2010). This species was collected in headwaters of the Shiawassee River, in Oakland and Genessee counties, **Michigan**, in 1958 and 1959 where it was considered to be established (Schultz 1960). Recently established near the Celery Farm Natural Area in Allendale, **New Jersey**. Two populations of weatherfish are present in **New York**. One is located in western New York and has been present for several years; the other is located in southeastern New York and was discovered in 2009 (L. Supernant and P. McKeown, pers. comm.). Two Oriental weatherfish were collected in the Haw system, **North Carolina**, in 2009 (B. Tracy and W. Starnes, pers. comm.). The species has been reported from a diked secondary channel of the Clackamas River, **Oregon**, since the mid 1980s; it was found in the Malheur, Owyhee, and Snake River systems in 1995 (Logan et al. 1996). Several specimens were also collected in 1997 from Burlington Bottoms near the Multnomah Channel of the Columbia River (N. Bowers, personal communication), and farther downstream from Scappoose Bay on the Columbia River in 1994 (L. Pierce, personal communication; Beaton, personal communication). This species is known from **Tennessee** where it was collected in a tributary of Coffee Creek, near the Hiwassee River, Polk County, in April 1995 (D. Etnier, personal communication). Present in Lake Washington in Seattle, **Washington**, since the mid-1990s (K. Aitkin and R. Tabor, personal communication; Tabor et al. 2001). Recently collected in Tulalip Creek, near Marysville, Washington (DeLong 1999).”

## Means of Introductions

From Nico et al. (2012):

“California populations were apparently descended from individuals that had escaped from a local goldfish farm, possibly as early as the 1930s (St. Amant and Hoover 1969). Similarly, populations in the upper Shiawassee River system, Michigan, were believed to have descended from individuals imported from Kobe, Japan, that had escaped from a nearby aquarium supply company in Oakland County before 1951 and possibly as early as about 1939 (Schultz 1960; Courtenay et al. 1984). In Hawaii, the species was presumably introduced by Asian immigrants during the 1800s, probably to serve as a source of food (Maciolek 1984; Devick 1991b). Brock (1960) stated that its use as bait for fish was apparently instrumental in its spread in Hawaii. Collections in Louisiana were the result of escapes from a fish farm. Introductions into other states were presumably the result of aquarium releases.”

## Remarks

From Nico et al. (2012):

“Established in Shiawassee River and L. Michigan (U.S.EPA 2008). Established in California, Florida, Hawaii, Idaho, Illinois, Michigan, New York, Oregon, and Washington, and possibly in Louisiana. Reported from Tennessee and North Carolina.”

“In addition to appearing in the aquarium trade, *M. anguillicaudatus* has been introduced into several parts of the world for aquaculture purposes and as a bait fish (Welcomme 1988). It is considered a cool-water species (Welcomme 1988); individuals burrow into soft substrates and tolerate low oxygen conditions by breathing atmospheric air (Sterba 1973). As its name suggests, this fish becomes more active in response to changes in barometric pressure; thus it frequently has been cited as a harbinger of storms (Sterba 1973; Axelrod et al. 1985). There is concern that if *M. anguillicaudatus* becomes more abundant and spreads, it will reduce populations of aquatic insects important as food to native fishes (Page and Laird 1993). Maciolek (1984) categorized *Misgurnus* along with several other introduced fishes as species having an intermediate impact on Hawaiian streams, this conclusion based on their preferred habitat and diet and on their numbers. The Bolsa Chica Channel, California, cited by Shapovalov et al. (1981), likely represents the Huntington Beach, Orange County site reported by other authors (e.g., Courtenay et al. 1986; Page and Burr 1991).”

