Wakasagi (*Hypomesus nipponensis*)
Ecological Risk Screening Summary

U.S. Fish and Wildlife Service, November 2023
Revised, December 2024
Web Version, 9/26/2025

Organism Type: Fish
Overall Risk Assessment: High

Photo: René Reyes - Bureau of Reclamation. Public Domain. Available: https://nas.er.usgs.gov/queries/FactSheet.aspx?SpeciesID=794 (December 2024).

1 Native Range and Status in the United States

Native Range

From Bogutskaya (2021):

"*Hypomesus nipponensis* occurs within continental rivers of Russia, Sakhalin island, the Democratic People's Republic of Korea, and the islands of Hokkaido and Honshu (south to Tokyo), Japan. Within the Amur drainage this species is found from the north-east estuary and Kizi Lake, southward along the Russian continental coast of the Sea of Japan from the Amur Liman Strait down to the Korean Peninsula (Bogutskaya et al. 2008, Dyldin and Orlov 2016, Antonov et al. 2019). It is also known on the southern Kurils, where it occurs upon Iturup, Kunashir, Panfilyev, and Zelionyi (Pietsch et al. 2001). Upon Sakhalin this species is known along all the coasts, including brackish lakes of Tunaicha, Izmenchivoye, Baikal, and Ainu, in the Amur Liman, and the Chayvo and Pil'tun lagoons, as well as the southern freshwater lakes of Vavai–Chibisan (Dyldin and Orlov 2016)."

Status in the United States

From Fuller (2024):

"This species is established in several reservoirs and associated tributaries in California (Moyle 1976a; Shapovalov et al. 1981; Courtenay et al. 1986). It has not been recorded in Big Bear Lake since 1960 (Swift et al. 1993)."

From NatureServe (2024):

"This species can be expected anywhere in the lower Klamath River system, in the Sacramento River system, and possibly in other systems as well (Moyle 1976[a]). Recently found in the Sacramento-San Joaquin estuary (see Fuller et al. 1999)."

From Fofonoff et al. (2018):

"A population of Wakasagi had established in this lake [Freshwater Lagoon, Humboldt County, California] by 1961. Other stockings were in northern California (Siskiyou County) and southern California (Big Bear Lake, San Bernardino County), and two lakes in the upper San Francisco Bay watershed, Spaulding Lake (Nevada County), and Jenkinson Lake (El Dorado County), In 1972, Wakasagi were stocked in Lake Almanor, Plumas County, in the upper mountain reaches of the San Francisco Bay watershed and then spread further downstream to Lake Oroville in the foothills (Dill and Cordone 1997)."

"Wakasagi were first collected in the Sacramento-San Joaquin Delta in 1974, […]. The specimens were long unrecognized, due to their similarity to Delta Smelt. […] Wakasagi have now been collected from Cache Slough (upstream) to Suisun Bay (downstream) […] They have also been collected in reservoirs which feed into the Delta-Mendota Canal and the California aqueduct, so there is a potential for transport to southern California (Aasen et al. 1998). Wakasagi have expanded their range in the Central Valley, but have a patchy distribution in the estuary."

No information was found on *Hypomesus nipponensis* in live trade in the United States.

Regulations

No species-specific regulations on possession or trade were found within the United States.

Means of Introductions within the United States

From Fuller (2024):

"Wakasagi were intentionally introduced in 1959 from Japan by the California Department of Fish and Game as an experimental forage fish for trout (Wales 1962; Moyle 1976b; Dill and Cordone 1997)."

From Fofonoff et al. (2018):

"[…] probably transported by water releases from the Lake Oroville reservoir. […] High river outflows in the 1990s may have increased the population in the estuary. […] It is likely that some fish will be transported into San Pablo Bay during heavy river outflows."

Remarks

From Fuller (2024):

"Dill and Cordone (1997) reviewed its introduction history in California. In documenting the original introduction, Wales (1962) incorrectly identified the species as *Hypomesus olidus*. Several authors (e.g., Moyle 1976a; Lee et al. 1980 et seq.) treated the introduced wakasagi as a subspecies of *H. transpacificus* (i.e., as *H. t. nipponensis*). In California the wakasagi is generally considered a freshwater species, hence its often-used name "freshwater smelt" in that state; however, it has recently been discovered in brackish waters, further threatening the continued survival of the imperiled delta smelt (Dill and Cordone 1997)."

From Fofonoff et al. (2018):

"[…] closely related to the very similar Delta Smelt (*Hypomesus transpacificus*), an endangered species native to the San Francisco Bay estuary. The two species were once considered conspecific subspecies (Page and Burr 1991; Froese and Pauly 2018)."

Hypomesus nipponensis has been intentionally stocked outside its native range within the United States by State fishery managers to achieve fishery management objectives. State 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.

