

Ide (*Leuciscus idus*)

Ecological Risk Screening Summary

U.S. Fish and Wildlife Service, November 2023
Revised, December 2023
Web Version, 6/24/2026

Organism Type: Fish

Overall Risk Assessment Category: Uncertain



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<https://commons.wikimedia.org/wiki/File:IdeLeuciscusIdus50cm.JPG> (November 2023).

1 Native Range and Status in the United States

Native Range

From Nico et al. (2026):

“Native from northern Europe through Siberia (Berg 1949; Robins et al. 1991).”

From Froese and Pauly (2023):

“Europe and Asia: Baltic, Black, northern Caspian and North Sea basins, Atlantic basin southward to Seine and lower Loire drainages (France). Absent in Scandinavia north of 69°N. In Asia, eastward to Lena drainage and Aral basin.”

Status in the United States

From Nico et al. (2026):

“The ide has been recorded from nine states, but the documentation of its true status in the United States is poor and often contradictory. Courtenay and Stauffer (1990), Courtenay et al. (1991) and Courtenay (1993) listed it as established in Maine; Page and Burr (1991) stated that the species is locally established in a pond in Maine. However, in some early accounts the only known Maine population was thought to have been eradicated (e.g., Courtenay et al. 1984, 1986). In fact, Courtenay et al. (1986) stated that the Maine Department of Inland Fisheries and Wildlife eradicated the population in May 1983. According to Whitworth et al. (1968) one small pond in Connecticut has maintained a population since 1962 or 1963; Schmidt (1986) also listed *L. idus* as introduced to lowland lacustrine habitat in the Connecticut River drainage. Subsequently, Courtenay et al. (1984, 1986) and Whitworth (1996) stated that the population in Connecticut had been eradicated. It was formerly established in one or a few water bodies in Pennsylvania and New York; however, according to Courtenay et al. (1984, 1986), those populations are no longer extant. The fish that escaped from Washington, D.C. ponds in 1889 apparently persisted for some time. That escape also apparently resulted in the species being listed as occurring in several states along Potomac River, including Virginia and Maryland. Although the literature seems to suggest that the ide population in the Potomac was self sustaining, it is not known when ide actually disappeared completely from the Potomac drainage. For instance, Schwartz (1963) apparently considered the ide to be established in the Potomac River; and Hocutt et al. (1986) listed it as introduced to the Potomac River. However, Musick (1972) doubted that this species still survived there, and both Jenkins and Burkhead (1994) and Starnes et al. (2011) also concluded that there was no evidence indicating the ide persists in the Potomac drainage. Stockings of this species during the late 1800s were unsuccessful in both Nebraska (Morris et al. 1974) and Texas (Howells 1992). There is only a single record documenting its occurrence in open waters of Tennessee (Saylor, personal communication). Howells (1992) indicated that the U.S. Bureau of Fisheries (i.e., the U.S. Fish Commission) distributed the species to private individuals for introduction, but the actual introduction sites are largely unrecorded. The species never became established in Texas and has not been reported since their original introduction (Howells 1992).”

Additionally, Nico et al. (2026) reports nonnative introductions of *Leuciscus idus*, primarily in the late 1800s, with a status of ‘failed’ in Arkansas, Colorado, Florida, Georgia, Illinois, Indiana, Kansas, Louisiana, Minnesota, Missouri, Nebraska, New Jersey, North Carolina, Ohio; and with a status of ‘unknown’ in Tennessee and ‘collected’ in West Virginia.

From Full Service Aquatics (2012):

“The Golden Orfe, or Ide, is a somewhat overlooked choice as a fish to stock your pond and water garden with these days; yet the Orfe is an easy to find and affordable pond and water garden fish.”

Regulations

Leuciscus idus is regulated in Arizona (Arizona Game and Fish Commission 2022), Arkansas (AGFC 2022), California (CDFW 2021), Colorado (CPW 2023), Connecticut (Connecticut

DEEP 2020), Hawaii (HDOA 2019), Idaho (IDDA 2022), Michigan (Michigan Compiled Laws 2022), Ohio (ODNR 2022), Oregon (ODFW 2022), and Washington (WDFW 2022). It is regulated at the genus level (*Leuciscus*) in New Mexico (NMDGF 2023), Nevada (NBWC 2022), and Texas (TPWD 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. (2026):

“*Leuciscus idus* was first imported in 1877 by the U.S. Fish Commission (Baird 1879). Historically, it was intentionally stocked by the U.S. Fish Commission; recent introductions include intentional stocking by a state agency and escapes from commercial and government ponds (Lee et al. 1980 et seq.). In 1889, an estimated 20 Ide, along with other foreign cyprinids, escaped into the Potomac River from fish ponds in Washington, D.C., during a flood event (McDonald 1893). Similarly, Schwartz (1963) stated that it may have escaped from commercial ponds at Thurmont, Maryland into the Monocacy River; but he did not provide a date nor other details. Ide were also consigned to applicants in Virginia from 1892 to 1894 (Jenkins and Burkhead 1994). According to Courtenay et al. (1984, 1986), the U.S. Fish Commission gave no specific reason for importing and distributing this species, although they assumed that the intended use was both as an ornamental and food fish. Bean (1903) indicated that this species was introduced into American ponds for ornamental purposes. [...] Reports of Ide culture in Arkansas are incongruous. Fletcher and Hallock (1992) reported that Arkansas fish farmers were raising Ide for bait in the early 1990s. However, recent discussions with University of Arkansas personnel, fish farmers, and other local experts indicate there are no known records of Ide culture in Arkansas and that they are doubtful the the [sic] species was ever raised commercially there (N. Stone, Univ. of Ark., pers. comm., 2005). In the early 1980s this species was reportedly being used as a bait fish in Tennessee (Courtenay et al. 1984, 1986).”