## 2 Biology and Ecology

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### Taxonomic Hierarchy and Taxonomic Standing

From ITIS (2012):

Kingdom Animalia  
  Phylum Chordata  
    Subphylum Vertebrata  
      Superclass Osteichthyes  
        Class Actinopterygii  
          Subclass Neopterygii  
            Infraclass Teleostei  
              Superorder Ostariophysi  
                Order Cypriniformes  
                  Superfamily Cobitoidea  
                    Family Cobitidae  
                      Subfamily Cobitinae  
                        Genus *Misgurnus* Lacepède, 1803 – weatherfishes  
                          Species *Misgurnus anguillicaudatus* – oriental weatherfish

## **Size, Weight, Age**

From Froese and Pauly (2010):

“Max length: 28.0 cm SL male/unsexed; (Kottelat and Freyhof 2007); common length: 15.0 cm TL male/unsexed; (Hugg 1996).”

## **Environment**

From Froese and Pauly (2010):

“Demersal; freshwater; depth range 5 - ? m (Kottelat 1998).”

## **Climate/Range**

“From Froese and Pauly (2010):

Subtropical; 5°C - 25°C (Baensch and Riehl 1985); 53°N - 27°S.”

## **Distribution**

From Froese and Pauly (2010):

“Asia: Native to Siberia (Tugur and Amur drainages), Sakhalin, Korea, Japan, China south to northern Vietnam. Europe: Introduced in several localities in Rhine (Germany) and Ticino (Italy, north of Milano) drainages, Aral Sea basin, North America, Australia and Hawaii. This species proved successful in the aquarium fish trade and has also been introduced to other countries (Yamamoto and Tagawa 2000). At least one country reports adverse ecological impact after introduction.”

## **Short description**

From Froese and Pauly (2010):

“Dorsal view shows the male with larger pectoral fins and the female with fuller abdomen (Yamamoto and Tagawa 2000). Body is mottled with darker greenish-gray to dark brown markings, against a yellow-brown to brown color; conspicuous adipose crests along the ventral and dorsal mid-lines of the caudal peduncle; 10 barbels; suborbital spine hidden in the skin (Kottelat 1998).”

## **Biology**

From Froese and Pauly (2010):

“Found in rivers, lakes and ponds. Also in swamps and rice fields (Kottelat 1998, Allen et al. 2002). Adults prefer still or gently flowing water (Allen et al. 2002), also the muddy bottoms, where they hide in the muck and leaf litter with only their heads sticking out; also found in muddy bottoms of streams and ponds; in Hawaii, can also be found under mats of honohono

(*Commelina diffusa* and California grass (*Brachiara nautica*). Feed on worms, small crustaceans, insects, insect larvae, and other small aquatic organisms (Yamamoto and Tagawa 2000). Benthic (Mundy 2005). Can tolerate temperatures between 2 and 30°C, and can breathe air to supplement respiratory requirements in oxygen-depleted waters. Commonly used by anglers as live bait, so escapes may also have contributed to their spread (Allen et al. 2002).”

## Human uses

From Froese and Pauly (2010):

“Fisheries: commercial; aquaculture: commercial; aquarium: commercial; bait: occasionally.”

## Diseases

From Froese and Pauly (2010):

“Yellow Grub, Parasitic infestations (protozoa, worms, etc.)  
Turbidity of the Skin (Freshwater fish), Parasitic infestations (protozoa, worms, etc.)  
Bacterial Infections (general), Bacterial diseases  
Hidden Viral Infection, Viral diseases  
Viral Diseases (general), Viral diseases”

## Threat to humans

From Froese and Pauly (2010):

“Potential pest.”

## 3 Impacts of Introductions

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From: Nico et al. (2012):

“It may reduce populations of aquatic insects important as food to native fishes (U.S.EPA 2008).”

