Pond Loach (*Misgurnus anguillicaudatus*)
Ecological Risk Screening Summary

U.S. Fish and Wildlife Service, March 2024
Revised, May 2025
Web Version, 7/21/2026

Organism Type: Fish
Overall Risk Assessment Category: Uncertain


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1 Native Range and Status in the United States

Native Range

From Nico et al. (2024):

"Eastern Asia from Siberia south to northern Vietnam, including Japan (Berg 1949; Masuda et al. 1984; Talwar and Jhingran 1992)."

From Top-Karakuş and Karakuş (2022):

"*Misgurnus anguillicaudatus* is native to East Asian temperate regions, including Cambodia, China, India, Japan, Korea, Laos, Taiwan, Thailand, Vietnam and the Tugur and Amur River catchments in Siberia (Koster et al., 2002; Kottelat and Freyhof, 2007)."

Status in the United States

From Nico et al. (2024):

"Established in Shiawassee River and Lake Michigan [Michigan] (Simon et al. 2006; USEPA 2008). Established in Alabama, California, Florida, Hawaii, Idaho, Illinois, Michigan, New Jersey, New York, Oregon, and Washington […]. Status is unknown in Tennessee […] and Maryland."

Nico et al. (2024) report additional nonindigenous occurrences of *Misgurnus anguillicaudatus* leading to establishment in Georgia, Indiana, Louisiana, North Carolina, and Wisconsin. They report nonindigenous occurrences of *M. anguillicaudatus* with unknown status in Ohio, Pennsylvania, Utah, and Virginia.

Misgurnus anguillicaudatus is available in the aquarium trade in the United States (e.g., Aqua Imports.com 2025; Aquariumfish.com 2025).

Regulations

Misgurnus anguillicaudatus is regulated in Maryland (Code of Maryland Regulations 2022), Michigan (Michigan Compiled Laws 2022), Minnesota (Minnesota DNR 2022), New Jersey (NJFW 2022), New York (New York DEC 2022), North Carolina (North Carolina DEQ 2022), and Oregon (ODFW 2022). Please refer back to state agency regulatory documents for details on the regulations, including restrictions on activities involving this species. While effort was made to find all applicable regulations, this list may not be comprehensive. Notably, it does not include regulations that do not explicitly name this species or its genus or family, for example, when omitted from a list of authorized species with blanket regulation for all unnamed species.

Means of Introductions within the United States

From Nico et al. (2024):

"California populations are apparently descended from individuals that 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, are believed to have descended from individuals imported from Kobe, Japan, which escaped from a nearby aquarium supply company in Oakland County before 1951, possibly as early as 1939 (Schultz 1960; Courtenay et al. 1984). In Hawaii, the species was presumably introduced by Asian immigrants during the 1800s, probably for food (Maciolek 1984; Devick [1991]). 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."

From Top-Karakuş and Karakuş (2022):

"The means of the transportation of *M. anguillicaudatus* between countries has been clarified as a result of commercial agreements made by the United States of America, China and the European Union Commission. This species began to be transported for many reasons such as game fishing, aquarium fishing and forage fish production. The species was introduced to Hawaii by the end of the 1800s as a food source (Maciolek, 1984). Afterwards, it was released into the wild mostly by aquarists or breeders, either accidentally or on purpose."

Remarks

From Nico et al. (2024):

"**Synonyms and Other Names:** Oriental Weatherfish, Dojo, Dojo Loach, Weather Loach, Japanese Weatherfish, Amur Weatherfish"

From Top-Karakuş and Karakuş (2022):

"*Misgurnus anguillicaudatus* is known to hybridize in the wild with *Paramisgurnus dabryanus* (Verreycken 2021) and introgression from loaches in the genus *Cobitis* has been observed in the mitochondrial genome (Kitagawa et al. 2011)."

"[…] fish previously identified as *M. anguillicaudatus* from the Inn river in Germany were later identified as *Misgurnus bipartitus*, raising the possibility of other misidentifications having occurred (Zangl et al., 2020)"

Mention of commercial products in this Ecological Risk Screening Summary does not entail endorsement by the U.S. Federal Government.

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From ITIS (2024):

Kingdom Animalia
  Subkingdom Bilateria
    Infrakingdom Deuterostomia
      Phylum Chordata
        Subphylum Vertebrata
          Infraphylum Gnathostomata
            Superclass Actinopterygii
              Class Teleostei
                Superorder Ostariophysi
                  Order Cypriniformes
                    Superfamily Cobitoidea
                      Family Cobitidae

Subfamily Cobitinae
Genus *Misgurnus*
Species *Misgurnus anguillicaudatus* (Cantor, 1842)

According to Fricke et al. (2024), *Misgurnus anguillicaudatus* (Cantor 1842) is the current valid name for this species.

Size, Weight, and Age Range

From Nico et al. (2024):

"To 28 cm SL [standard length] (Kottelat and Freyhof 2007), but averages 10-20 cm."

"This species exhibits sexual size dimorphism, with the average length of female Pond Loach being considerably larger than that of the males (Tabor et al. 2001; Schmidt and Schmidt 2014)."

From Top-Karakuş and Karakuş (2022):

"Studies have reported that the lifespan of *M. anguillicaudatus* is more than 13 years (Lintermans and Burchmore, 1996)."

Environment

From Nico et al. (2024):

"The Pond Loach is found in muddy or silty substrates in low-gradient, shallow water, often in aquatic macrophyte beds (Tabor et al. 2001; Schmidt and Schmidt 2014)."

"Pond Loach is highly tolerant to extreme conditions or marginal habitat quality: Koetsier and Urquhart (2012) found that Pond Loach can withstand desiccation and starvation for more than 81 days, and Urquhart and Koetsier (2014a) estimated a critical thermal minimum of between -1° and -2°C and reported survival of experimental fish partially or fully encased and in direct contact with ice. Further, it can withstand a maximum temperature of around 38°C and O2 concentrations below 2 mg/L (McMahon and Burggren 1987; Rixon et. al. 2005; Urquhart and Koetsier 2014b). It can use its intestine as an accessory respiratory organ, enabling it to live in oxygen-poor waters and to bury itself in soft substrates to survive long droughts (Ip et al. 2004). As a side effect of its ability to breathe air, Pond Loach can also tolerate extremely high concentrations of ammonia (Ip and Chew 2018)."