Remarks

This ERSS was previously published in June 2015. Revisions were completed to incorporate new information and conform to updated standards.

Leuciscus idus has been intentionally stocked outside its native range within the United States by State and Federal fishery managers to achieve fishery management objectives. State and Federal fish and wildlife management agencies are responsible for balancing multiple fish and wildlife management objectives. The potential for a species to become invasive is now one important consideration when balancing multiple management objectives and advancing sound, science-based management of fish and wildlife and their habitat in the public interest.

From Siriwardena (2008):

“Commonly known as the ‘orfe’, there are two colour morphs known as ‘silver orfe’ and ‘golden orfe’ [...]”

“*L. idus* can be confused with *Scardinius erythrophthalmus* (rudd) in the wild owing to both have orange-red coloured fins, but they can be differentiated as *L. idus* has much smaller scales. *L. idus* is also superficially similar to many native North American cyprinids and does not possess a unique characteristic that sets it apart from native species (Nico and Fuller, 2008). According to Nico and Fuller (2008), however, *L. idus* can be distinguished from most native North American cyprinids by the following combination of characteristics: pharyngeal teeth 3,5-5,3, no barbels, lateral-line scales 55-63, and usually 8 branched dorsal rays and can be distinguished from other non-native cyprinids by the combination of a short dorsal fin (usually 8 branched dorsal rays) and 55-63 lateral-line scales.”

From Froese and Pauly (2023):

“Reported to sometimes hybridizes [sic] with *Aspius aspius* (Kottelat and Freyhoff 2007).”

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

According to Fricke et al. (2023), *Leuciscus idus* (Linnaeus, 1758) is the current valid name for this species.

From ITIS (2023):

Kingdom Animalia
Subkingdom Bilateria
Infrakingdom Deuterostomia
Phylum Chordata
Subphylum Vertebrata
Infraphylum Gnathostomata
Superclass Actinopterygii
Class Teleostei
Superorder Ostariophysi
Order Cypriniformes
Superfamily Cyprinoidea
Family Leuciscidae
Subfamily Leuciscinae
Genus *Leuciscus*
Species *Leuciscus idus* (Linnaeus, 1758)

Size, Weight, and Age Range

From Froese and Pauly (2023):

“Max length : 85.0 cm SL [standard length] male/unsexed; (Kottelat and Freyhof 2007); common length : 30.0 cm TL [total length] male/unsexed; max. published weight: 4.0 kg (Muus and Dahlström 1968); max. reported age: 29 years (Rohtla et al. 2015)”

Environment

From Froese and Pauly (2023):

“Freshwater; brackish; benthopelagic; pH range: 7.0 - 7.5; dH range: 10 - 15; potamodromous (Riede 2004). [...]; 4°C - 20°C [Riehl and Baensch 1991; presumed to be recommended aquarium temperature based on the source]”

From Nico et al. (2026):

“*Leuciscus idus* tolerates a wide range of conditions (Seeley 1962) and can successfully reproduce in waters of 8-23°C (Kupren et al. 2011).”

Climate

From Froese and Pauly (2023):

“Temperate [...]; 73°N - 37°N, 7°E - 136°E”

From Nico et al. (2026):

“The Siberian climate [part of the native range] is quite varied, but has an average low temperature in January of -12°C, and an average high temperature in July of 25.7°C. Precipitation is low in the north, but high in the south with heavy summer rainfall up to 850mm.”

Distribution Outside the United States

Native

From Nico et al. (2026):

“Native from northern Europe through Siberia (Berg 1949; Robins et al. 1991).”

From Froese and Pauly (2023):

“Europe and Asia: Baltic, Black, northern Caspian and North Sea basins, Atlantic basin southward to Seine and lower Loire drainages (France). Absent in Scandinavia north of 69°N. In Asia, eastward to Lena drainage and Aral basin.”

Introduced

From Siriwardena (2008):

“*L. idus* was introduced to the UK in 1874, where the golden ornamental variety became common in lakes (Lever, 1977). *L. idus* was introduced to The Netherlands from France and Germany as an ornamental fish and it is cultured on a large scale for ornamental purpose (Groot, 1985). [...] It has been introduced to New Zealand from the UK and the USA during the 1980s and has been captured in the wild, and occurs and reproduces in several small lakes in northern New Zealand (McDowall, 1990)”

From Froese and Pauly (2023):

“Introduced to Great Britain and northern Italy (Kottelat and Freyhof, 2007).”

From Nico et al. (2026):

“Outside of the United States, *L. idus* has introduced [sic] to [...] France (IUCN SSC Invasive Species Specialist Group 2010).”

Means of Introduction Outside the United States

From Siriwardena (2008):

“Natural dispersal of individuals and populations occurs through swimming, and they can thus expand their range within and between connected water bodies.”

“The golden variety of *L. idus* which is valued as ornamental pond fish is spread to new locations through the aquarium trade. In addition to its ornamental purpose it [sic] there have also been instances of *L. idus* being illegally introduced to new locations by anglers. *L. idus* eggs, derived from ornamental pond stocks, have been illegally imported to New Zealand by mail sometime in the 1980s and subsequent releases occurred in 1985-86 in a number of sites north of Auckland; however, the current status of these populations is not known.”

Short Description

From Siriwardena (2008):

“*L. idus* is a medium-sized fish, typically growing to 30-43 cm in total length with a weight of 680 g (Wheeler, 1978). [...] It has a typical minnow-shaped body that is moderately thick, and older adults have a raised humped back nape and 55-63 lateral-line scales (Nico and Fuller, 2008). The snout is blunt and the mouth is small, terminal, and oblique. Gill rakers are short, widely spaced, and number 10-14 on the first arch. The pharyngeal teeth are conic, smooth (not serrated), and arranged in two rows. It has dorsal spines in total 3 - 3; dorsal soft rays in total 8 - 11; anal spines 3; anal soft rays 8 – 11; vertebrae 47 (Fishbase, 2008) and caudal fin with 19 rays (Spillman, 1961).”