From: Global Invasive Species Database (2005):

“*Misgurnus anguillicaudatus* was found to cause significant reductions in macroinvertebrate numbers and biomass in experimental conditions. It is also associated with elevated ammonia, nitrate/nitrite (NO<sub>x</sub>), and turbidity levels, having a similar effect on water quality as carp (*Cyprinus carpio*). There is concern that *M. anguillicaudatus* may impact native fishes by reducing populations of macroinvertebrate prey, competing for shelter and spawning sites, and preying on eggs and juveniles. Such impacts combined with its environmental adaptability, high competitive ability, high reproductive capacity, high survivorship, and high dispersal ability make it a potentially problematic invasive. In Hawaii it is reported as having an intermediate

ecological effect in Hawaii based on its habitat, diet, and populations (Keller & Lake 2007; Koster et al, 2002; Freyhoff & Korte, 2005; Nico et al. 2012).”

From: Burchmore et al. (1989)

“Accidentally released by aquarists into Lake Burley Griffin, and in Yarra and Owens rivers. Established in the local streams around Canberra, Sydney, New South Wales and in Victoria. The species was banned from import to Australia as an aquarium fish due to its documented feral habits.”

From: Oregon Department of Fish and Wildlife (2012):

“Potentially, weatherfish could impact native species by predation and competition for food and habitat.”

From: Tabor et al. (2001)

“The impact of oriental weatherfish introductions on aquatic ecosystems has received little attention. In Hawaii, they were categorized as having intermediate impacts to native stream fauna because of their preferred habitat, food habits, and abundance (Maciolek 1984). In some areas oriental weatherfish introductions have been considered beneficial (Welcomme 1984) because they can be used as a food fish or used for mosquito control (Kim et al. 1994). Due to possible impacts to native fishes and other organisms in Australia, the government made the importation of oriental weatherfish illegal in 1986 (Lintermans and Rutzou 1990; Dove and Ernst 1998). Presently, fishery managers have speculated on possible impacts but little data is available. Possible interactions include introduction of fish parasites (Dove and Ernst 1998), competition for food or space, predation of fish eggs, or some type of indirect effect by restructuring the aquatic ecosystem.”

From Invasive Species Compendium (2011):

“Impact: Environmental

#### Impact on Biodiversity

This species can impact native species through direct predation and through transmission of diseases (Logan et al., 1996). *M. anguillicaudatus* are of special concern because they possess many of the characteristics of previous successful invaders. They have broad tolerance for physiological parameters, low vulnerability to predation, a flexible diet, and a high reproductive potential (Logan et al., 1996).

#### Risk and Impact Factors

##### Invasiveness

Has a broad native range

Has high reproductive potential

Highly adaptable to different environments

Impact outcomes

Threat to/ loss of native species

Impact mechanisms

Pest and disease transmission

Predation

Likelihood of entry/control

Highly likely to be transported internationally deliberately.”

## 4 Global Distribution

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**Figure 1.** Global distribution of *M. anguillicaudatus*. Map from GBIF (2010).

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## 5 Distribution within the United States



Figure 2. US distribution of *M. anguillicaudatus*. Map from Nico et al. (2012).

## 6 CLIMATCH

### Summary of Climate Matching Analysis

The climate match (Australian Bureau of Rural Sciences 2010, 16 climate variables; Euclidean Distance) was high throughout the US except for Southern California and extreme high elevations. Climate 6 match indicated that the US has a high climate match. The range for a high climate match is 0.103 and greater, climate match of *M. anguillicaudatus* is 0.833.