From Norris (2015):

"Oriental Weatherloach are eurythermic and are commonly found in water temperatures ranging from 2 ºC to 30ºC [sic], but can also tolerate thermal hot springs up to 42ºC (Logan et al. 1996)."

Climate
From Froese and Pauly (2024):

"Subtropical; […] 53°N - 27°S"

Distribution Outside the United States
Native
From Nico et al. (2024):

"Eastern Asia from Siberia south to northern Vietnam, including Japan (Berg 1949; Masuda et al. 1984; Talwar and Jhingran 1992)."

Introduced
From Top-Karakuş and Karakuş (2022):

"It was introduced to Oceania, first to Palau in 1914 and 1944 (Bright 1979), and then to Australia in 1984 (Koster et al. 2002). It has been reported that a fish farm in Mexico stopped its production and released these fish into the wild in 1961 (Contreras and Escalante, 1984). In 1991, the distribution in Asia expanded to the Karakum Channel in Turkmenistan (Freyhof and Korte, 2005). It is thought *M. anguillicaudatus* spread to Uzbekistan and Kazakhstan from Turkmenistan. In Europe it was reported that this fish species was found in a private pond in 1978 and 1995, but with no reports of the species occurring in the wild (Lever, 1996). Although there have been reports of *M. anguillicaudatus* in Germany in 1990, the first established population was formed in 2002 (Freyhof and Korte, 2005). […] The species was reported first from Italy in 1997 (Razzetti et al., 2001), then from Spain in 2001 (Franch et al., 2018) and finally from the Netherlands in 2012 (Kessel et al., 2013). This species was identified on the continent of South America in Brazil by 2010 (Gomes et al., 2011)."

From Franch et al. (2008):

"[…] we report the presence of an established weatherfish population in northeastern Iberian Peninsula [Spain] and describe, for the first time in Europe, a clear range expansion."

From Binnendijk et al. (2017):

"The Asian weather loach (*Misgurnus anguillicaudatus*) was found for the first time in the Netherlands in the Tungelroysebeek brook in 2012. […] Since 2012, the population has continued to grow, however, and shows no sign of saturation, despite the elimination efforts: more individuals, wider dispersion and more age classes."

From Vasil'eva et al. (2024):

"[…] the oriental weatherfish *Misgurnus anguillicaudatus* has naturalized in the Balkhash-Ili basin [Kazakhstan]."

From Sheraliev (2026):

"This study reports the first record of the non-native pond loach, *Misgurnus anguillicaudatus* (Cantor, 1842) (Oriental Weatherfish), from the lower reaches of the Amu Darya River in northwestern Uzbekistan. […] The presence of a reproducing population, including both mature adults and juveniles, suggests the species is well-established."

From Invasive Species Council of BC (2023):

"Present in the lower Fraser Valley [British Columbia, Canada]."

According to Froese and Pauly (2026), *M. anguillicaudatus* is also established outside its native range in Australia, France, Italy, Palau, Philippines, and Turkmenistan; it is probably not established in Mexico.

Means of Introduction Outside the United States

From Top-Karakuş and Karakuş (2022):

"*Misgurnus anguillicaudatus* is capable of moving overland between river systems (Koster et al., 2002). Water diversion schemes such as irrigation channels and dams may be counted as responsible for widespread records."

"The main introduction pathways for the oriental weatherloach are varied, including use as an ornamental fish, live bait and as attractant for animal feed. Fish stocking and mosquito control are also responsible for its intentional introduction in some countries (Kim et al., 1994). This species has proved successful in the aquarium fish trade. Dumping of unwanted aquarium fish is a key initial method of release. The majority of the establishments outside of the natural range have been from escapes from fish farms, or accidental or deliberate release of unwanted aquarium fish."

Short Description

From Nico et al. (2024):

"Eel-like body, brown with greenish grey-brown marble markings dorsally, pale silver ventrum. The mouth is small, narrow and subinferior surrounded by six barbels. The lips are thick and fleshy. Short lateral line, not exceeding the length of the pectoral fin. Has a stout spine on its pectoral fin. Dorsal fin origin is above the pelvic fin origin. There are 9 dorsal rays, 6–7 pelvic rays, and 7–8 anal rays. Distinguishing characteristics were given by Berg (1949), Sterba (1973), Masuda et al. (1984), Page and Burr (1991), and Talwar and Jhingran (1992)."

Biology

From Nico et al. (2024):

"It does not forage by sight, but requires chemical stimuli to induce feeding behavior (Watanabe and Hidaka 1983). Its diet is composed mostly of small benthic invertebrates and detritus; Tabor et al. (2001) found that cladocerans and chironomids were the most frequently ingested prey items collectively; Schmidt and Schmidt (2014) found that amphipods, gastropods and chironomids comprised the most important food items in several New York populations; Urquhart and Koetsier (2014b) identified chironimids and small bivalves as the most frequently ingested prey items in Idaho populations."

"It is an external fertilizer that spawns multiple times from April to October (Milton et al. 2018). Schmidt and Schmidt (2014) examined the fecundity of introduced New York populations: ovary weight was 4-19% of total wet body weight, and total oocytes in unmated females ranging between 150-18,000 (with fecundity increasing with total length)."

From Top-Karakuş and Karakuş (2022):

"*Misgurnus anguillicaudatus* is well adapted to survive in aquatic environments that can stay stagnant for long periods of time and dry out, such as swamps and shallow water. It can survive in an oxygen-free environment by intestinal respiration (Koster et al., 2002). This fish also has the ability to breathe through the skin (cutaneous), especially when buried in mud (Park and Kim, 1999)."

Human Uses

From Top-Karakuş and Karakuş (2022):

"*Misgurnus anguillicaudatus* has been extensively imported around the world as a cold-water scavenger fish in the aquarium trade (Koster et al. 2002) and extensively cultured in aquaculture facilities."