“Adults are dark on the back and sides above the lateral line, the lower parts of the sides are light or silvery and the fins are red, especially the anal fin and paired fins (Nico and Fuller, 2008). Some colour variations of *L. idus* have been documented. The wild form is a greyish-olive colour on the back and upper sides, paling to silver on the sides and silvery-white on the belly, whereas both anal and pelvic fins are a reddish colour. The ornamental variety has a bright orange back, silvery-orange sides and belly, and bright orange tail and dorsal fin.”

Biology

From Siriwardena (2008):

“Occurs in schools in clear pools of medium to large rivers, ponds and lakes (Page and Burr, 1991), however, deeper waters are sometimes used in winter (Wheeler, 1969). Wheeler (1978) noted that *L. idus* inhabits the lower reaches of large rivers, lowland lakes, and brackish estuaries of rivers, adding that it schools in clean, deep water, moving into shallow freshwater to spawn in the spring. Zhadin and Gerd (1963) reported it was one of the most common fishes in reservoirs on the Ob, Novosibirsk, and Bukhtarma-Zaisan rivers of the former Soviet Union. Seeley (1886) reported that the species is not confined to freshwaters, as it is also found in the Baltic Sea. In Sweden, *L. idus* spent the first year of life in the river and then joined older fish migrating to the Baltic Sea during the summer months, returning to the river in the autumn and remaining near the mouth and in the lower reaches throughout the winter (Cala, 1970). It enters rivers in spring to spawn over gravel or vegetation (Fishbase, 2008), and after spawning, *L. idus* returns to coastal waters (Cala, 1970). [...] *L. idus* matures sexually at the age of 3-5 years and at total lengths varying from 22 cm to 43 cm (Banareescu, 1964; Cala, 1971). At maturity, males maybe [sic] smaller than females (Cala, 1971). In contrast, *L. idus* inhabiting a reservoir in a more northern location (Finnish Lapland) reached maturity at a larger size and older age (6-7 years) (Mutenia, 1978).”

From Froese and Pauly (2023):

“Usually inhabits large lowland rivers and nutrient-rich lakes. Adults are solitary while juveniles are gregarious. [...] Feeds on various aquatic and terrestrial animals and plant material. Larger individuals feed mainly on fishes. Feeding larvae and juveniles thrive in a wide variety of shoreline habitats and leave the shores for deeper waters when growing.”

Human Uses

From Siriwardena (2008):

“The golden variety of *L. idus* has an economic as well as livelihood value as an ornamental fish in the ornamental fish trade.”

From Froese and Pauly (2023):

“Its flesh is not tasty (Billard 1997). Aquarium keeping: at least 10 individuals; minimum aquarium size >200 cm; not recommended for home aquariums (BMELF 1999).”

Diseases

***Leuciscus idus* has been documented as a possible carrier of Koi Herpesvirus, a disease listed by the World Organisation for Animal Health (2023).**

From Bergmann et al. (2009):

“In conclusion it was shown that more fish species than carp or koi, such as goldfish, ide, *Ancistrus* sp. and grass carp may carry KHV [koi herpesvirus] genetic material, especially from areas with endemic KHVD [koi herpesvirus disease] in eastern Asia, which was confirmed by sequence analysis of the PCR products and ISH [*in-situ* hybridization] with different fish tissues.”

From McAllister et al. (1985):

“The present report describes an outbreak of carp pox [epithelioma papillosum] in golden ide, *Leuciscus idus*. The disease appeared 1 yr after the fish were imported into the United States from the Federal Republic of Germany.”

From Ondraèková et al. (2004):

“Metacercariae of *P[osthodiplostomum] cuticola* have been found in over 50 fish species; with [six species including] *Leuciscus idus* [...] being the most common intermediate fish hosts [...]”

Poelen et al. (2014) states this species is a host of *Acanthocephalus anguillae*, *Acanthocephalus lucii*, Aquareovirus G, Carp sprivivirus, Cyprinid herpesvirus 1, Cyprinid herpesvirus 3, *Dactylogyrus crucifer*, *Dactylogyrus ramulosus*, *Dactylogyrus robustus*, *Dactylogyrus vistulae*, *Dactylogyrus tuba*, *Echinorhynchus salmonis*, *Gyrodactylus prostate*, *Myxobolus elegans*, *Myxobolus intimus*, Pike fry sprivivirus, Pike fry-like rhabdovirus, *Pomphorhynchus laevis*, and *Proteocephalus* sp.

Threat to Humans

From Froese and Pauly (2023):

“Harmless”

3 Impacts of Introductions

From Siriwardena (2008):

“*L. idus* is considered a potentially invasive fish that could damage native aquatic ecosystems, though there is lack of information regarding its impacts. The ability of *L. idus* to tolerate wide range of habitats including fresh, brackish, and sea water led to it being recognized it [sic] as a potential invasive species, similar to several other invasive members of the Cyprinidae (carp) family. However, there are no recorded negative environmental impacts caused by this species to date.”

New Mexico (NMDGF 2023), Nevada (NBWC 2022), and Texas (TPWD 2022) all regulate the entire genus of *Leuciscus* while Arkansas (AGFC 2022), Arizona (Arizona Game and Fish Commission 2022), California (CDFW 2021), Colorado (CPW 2023), Connecticut (Connecticut DEEP 2020), Hawaii (HDOA 2019), Idaho (IDDA 2022), Michigan (Michigan Compiled Laws 2022), Ohio (ODNR 2022), Oregon (ODFW 2022), and Washington (WDFW 2022) all regulate *Leuciscus idus* itself. See section 1.