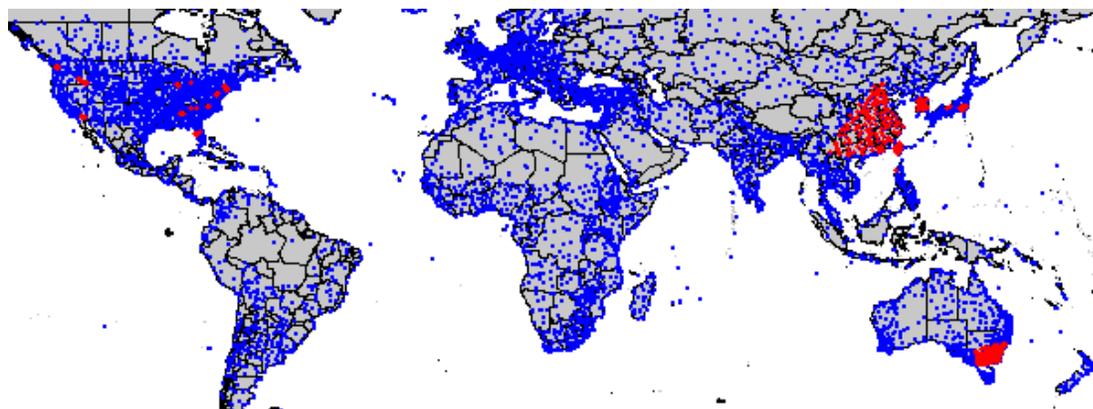
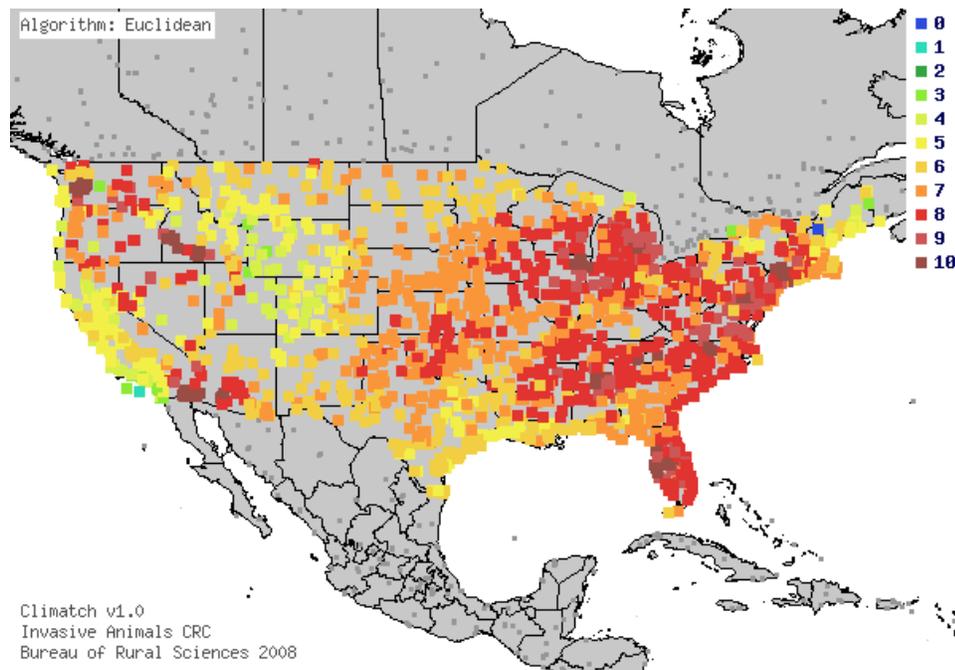


Figure 3. CLIMATCH (Australian Bureau of Rural Sciences 2010) source map showing weather stations selected as source locations (red) and non-source locations (blue) for *M. anguillicaudatus* climate matching. Source locations from GBIF (2010) and Nico et al. (2012). Only established locations were used.



**Figure 4.** Map of CLIMATCH (Australian Bureau of Rural Sciences 2010) climate matches for *M. anguillicaudatus* in the continental United States based on source locations reported by GBIF (2010) and Nico et al. (2012). 0= Lowest match, 10=Highest match.

**Table 1.** CLIMATCH (Australian Bureau of Rural Sciences 2010) climate match scores

CLIMATCH Score	0	1	2	3	4	5	6	7	8	9	10
Count	1	1	0	18	84	225	390	511	532	120	92
Climate 6 Proportion =			0.833 (High)								

## 7 Certainty of Assessment

Information on the biology of this species is fairly abundant. However, while information on the impacts caused by introduction of this species is available, in order for higher certainty more research is needed. Certainty of this assessment is medium.