"*Misgurnus anguillicaudatus* are used for food, consumed as fresh meat (Kim et al. 1987; Welcomme 1988)."

From Kuhn et al. (2024):

"Pond loaches are popular as an ornamental fish, and are used in traditional Chinese medicine, as well as a food source for humans and angling bait (Li et al., 2018) […]"

Diseases

No information was found associating *Misgurnus anguillicaudatus* with any diseases listed by the World Organisation for Animal Health (2024).

Poelen et al. (2014) list the following as parasites of *Misgurnus anguillicaudatus*: *Acanthocephalus opsariichthydis*, *Allocreadium gotoi*, *Allocreadium hupehensis, Ancyrocephalus cruciatus*, *Camallanus cotti, Centrocestus armatus, Clonorchis sinensis, Cryptocotyle misgurni*, *Diplostomum, Echinochasmus, Echinochasmus japonicus, Echinostoma, Echinostoma hortense*, *Exorchis oviformis, Gnathostoma hispidum, Gnathostoma nipponicum, Gnathostoma spinigerum, Gyrodactylus macracanthus, Gyrodactylus misgurni, Gyrodactylus monstruosus*, *Gyrodactylus paralatus, Gyrodactylus strelkovi, Metagonimus takahashii, Metagonimus yokogawai, Microparyphium kyushuensis, Pallisentis celatus, Pallisentis* *umbellatus*, *Paracaryophyllaeus dubininae*, *Paracaryophyllaeus gotoi*, *Paradiplozoon, Paraphilopinna fluviatilis, Pseudexorchis major* and *Spiroxys hanzaki.*

From Reyda et al. (2020):

"This Asian loach species carried *G*[*yrodactylus*] *jennyae* from Asia to North America and introduced it to bullfrog [*Lithobates catesbeianus*]. We predict that *M. anguillicaudatus* has likely spread several other *Gyrodactylus* species or strains worldwide."

Threat to Humans

From Froese and Pauly (2024):

"Potential pest [Burchmore et al. 1989]"

3 Impacts of Introductions

The following quotations detail **potential or highly generalized** information on impacts of introduction from *Misgurnus anguillicaudatus*.

From Nico et al. (2024):

"It may reduce populations of aquatic insects important as food to native fishes (Page and Laird 1993; USEPA 2008). Based on its preferred habitat and diet, and on its population size, Maciolek (1984) categorized *Misgurnus* along with several other introduced fishes as species having an intermediate impact on Hawaiian streams. Schmidt and Schmidt (2014) suggested that Pond Loach may compete with native Eastern Mudminnow (*Umbra pygmaea*) for food where the two species co-occur."

From Keller and Lake (2007):

"In mesocosms designed to mimic natural conditions Oriental weatherloach reduced population sizes of their macroinvertebrate prey relative to fishless controls. In addition, mesocosms with Oriental weatherloach had higher water column nitrogen and turbidity levels than fishless controls. These impacts were found during cool months at Oriental weatherloach densities known to occur in local freshwater systems. To our knowledge this is the first study to investigate the impacts of this species. Although there are issues involved in extrapolating mesocosm results to natural systems (see below), our results demonstrate that nonindigenous populations of Oriental weatherloach may be altering macroinvertebrate communities."

"While our results suggest significant Oriental weatherloach impacts, three caveats associated with mesocosm studies need to be considered. First, animals confined to mesocosms may be released from predators and/or competitors and thus show greater rates of feeding. For the present study, this would lead to increased effects on invertebrate numbers and increased effects of bioturbation. Second, there may be fewer refugia for invertebrates in mesocosms than in natural habitats, thus offering fewer opportunities to escape predation. Third, mesocosms are isolated from natural systems and thus experience different disturbance and flow regimes relative to natural systems."

From VanHaitsma (2020):

"In 2014, the invasive Oriental weather loach was found in the Prairie Creek wetland at Midewin National Tallgrass Prairie. While little is known about the Oriental weather loach and its impact on freshwater ecosystems it has become a widespread invasive species. Being the first to investigate the impact of the Oriental weather loach on the Grant Creek and Prairie Creek watersheds at Midewin National Tallgrass Prairie, we set traps for specimens from early June till late July in both watersheds. Each loach that was caught was euthanized and dissected in order to understand what the Oriental weather loaches are eating and how they are likely impacting the ecosystem. Of the 138 total Oriental weather loaches caught, none were found in the Grant Creek watershed or the creek of the Prairie Creek watershed. The stomach contents contained a wide variety of prey items but *Alonella* [cladoceran], Nonbiting midge larvae, insect eggs, and *Simocephalus* [cladoceran] were the most abundant. The Oriental weather loach's diet was similar to that of native Bluegill, Central mudminnows, and tadpoles, which could suggest that they are competing with these native species. The results of this study suggest that Oriental weather loaches may be negatively impacting the freshwater ecosystem of the Prairie Creek wetland at Midewin National Tallgrass Prairie. Future studies are needed to better understand the severity of the Oriental weather loaches impact at Midewin National Tallgrass Prairie and other freshwater ecosystems."

From Franch et al. (2008):

"There is very little available information on weatherfish impacts on native biota in those areas where the species has become invasive. In fact, no negative impacts on native fish have been reported in the USA (Logan et al. 1996) or Europe (Freyhof and Korte 2005)."

The following information pertains to introduction and impacts of *Gyrodactylus* parasites. The specific species mentioned below were introduced to the United States via introductions of *Misgurnus anguillicaudatus*.

From Reyda et al. (2020):

"This Asian loach species carried *G*[*yrodactylus*] *jennyae* from Asia to North America and introduced it to bullfrog [*Lithobates catesbeianus*]. We predict that *M. anguillicaudatus* has likely spread several other *Gyrodactylus* species or strains worldwide."

"A monogenean flatworm species *Gyrodactylus jennyae* Paetow, Cone, Huyse, McLaughlin and Marcogliese 2009 was described as a new pathogenic parasite on the American bullfrog *Lithobates catesbeianus* Shaw, 1802 in North America. […] Paetow et al. (2013) also demonstrated that *G. jennyae* infection increased the mortality of the tadpoles associated with fungal disease *Batrachochytrium dendrobatidis* Longcore, Pessier & Nichols, 1999, making matters worse."