4 History of Invasiveness

The History of Invasiveness for *Leuciscus idus* is classified as Data Deficient. There are records of this fish being introduced outside of its native range in the United States, Europe, and New Zealand. In many cases outside the United States, the introductions resulted in established populations. *L. idus* may have persisted in some locations in the United States for a period of time but there were no documented locations where a currently established population could be found. Although these fish have become established outside the United States, no information was found documenting impacts or lack of impacts from introduction, just speculation on potential impacts.

5 Global Distribution

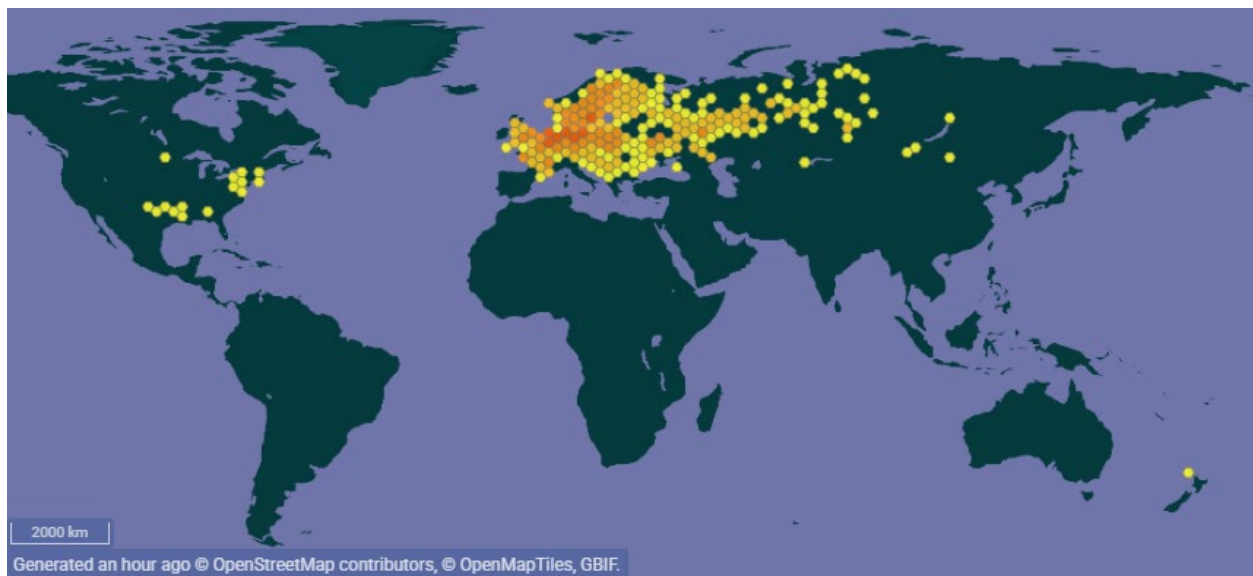


Figure 1. Reported global distribution of *Leuciscus idus*. Map from GBIF Secretariat (2023). Observations are reported from Europe, Northern and Western Asia, New Zealand, and the United States. Records from the United States were not used in the climate matching analysis (see section 6).