## 8 Risk Assessment

### Summary of Risk to the Continental United States

*M. anguillicaudatus* has been established in the US and many other countries worldwide and is continually expanding. There is a high risk of additional introductions, establishment, and impacts in other areas because this species is highly adaptable, quick to reproduce, and is extremely popular in the aquaculture and aquarium industry. Multiple authors have found that this species has caused reductions in macroinvertebrate populations, altered aquatic habitats, and

are vectors for certain fish parasites. Due to the impacts from introduction of this species into Australia, importation of this species was banned in 1986. Climate match with the US is high, with very high readings surrounding the Great Lakes.

## Assessment Elements

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

## 9 References

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

Australian Bureau of Rural Sciences. CLIMATCH. 2010. <http://adl.brs.gov.au:8080/Climatch>. (July 20, 2010)

Burchmore, J., R. Faragher, and G. Thorncraft. 1989. Occurrence of the introduced oriental weather loach (*Misgurnus anguillicaudatus*) in the Wingecarribee River, New South Wales. p. 38-46. In D.A. Pollard (ed.) Introduced and translocated fishes and their ecological effects. Proceedings of the Australian Society for Fish Biology Workshop No. 8. Magnetic Island. 24-25 August 1989.

Froese, R. and D. Pauly. Editors. 2010. FishBase. World Wide Web electronic publication. [www.fishbase.org](http://www.fishbase.org), version (04/2010). (<http://www.fishbase.org/Summary/speciesSummary.php?ID=3016>)

GBIF (Global Biodiversity Information Facility). 2010. (<http://data.gbif.org/species/13536482/>; accessed on July 20, 2010).

Global Invasive Species Database (ISSG), 2005. *Misgurnus anguillicaudatus*. Available from: <http://www.issg.org/database/species/ecology.asp?si=1537>. January 2012.

Invasive Species Compendium (CABI). 2011. CAB International, Wallingford, UK, 2011. <http://www.cabi.org/isc/?compid=5&dsid=75075&loadmodule=datasheet&page=481&site=144>. (January 2012).

ITIS (Integrated taxonomic information system). 2011. Available: [http://www.itis.gov/servlet/SingleRpt/SingleRpt?search\\_topic=TSN&search\\_value=163978](http://www.itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=163978) (Accessed August 21, 2012).

Nico, L., P. Fuller, M. Neilson, J. Larson, and A. Fusaro. 2012. *Misgurnus anguillicaudatus*. USGS Nonindigenous Aquatic Species Database, Gainesville, FL.

Oregon Department of Fish and Wildlife. 2012. Invasive Species - *Oriental Weatherfish*. [http://www.dfw.state.or.us/conservationstrategy/invasive\\_species/oriental\\_weatherfish.asp](http://www.dfw.state.or.us/conservationstrategy/invasive_species/oriental_weatherfish.asp). (January 2012).

Tabor, R. A., E. Warner, and S. Hager. 2001. An oriental weatherfish (*Misgurnus anguillicaudatus*) population established in Washington state. *Northwest Science* 75(1): 72-76.

## 10 References Quoted But Not Accessed

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**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.**

Aitkin, K. [*Personal communication - Source material did not give full citation for this reference*]

Allen, G.R., S.H. Midgley and M. Allen. 2002. Field guide to the freshwater fishes of Australia. Western Australian Museum, , Perth, Western Australia. 394 p.

Ashton, M., and P. Ciccotto. 2010. First records of oriental weatherfish (*Misgurnus anguillicaudatus*) in Maryland. *Northeastern Naturalist* 17:671-672.

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, NJ.

Baensch, H.A. and R. Riehl. 1985. Aquarien atlas. Band 2. Mergus, Verlag für Natur- und Heimtierkunde GmbH, Melle, Germany. 1216 p.