"We report here two [*Gyrodactylus*] species related to *G. jennyae* that were found in North America, but they evidently originated from Far East Asia, together with their invasive host fish *M. anguillicaudatus*."

Misgurnus anguillicaudatus is regulated in Maryland (Code of Maryland Regulations 2022), Michigan (Michigan Compiled Laws 2022), Minnesota (Minnesota DNR 2022), New Jersey (NJFW 2022), New York (New York DEC 2022), North Carolina (North Carolina DEQ 2022), and Oregon (ODFW 2022). See section 1.

4 History of Invasiveness

The History of Invasiveness for *Misgurnus anguillicaudatus* is classified as Data Deficient. *Misgurnus anguillicaudatus* has a long history of introduction through aquaculture, aquarium use and release as a bait fish. In a mesocosm study, *M. anguillicaudatus* caused changes in macroinvertebrate communities and reduced water quality, but analogous impacts have not been reported from natural systems and the authors of the mesocosm study caution against assuming the impacts would be the same in natural systems. Other studies have suggested negative impacts on native fish via competition for prey, but no clear, convincing, and reliable documentation of such impacts was found.

5 Global Distribution

Figure 1. Reported global distribution of *Misgurnus anguillicaudatus*. Map from GBIF Secretariat (2023). Observations are reported from North America, Europe, Southeast Asia, and Australia. Points in Austria, Belgium, parts of Canada (Alberta, New Brunswick, Nova Scotia), western China, and parts of the United States (Ohio, Utah) are not known to represent established populations of *M. anguillicaudatus* and were not used to select source points for the climate matching analysis.

Additional source points in Uzbekistan were available from Sheraliev (2026).

No georeferenced occurrences were found for portions of the native range of *M. anguillicaudatus* in Cambodia, India, or Thailand; or for portions of the established range in France, Kazakhstan, or Turkmenistan.

6 Distribution Within the United States

Figure 2. Reported distribution of *Misgurnus anguillicaudatus* in the contiguous United States. Map from USGS (2026). Yellow points represent established nonnative populations of *M. anguillicaudatus* and orange points represent other reported nonnative occurrences. Only established populations were used to select source locations for the climate matching analysis.

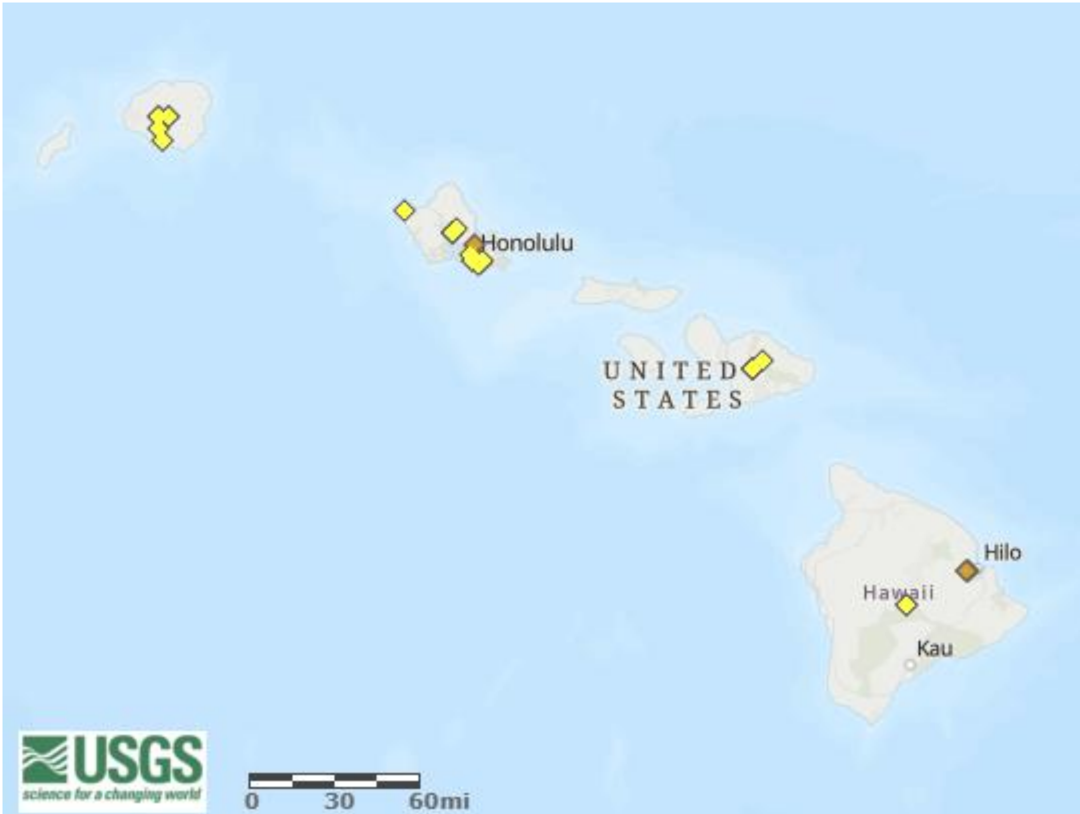

Figure 3. Reported distribution of *Misgurnus anguillicaudatus* in Hawaii. Map from USGS (2026). Yellow points represent established nonnative populations of *M. anguillicaudatus* and orange points represent other reported nonnative occurrences. Only established populations were used to select source locations for the climate matching analysis.

7 Climate Matching

Summary of Climate Matching Analysis

The climate match for *Misgurnus anguillicaudatus* to the contiguous United States was consistently medium or high, with minimal areas of low climate match. Areas with the greatest extent of high climate match included the Great Basin, Great Lakes, Mid-Atlantic, and Southeast regions. However, all regions had mostly high climate match. The lowest climate matches were found in the Sonoran Desert region of Arizona. The overall Climate 6 score (Sanders et al. 2023; 16 climate variables; Euclidean distance) for the contiguous United States was 0.981, indicating that Yes, there is establishment concern for this species. The Climate 6 score is calculated as: (count of target points with scores ≥ 6)/(count of all target points). Establishment concern is warranted for Climate 6 scores greater than or equal to 0.002 based on an analysis of the establishment success of 356 nonnative aquatic species introduced to the United States (USFWS 2024).