6 Distribution Within the United States

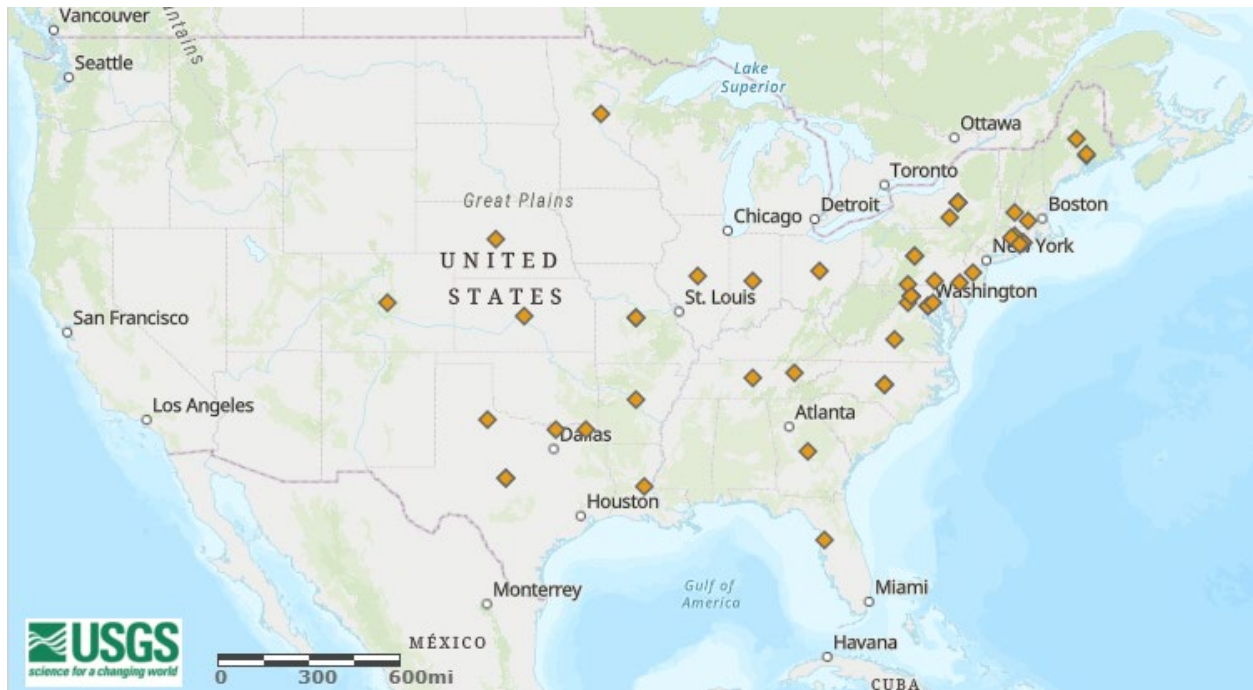


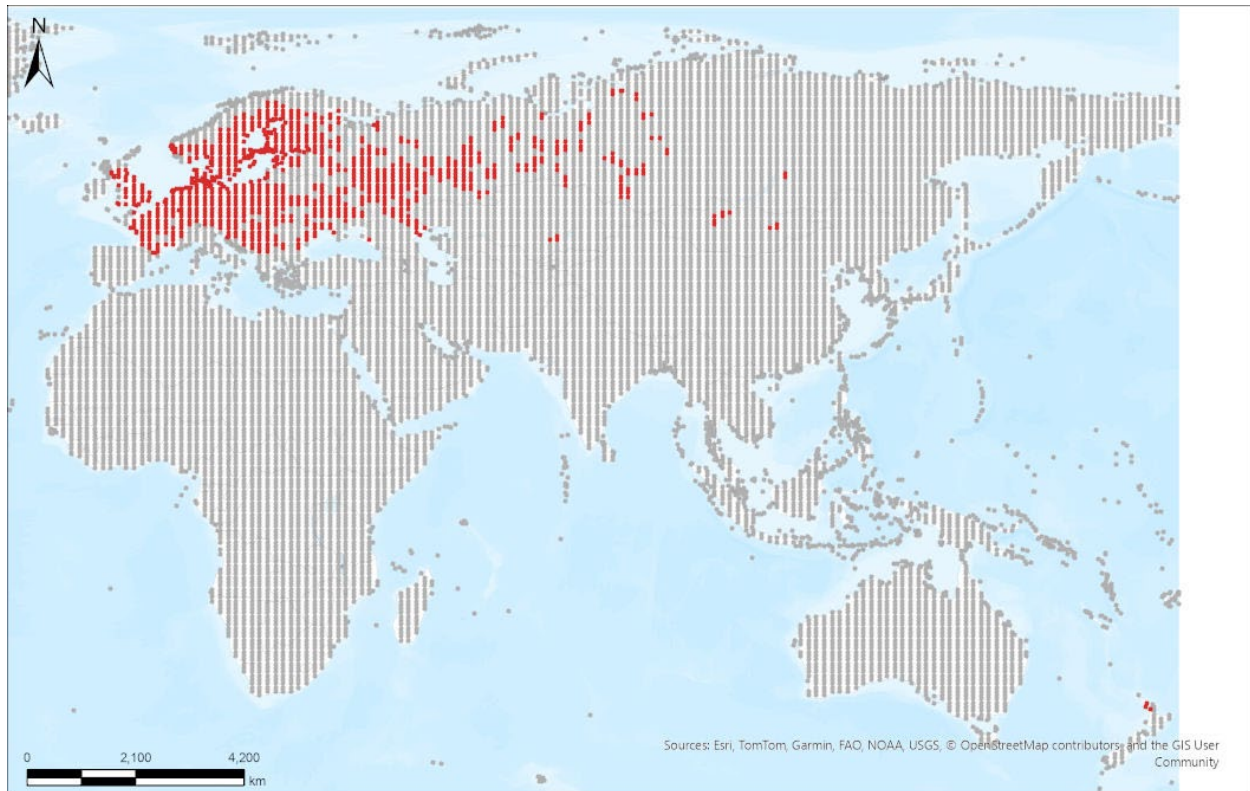
Figure 2. Reported distribution of *Leuciscus idus* in the United States. Map from Nico et al. (2026). None of these records were used in the climate matching analysis. Introductions either failed, once-established populations disappeared, or establishment status was unclear.

7 Climate Matching

Summary of Climate Matching Analysis

The climate matching analysis found a generally medium to high match for *Leuciscus idus* to the contiguous United States. The areas of high match were found in the Appalachian Range, Colorado Plateau, Great Basin, Great Lakes, Mid-Atlantic, Northeast, and upper Northern Plains regions. Areas of low match were found along the Pacific Coast, in the Desert Southwest, in southern Louisiana, and peninsular Florida. Generally, everywhere else had a medium climate match. The overall Climate 6 score (Sanders et al. 2023; 16 climate variables; Euclidean distance) for the contiguous United States was 0.822, 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 *Leuciscus idus* (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.



Species: *Leuciscus idus*

Selected Climate Stations ●



RAMP

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Figure 3. RAMP (Sanders et al. 2023) source map showing weather stations in North America, Europe, Asia, and New Zealand selected as source locations (red; Andorra, Austria, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Isle of Man, Kazakhstan, Latvia, Lithuania, Luxembourg, Moldova, Mongolia, Montenegro, Netherlands, New Zealand, Norway, Poland, Romania, Russia, Serbia, Slovakia, Slovenia, Sweden, Switzerland, United Kingdom, and Ukraine) and non-source locations (gray) for *Leuciscus idus* climate matching. Source locations from GBIF Secretariat (2023). Selected source locations are within 100 km of one or more species occurrences, and do not necessarily represent the locations of occurrences themselves.