Beaston. [*Personal communication - Source material did not give full citation for this reference*]

Bowers, N. [*Personal communication - Source material did not give full citation for this reference*]

Berg, L. S. 1949. Freshwater fishes of the U.S.S.R. and adjacent countries, 4th edition. Three volumes. Translated from Russian, 1962-1965, for the Smithsonian Institution and the National Science Foundation, by Israel Program for Scientific Translations, Jerusalem, Israel. Volume 1:504 pp.; volume 2:496 pp.; volume 3:510 pp.

- Brock, V. E. 1960. The introduction of aquatic animals into Hawaiian waters. *Internationale Revue der Gestamen Hydrobiologie* 45:463-480.
- Burr, B. M., D. J. Eisenhour, K. M. Cook, c. A. Taylor, G. L. Seegert, R. W. Sauer, and E. R. Atwood. 1996. Nonnative fishes in Illinois waters: what do the records reveal? *Transactions of the Illinois State Academy of Science* 89:73-91.
- Charlotte Harbor NEP. 2004. Minutes of the Technical Advisory Committee, Habitat Conservation Subcommittee. February 19, 2004, Punta Gorda.
- 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, MD.
- 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, NY.
- DeLong, J. 1999. The Great NANFA Loach Hunt of '99. Available:  
[http://www.nanfa.org/NANFAregions/or\\_wa/Loach99/LoachHunt99.htm](http://www.nanfa.org/NANFAregions/or_wa/Loach99/LoachHunt99.htm)
- Devick, W. S. 1991a. Disturbances and fluctuations in the Wahiawa Reservoir ecosystem. Project F-14-R-15, Job 4, Study I. Division of Aquatic Resources, Hawaii Department of Land and Natural Resources. 21 pp.
- Devick, W. S. 1991b. 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.
- Dove, A.D.M., I. Ernst. 1998. Concurrent invaders—four exotic species of Monogenea now established on exotic freshwater fishes in Australia. *International Journal for Parasitology*. 28 (11). Pages 1755-1764.
- Etnier, D. [*Personal communication - Source material did not give full citation for this reference*]
- Freyhof, J., and Korte, E. 2005. The first record of *Misgurnus anguillicaudatus* in Germany. *Journal of Fish Biology*. 66(2). February 2005. 568-571.

- Hugg, D.O. 1996. MAPFISH georeferenced mapping database. Freshwater and estuarine fishes of North America. Life Science Software. Dennis O. and Steven Hugg, 1278 Turkey Point Road, Edgewater, Maryland, USA.
- Idaho 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.
- Keller, R.P. and P.S. Lake. 2007. Potential impacts of a recent and rapidly spreading coloniser of Australian freshwaters: Oriental weatherloach (*Misgurnus anguillicaudatus*). Ecology of Freshwater Fish. 16(2). JUN 2007. 124-132.
- Kim, H. C., M.S. Kim., H.S. Yu. 1994. Biological control of vector mosquitoes by the use of fish predators, *Morone oxycephalus* and *Misgurnus anguillicaudatus* in the laboratory and semi-field rice paddy. Korean Journal of Entomology. 24(4) pp. 269-284.
- Koster, et. Al. 2002. *[Source material did not give full citation for this reference]*
- Kottelat, M. 1998. Fishes of the Nam Theun and Xe Bangfai basins, Laos, with diagnoses of twenty-two new species (Teleostei: Cyprinidae, Balitoridae, Cobitidae, Cobiidae and Odontobutidae). Ichthyol. Explor. Freshwat. 9(1):1-128.
- Kottelat, M. and J. Freyhof. 2007. Handbook of European freshwater fishes. Publications Kottelat, Cornol, Switzerland. 646 p.
- Kuhajda, B. *[Personal communication - Source material did not give full citation for this reference]*
- Laird, C. A. and L. M. Page. 1996. Non-native fishes inhabiting the streams and lakes of Illinois. Illinois Natural History Survey Bulletin 35(1):1-51.
- Lemon. *[Personal communication - Source material did not give full citation]*
- Lintermans, M., and T. Rutzou. 1990. The fish fauna of the upper Cotter River catchment. ACT Parks and Conservation Service Canberra, Research Report No. 4.
- Logan D.J., E.L. Bibles, and D.F. Markle. 1996. Recent collections of exotic aquarium fishes in the freshwaters of Oregon and thermal tolerance of oriental weatherfish and pirapatinga. California Fish and Game, 82(2):66-80.
- Maciulek, 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, MD.
- Masuda, H., K. Amaoka, C. Araga, T. Uyeno, and T. Yoshino, editors. 1984. The fishes of the Japanese Archipelago. Tokai University Press. Text: i-xxii + 437 pp.; atlas: pls. 1-370.