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

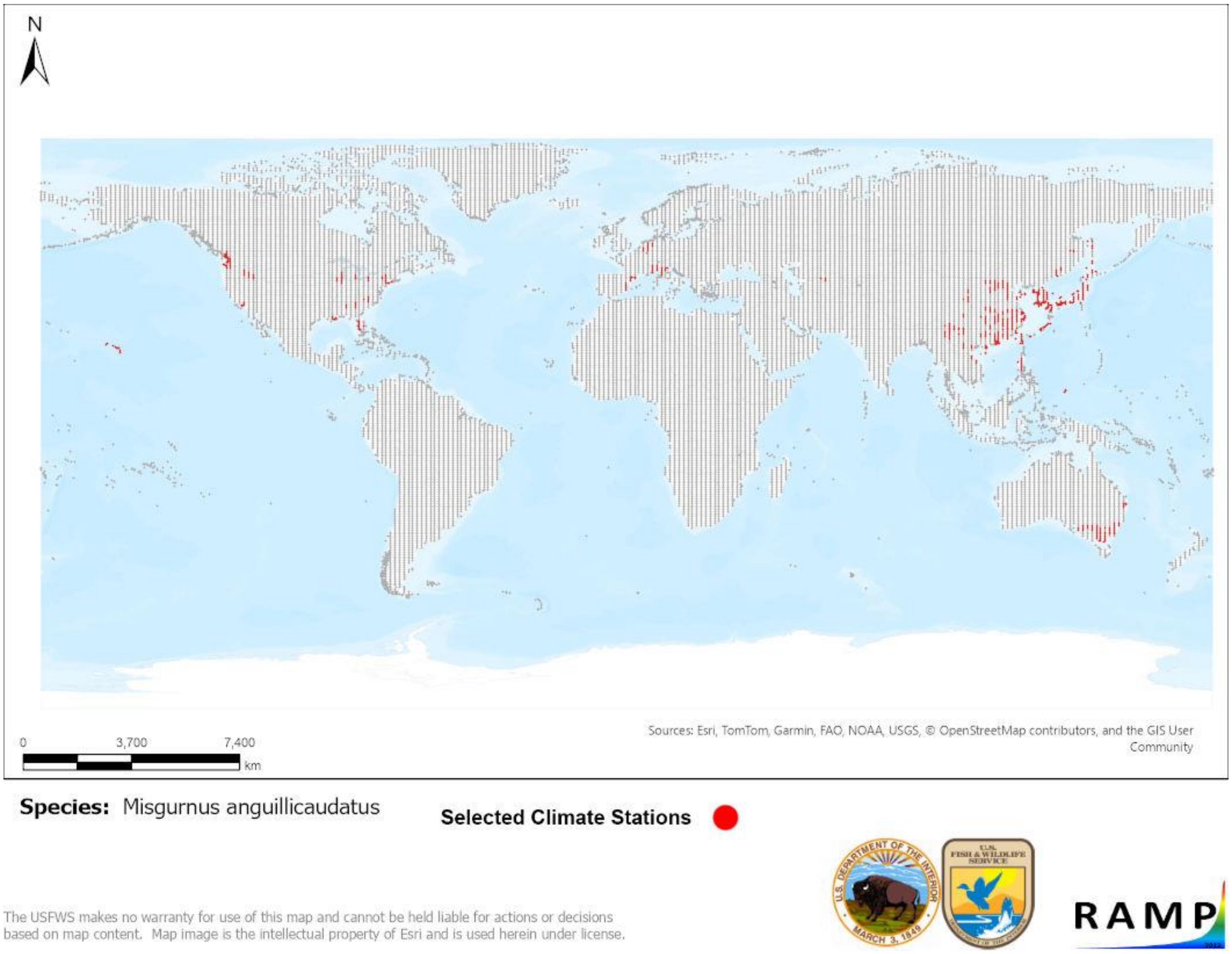

Figure 4. RAMP (Sanders et al. 2023) source map showing weather stations in the world selected as source locations (red; Australia, Belgium, Canada, China, France, Germany, Italy, Japan, Myanmar, Netherlands, North Korea, Palau, Philippines, Russia, South Korea, Spain, Switzerland, Taiwan, Turkmenistan, United States, Uzbekistan, and Vietnam) and non-source locations (gray) for *Misgurnus anguillicaudatus* climate matching. Source locations from GBIF Secretariat (2023) and Sheraliev (2026). Selected source locations are within 100 km of one or more species occurrences, and do not necessarily represent the locations of occurrences themselves.