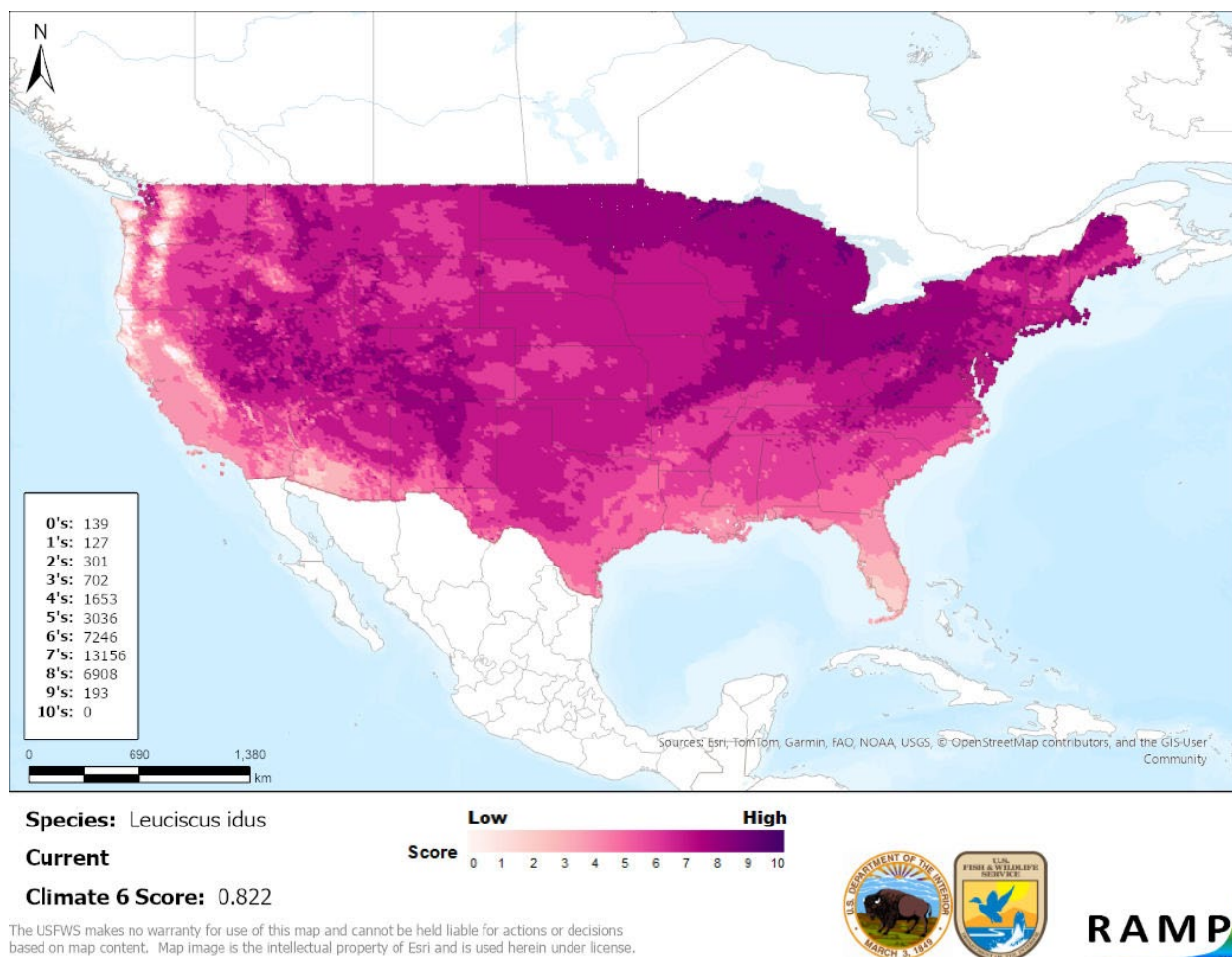


Figure 4. Map of RAMP (Sanders et al. 2023) climate matches for *Leuciscus idus* in the contiguous United States based on source locations reported by GBIF Secretariat (2023). Counts of climate match scores are tabulated on the left. 0/Pale Pink = Lowest match, 10/Dark Purple = Highest match.

8 Certainty of Assessment

The Certainty of Assessment for *Leuciscus idus* is classified as Low. There was limited and contradictory data on the species' establishment in the United States. General information on the biology, ecology, and distribution of the species outside of the United States was available from reliable sources. No information on documented impacts from introductions was found.

9 Risk Assessment

Summary of Risk to the Contiguous United States

Leuciscus idus, Ide, is a fish that is native to northern Europe and Asia. This species is a riverine species that can also live in brackish areas. As adults, they eat smaller fish. *L. idus* is commonly used as an ornamental fish for ponds. Escape from these ponds into the wild during flood events is a common means of introduction. Historically, *L. idus* was provided for intentional stocking by the U.S. Fish Commission. This species may carry Koi Herpesvirus, a disease listed by the

World Organisation for Animal Health. *L. idus* is regulated in 16 states with three of them regulating the entire genus. *L. idus* has been introduced in the United States and New Zealand, and outside its native range in Europe. In Europe and New Zealand, those introductions resulted in established populations. The status of this fish in the United States is more uncertain, with no evidence found for extant established populations. The History of Invasiveness for *L. idus* is classified as Data Deficient due to no information being found regarding documented impacts from introductions. The climate matching analysis for the contiguous United States indicates establishment concern for this species. Areas of high match were found within the Great Lakes, portions of the Mid-West, Great Basin, and Colorado Plateau. The Pacific Coast, Desert Southwest, and Florida had low matches. The Certainty of Assessment for this ERSS is classified as Low mainly due to there being a lack of information on documented impacts or lack of impacts from introductions. The Overall Risk Assessment Category for *Leuciscus idus* 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: Potential carrier of Koi Herpesvirus, a disease listed by the World Organisation for Animal Health.**
- **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).