- McKeown, P. ***[Personal communication - Source material did not give full citation for this reference]***
- Mundy, B.C. 2005. Checklist of the fishes of the Hawaiian Archipelago. Bishop Museum Bulletins in Zoology. Bishop Mus. Bull. Zool. (6):1-704.
- 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, MA.
- Page, L. M., and C. A. Laird. 1993. The identification of the nonnative fishes inhabiting Illinois waters. Report prepared by Center for Biodiversity, Illinois Natural History Survey, Champaign, for Illinois Department of Conservation, Springfield. Center for Biodiversity Technical Report 1993(4). 39 pp.
- Pierce, L. ***[Personal communication - Source material did not give full citation]***
- Piller, K. 2005. ***[Personal communication - Source material did not give full citation]***
- Schultz, E. E. 1960. Establishment and early dispersal of a loach, *Misgurnus anguillicaudatus* (Cantor), in Michigan. Transactions of the American Fisheries Society 89(4):376-377.
- Shapovalov, L., A. J. Cordone, and W. A. Dill. 1981. A list of freshwater and anadromous fishes of California. California Fish and Game 67(1):4-38.
- Simon, T. P., G. Bright, F. Veraldi, J. R. Smith, and J. R. Stahl. 2006. New records for the alien Oriental weatherfish, *Misgurnus anguillicaudatus*, in the Lake Michigan basin, Indiana (Cypriniformes: Cobitidae). Proceedings of the Indiana Academy of Science 115(1):32-36.
- 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.
- Starnes, W. ***[Personal communication - Source material did not give full citation]***
- Sterba, G. 1973. Freshwater fishes of the world. English translation and revision from German. Two volumes. Tropical Fish Hobbyist Publications, Inc., Neptune City, NJ.
- Supernant, L. ***[Personal communication - Source material did not give full citation]***
- Tabor, R. ***[Personal communication - Source material did not give full citation]***
- Talwar, P. K., and A. G. Jhingran, editors. 1992. Inland fishes of India and adjacent countries. A. A. Balkema, Rotterdam, The Netherlands. Two volumes.

Thiel, [*Personal communication - Source material did not give full citation*]

Tracy, B. [*Personal communication - Source material did not give full citation*]

U.S. EPA (Environmental Protection Agency). 2008. Predicting future introductions of nonindigenous species to the Great Lakes. National Center for Environmental Assessment, Washington, DC; EPA/600/R-08/066F. Available from the National Technical Information Service, Springfield, VA, and <http://www.epa.gov/ncea>.

Welcomme, R.L. 1984. International transfers of inland fish species., p. 22-40. In W.R. Courtenay, Jr. and J.R. Stauffer, Jr. (eds.) Distribution, biology and management of exotic fishes. Johns Hopkins University Press, Baltimore, USA.

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. 318 pp.

Yamamoto, M.N. and A.W. Tagawa. 2000. Hawai'i's native and exotic freshwater animals. Mutual Publishing, Honolulu, Hawaii. 200 p.