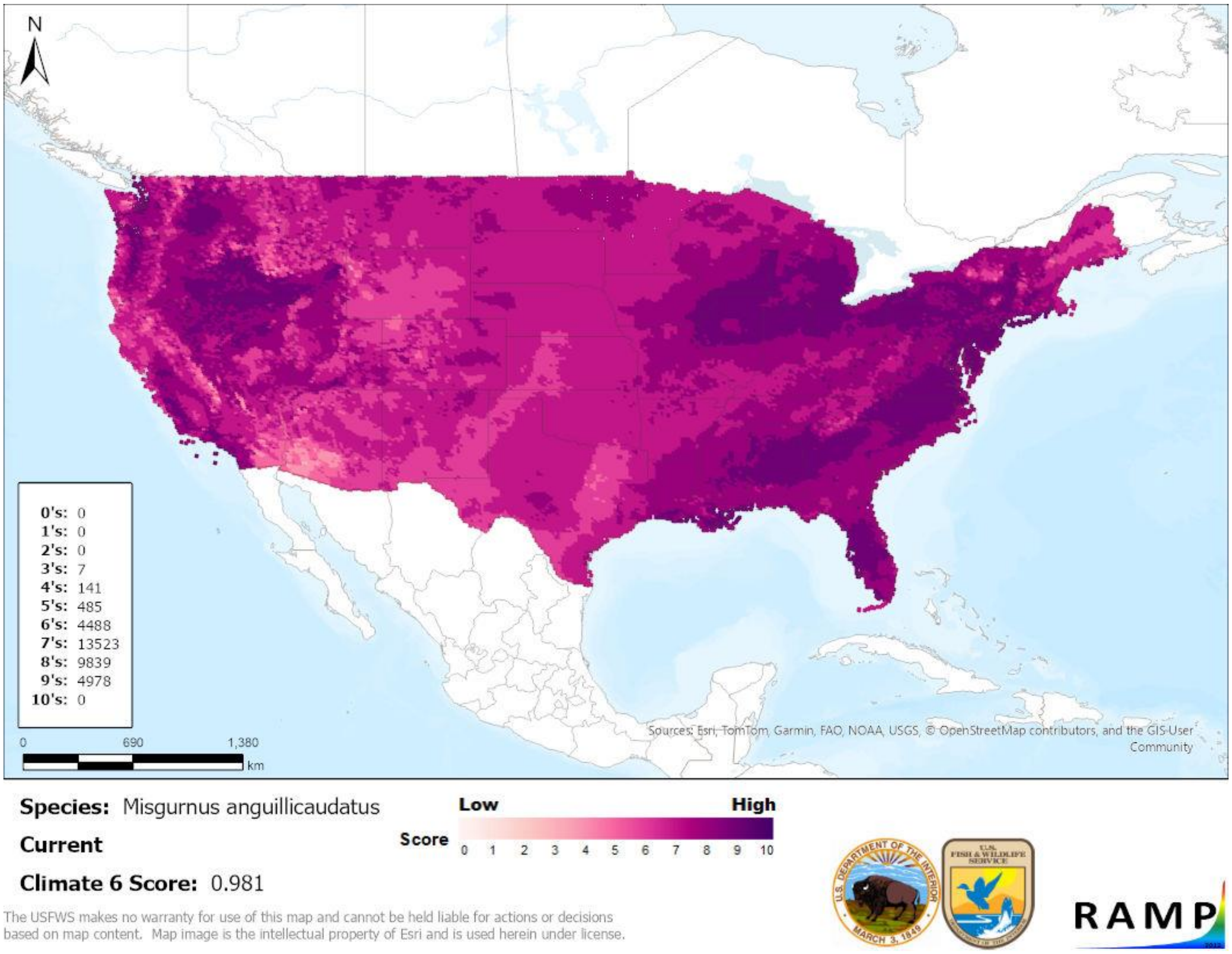

Figure 5. Map of RAMP (Sanders et al. 2023) climate matches for *Misgurnus anguillicaudatus* in the contiguous United States based on source locations reported by GBIF Secretariat (2023) and Sheraliev (2026). Counts of climate match scores are tabulated on the left. 0/Pale Pink = Lowest match, 10/Dark Purple = Highest match.

8 Certainty of Assessment

The Certainty of Assessment for *Misgurnus anguillicaudatus* is Low. There is adequate information available about the biology and ecology of the species. Records of introduction and established nonnative populations were found. However, there is limited information from natural systems on impacts of introduction.

9 Risk Assessment

Summary of Risk to the Contiguous United States

Misgurnus anguillicaudatus, Pond Loach, is a fish that is native to eastern Asia. This species can breathe through its skin and intestines, enabling it to survive through droughts and in low-oxygen environments. It is used globally as an aquarium fish and also used for aquaculture for human consumption, angling bait, and in traditional Chinese medicine. Its possession, trade, or transport is regulated in at least seven U.S. states. The History of Invasiveness for *Misgurnus* *anguillicaudatus* is classified as Data Deficient. The species has a long history of being introduced to new locations around the world and has established successful nonnative populations in North America, Europe, and Oceania. Although a mesocosm experiment demonstrated impacts to macroinvertebrate populations and water quality in the presence of *M. anguillicaudatus*, data on impacts within natural systems are limited. The climate matching analysis for the contiguous United States indicates establishment concern for this species. The areas with the greatest extent of high climate match included the Great Basin, Great Lakes, Mid-Atlantic, and Southeast regions, although all regions within the contiguous United States had mostly high climate match. The Certainty of Assessment for this ERSS is classified as Low due to the limited information available on impacts of introduction. The Overall Risk Assessment Category for *Misgurnus anguillicaudatus* in the contiguous United States is Uncertain.

Assessment Elements

- **History of Invasiveness (see Section 4): Data Deficient**
- **Establishment Concern (see Section 7): Yes**
- **Certainty of Assessment (see Section 8): Low**
- **Remarks, Important additional information: Associated with intercontinental spread of *Gyrodactylus* parasites.**
- **Overall Risk Assessment Category: Uncertain**

10 Literature Cited

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

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Appendix

Summary of Future Climate Matching Analysis

Future climate projections represent two Shared Socioeconomic Pathways (SSP) developed by the Intergovernmental Panel on Climate Change (IPCC 2021): SSP5, in which emissions triple by the end of the century; and SSP3, in which emissions double by the end of the century. Future climate matches were based on source locations reported by GBIF Secretariat (2023) and Sheraliev (2026).