Under the future climate scenarios (figure A1), on average, high climate match for *Leuciscus idus* was projected to occur in the Great Lakes region of the contiguous United States. The extent of area of high match was reduced under scenario SSP5 2085. Small areas of high match were found in the Colorado Plateau, Great Basin, and Western Mountains across most future scenarios. Areas of low climate match were projected to occur in the Northern Pacific Coast and Southern Florida regions. Areas of the Southern Plains and Southeast also had low matches under both SSP3 and SSP5 at time step 2085 with the extent of low match expanding further northward under SSP5 than under SSP3. The Climate 6 scores for the individual future scenario models (figure A2) ranged from a low of 0.205 (model: UKESM1-0-LL, SSP5, 2085) to a high of 0.749 (model: MPI-ESM1-2-HR, SSP3, 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 (0.822, figure 4) 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 all time step and climate scenarios only minor or no increases in the climate match relative to the current match were observed. Under one or more time step and climate scenarios, areas within the Appalachian Range, Colorado Plateau, Great Lakes, Gulf Coast, Mid-Atlantic, Southeast, Southern Plains, and Southwest saw a large decrease in the climate match relative to current conditions. Additionally, areas within California, the Great Basin, Northeast, Northern Pacific Coast, Northern Plains, Southern Atlantic Coast, and Western Mountains saw a moderate decrease in the climate match relative to current conditions. The magnitude and extent of decreases were larger in time step 2085 under both scenarios, with the areas of decrease having the largest extent under SSP5 at time step 2085. Additional very small areas of large or moderate change may be visible on the maps (figure A3).

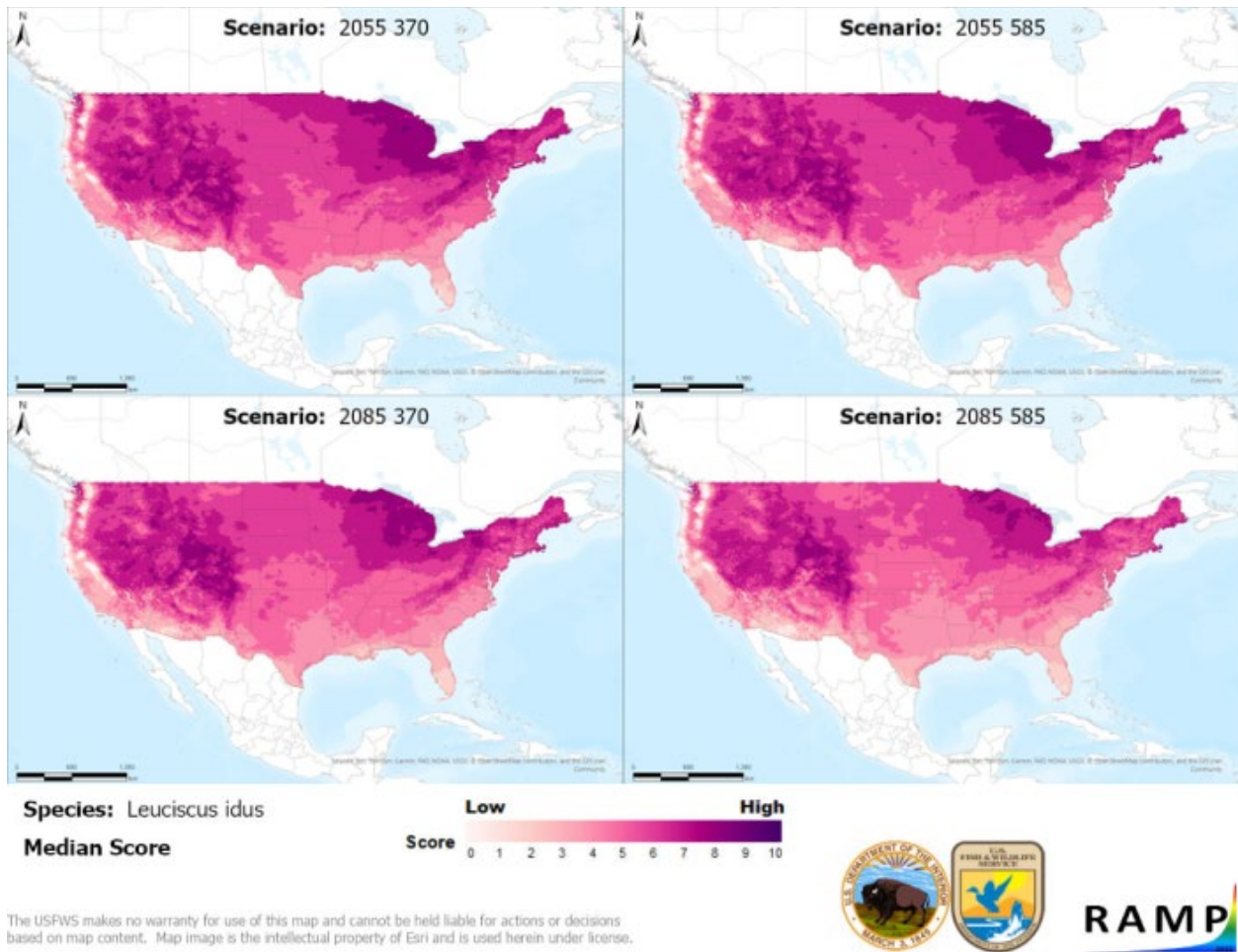


Figure A1. Maps of median RAMP (Sanders et al. 2023) climate matches projected under potential future climate conditions using five global climate models for *Leuciscus idus* in the contiguous United States. Climate matching is based on source locations reported by GBIF Secretariat (2023). Shared Socioeconomic 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.