Under the future climate scenarios (figure A1), on average, high climate match for *Misgurnus anguillicaudatus* was projected to occur in the Appalachian Range, Great Basin, Great Lakes, Mid-Atlantic, Northeast, Southern Atlantic Coast, and Southern Florida regions of the contiguous United States. The areas of high match contracted from the 2055 time step to the 2085 time step, and from SSP3 to SSP5 at the 2085 time step; these changes were more pronounced in the eastern two-thirds of the contiguous United States than in the western third. The Climate 6 scores for the individual future scenario models (figure A2) ranged from a low of 0.554 (model: UKESM1-0-LL, SSP5, 2085) to a high of 0.963 (model: MPI-ESM1-2-HR, SSP5, 2055). All future scenario Climate 6 scores were above the Establishment Concern threshold, indicating that Yes, there is establishment concern for this species under future scenarios. The Climate 6 score for the current climate match (0.981, figure 5) falls above the range of scores for future projections. The time step and climate scenario with the most change relative to current conditions was SSP5, 2085, the most extreme climate change scenario. Under most time step and climate scenarios, an area of northern Maine saw a moderate increase in the climate match relative to current conditions. There were no other notable areas of moderate or large increase relative to the current climate match, regardless of future time step and climate scenarios. Under the 2085 time step, areas within California, the Colorado Plateau, and Great Basin saw a large decrease in the climate match relative to current conditions. Additionally, areas within the Appalachian Range, Great Lakes, Gulf Coast, Mid-Atlantic, Northeast, Northern Pacific Coast, Northern Plains, Southeast, Southern Atlantic Coast, Southern Florida, Southern Plains, Southwest, and Western Mountains saw a moderate decrease in the climate match relative to current conditions under one or more time steps and scenarios. The decreases in climate match were notably more widespread under the SSP5, 2085 scenario. Additional very small areas of large or moderate change may be visible on the maps (figure A3).

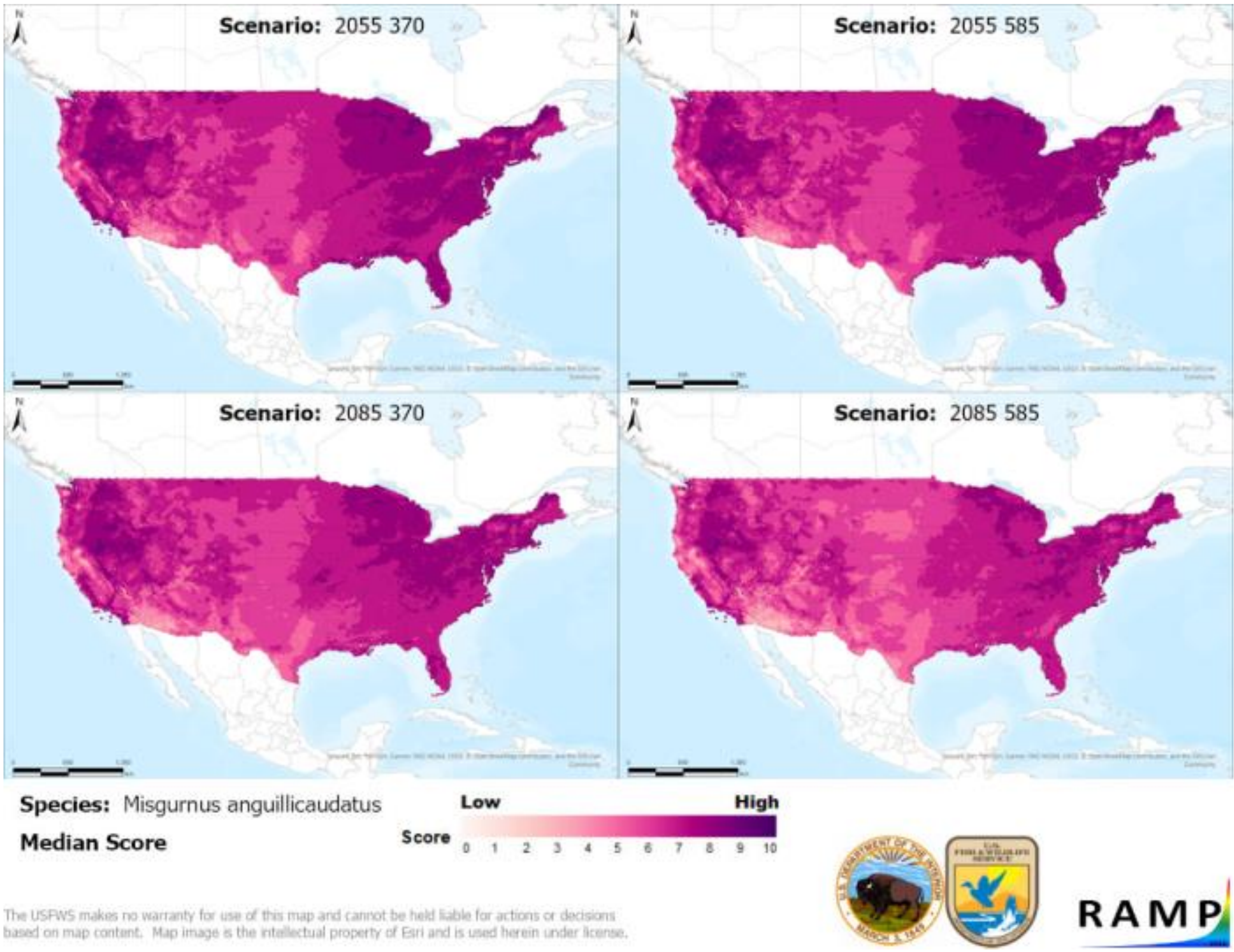

Figure A1. Maps of median RAMP (Sanders et al. 2023) climate matches projected under potential future climate conditions using five global climate models for *Misgurnus anguillicaudatus* in the contiguous United States. Climate matching is based on source locations reported by GBIF Secretariat (2023) and Sheraliev (2026). Shared Socioeconomic Pathways (SSPs) used (from left to right): SSP3, SSP5 (IPCC 2021). Time steps: 2055 (top row) and 2085 (bottom row). Climate source data from CHELSA (Karger et al. 2017, 2018); global climate models used: GFDL-ESM4, UKESM1-0-LL, MPI-ESM1-2-HR, IPSL-CM6A-LR, and MRI-ESM2-0. 0/Pale Pink = Lowest match, 10/Dark Purple = Highest match.

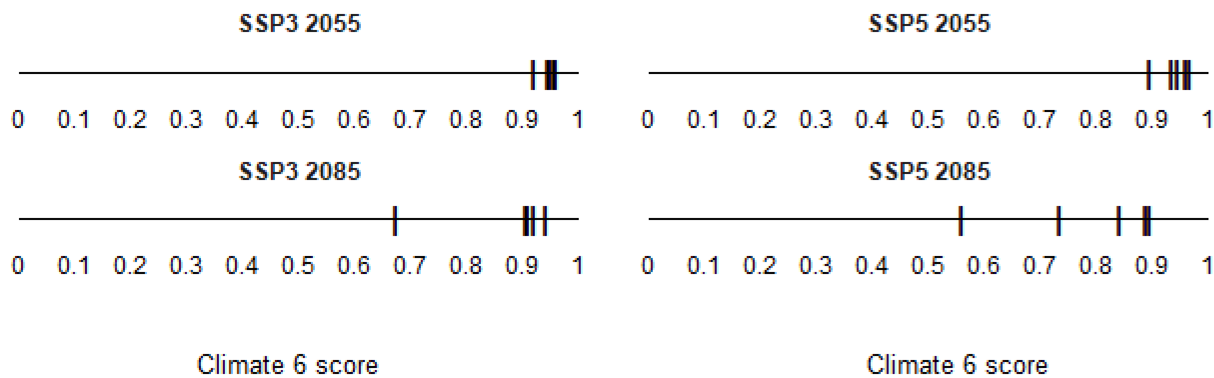

Figure A2. Comparison of projected future Climate 6 scores for *Misgurnus anguillicaudatus* in the contiguous United States for each of five global climate models under four combinations of Shared Socioeconomic Pathway (SSP) and time step. SSPs used (from left to right): SSP3, SSP5 (Karger et al. 2017,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

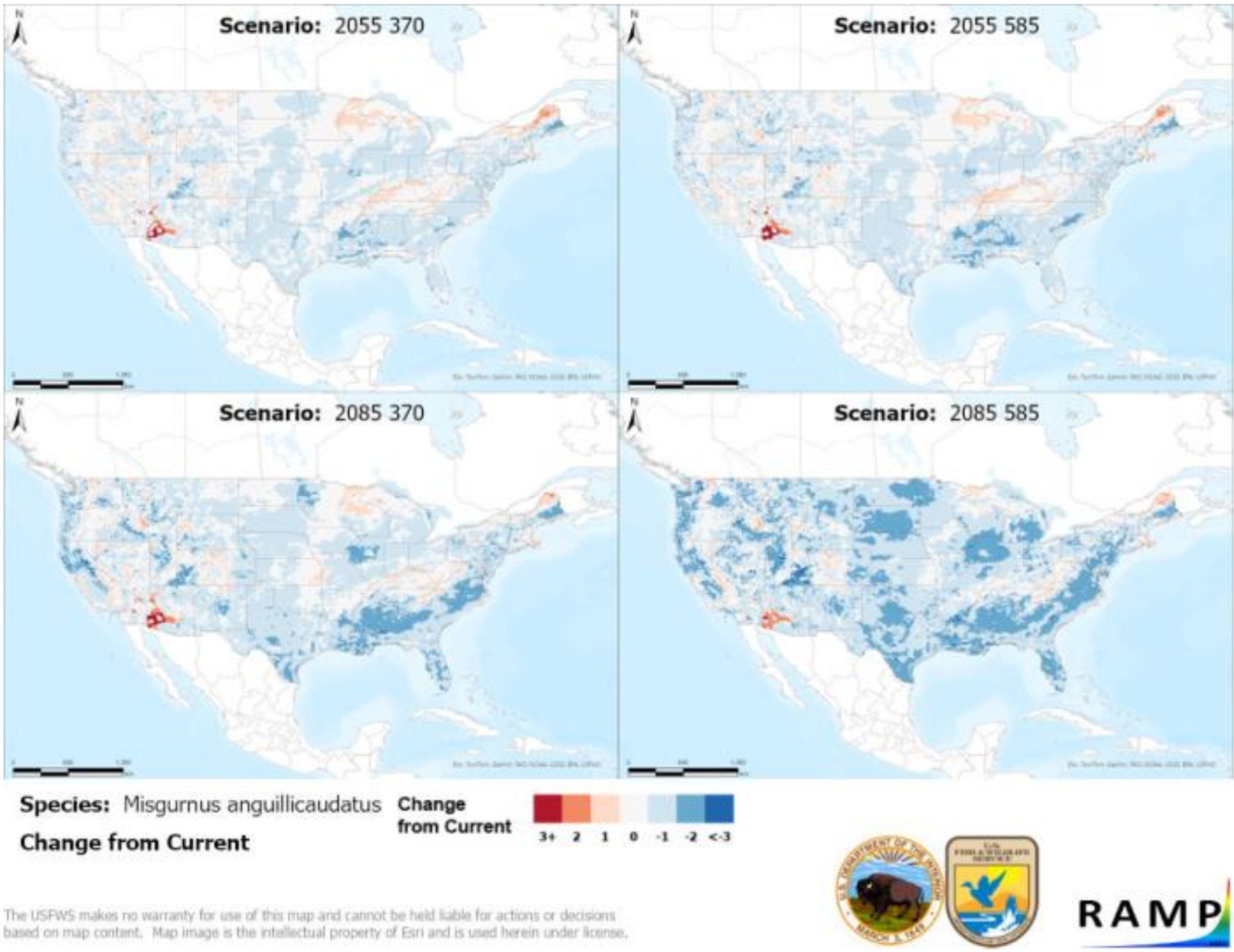

Figure A3. RAMP (Sanders et al. 2023) maps of the contiguous United States showing the difference between the current climate match target point score (figure 5) and the median target point score for future climate scenarios (figure A1) for *Misgurnus anguillicaudatus* based on source locations reported by GBIF Secretariat (2023) and Sheraliev (2026). Shared Socioeconomic Pathways (SSPs) used (from left to right): SSP3, SSP5 (IPCC 2021). Time steps: 2055 (top row) and 2085 (bottom row). Climate source data from CHELSA (Karger et al. 2017, 2018); global models used: GFDL-ESM4, UKESM1-0-LL, MPI-ESM1-2-HR, IPSL-CM6A-LR, and MRI-ESM2-0. Shades of blue indicate a lower target point score under future scenarios than under current conditions. Shades of red indicate a higher target point score under future scenarios than under current conditions. Darker shades indicate greater change.

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