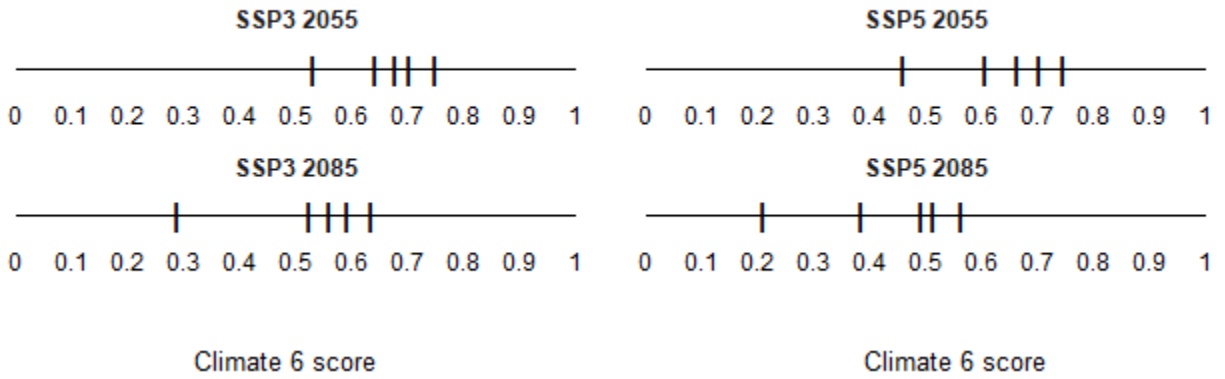


Figure A2. Comparison of projected future Climate 6 scores for *Leuciscus idus* in the contiguous United States for each of five global climate models under four combinations of Shared Socioeconomic Pathway (SSP) and time step. SSPs used (from left to right): SSP3, SSP5 (Karger et al. 2017, 2018; IPCC 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.

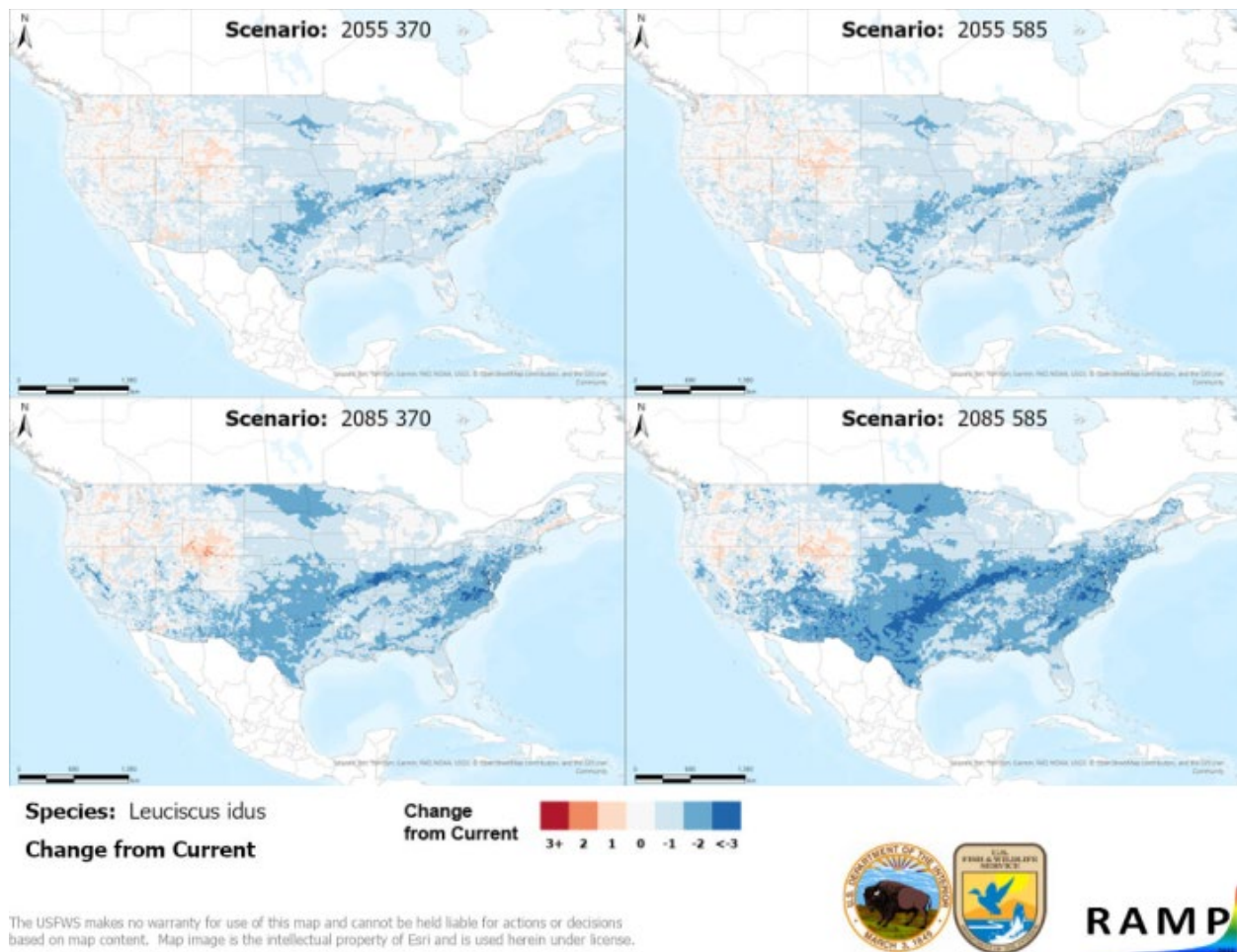


Figure A3. RAMP (Sanders et al. 2023) maps of the contiguous United States showing the difference between the current climate match target point score (figure 4) and the median target point score for future climate scenarios (figure A1) for *Leuciscus idus* based on source locations reported by GBIF Secretariat (2023). 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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