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From ITIS (2023):

Kingdom Animalia
  Subkingdom Bilateria
    Infrakingdom Deuterostomia
      Phylum Chordata
        Subphylum Vertebrata
          Infraphylum Gnathostomata
            Superclass Actinopterygii
              Class Teleostei
                Order Anseriformes
                  Suborder Osmeroidei
                    Superfamily Osmeroidea

Family Osmeridae
Genus *Hypomesus*
Species *Hypomesus nipponensis* McAllister, 1963

According to Fricke et al. (2024), *Hypomesus nipponensis* McAllister 1963 is the current valid name for this species.

Size, Weight, and Age Range

From Froese and Pauly (2024):

"Max length : 17.0 cm TL [total length] male/unsexed; [Page and Burr 1991]"

From Fofonoff et al. (2018):

"[…] is small (110-250 mm) […]"

Environment

From Froese and Pauly (2024):

"Marine; freshwater; brackish; pelagic-neritic; anadromous [Riede 2004]"

From Bogutskaya (2021):

"Freshwater populations are found within coastal rivers as both landlocked and river-lake forms (Antonov et al. 2019). This species is usually semi-anadromous and common in the lower reaches of rivers and lakes along the entire coast of the Sea of Japan (Bushuev and Barabanshchikov 2012)."

From Fofonoff et al. (2018):

"Experiments indicate that adult Wakasagi can tolerate a wide range of temperature (2-29 C) and salinity (0-27 PSU) (Swanson et al. 2000). The salinity tests used NaCl, rather than seawater, so may have underestimated the upper salinity tolerance. We know some Japanese populations occur in coastal seawater (Arai et al. 2006). In the San Francisco estuary, most of the fish have been captured at 0-10 PSU (Aasen et al. 1998). We have not found reports of capture in the San Francisco Bay proper or in other coastal waters."

Climate

From Froese and Pauly (2024):

"Temperate"

Distribution Outside the United States

Native

From Bogutskaya (2021):

"*Hypomesus nipponensis* occurs within continental rivers of Russia, Sakhalin island, the Democratic People's Republic of Korea, and the islands of Hokkaido and Honshu (south to Tokyo), Japan. Within the Amur drainage this species is found from the north-east estuary and Kizi Lake, southward along the Russian continental coast of the Sea of Japan from the Amur Liman Strait down to the Korean Peninsula (Bogutskaya et al. 2008, Dyldin and Orlov 2016, Antonov et al. 2019). It is also known on the southern Kurils, where it occurs upon Iturup, Kunashir, Panfilyev, and Zelionyi (Pietsch et al. 2001). Upon Sakhalin this species is known along all the coasts, including brackish lakes of Tunaicha, Izmenchivoye, Baikal, and Ainu, in the Amur Liman, and the Chayvo and Pil'tun lagoons, as well as the southern freshwater lakes of Vavai–Chibisan (Dyldin and Orlov 2016)."

Introduced

From Fofonoff et al. (2018):

"Wakasagi was introduced to lakes in northeast China in the 1940s, and introduced more widely to central and northwestern China in the 1990s, as a forage fish for the native European Perch (*Perca fluviatilis*) (Zhou et al. 2014)."

From Yin et al. (2022):

"The Japanese smelt (*Hypomesus nipponensis*) invaded and has become a dominant fish species in Lake Erhai, a highland lake in southwestern China, since 2016."

Means of Introduction Outside the United States

From Yin et al. (2022):

"It has been inadvertently introduced throughout China with the rapid development of aquaculture fish species (Xie et al., 1993; Zhou et al., 2013)."

Short Description

From Fofonoff et al. (2018):

"[…] [*Hypomesus nipponensis*] with a streamlined body, a single, soft-rayed dorsal fin, abdominal pelvic fins, and a small adipose fin anterior to the forked tail. Their scales are small and silvery. Wakasagi have an upper jaw that ends before the middle of the eye. There are 7-9 dorsal rays, 13-15 anal rays, 12-14 pectoral rays, and 54-60 lateral scales. These ranges differ, but overlap, with those of the native endangered Delta Smelt (*H. transpacificus*). The two species differ in coloration. Wakasagi is golden-brown above, with silvery-white, nearly translucent sides, with black specks on the back and side. There is a line of ten or more black specks, on the isthmus, the ventral ridge between the mandibles. The native Delta Smelt is steel-blue above, with a silver stripe on the side, and few or no black specks between the mandibles."

Biology

From Bogutskaya (2021):

"It spawns in rivers, with upstream migration beginning in late April and early May, but not rising very far upstream, commonly a few tens of kilometers or less (Bushuev and Barabanshchikov 2012). It spawns on stony-pebble soils in places with a fast current and after spawning, the smelt descends into the estuaries. During the summer, it stays in coastal parts of the sea, in lagoons and coastal lakes, which still have a connection with the sea (Bushuev and Barabanshchikov 2012). In autumn, usually in the second half of September, a second migration into the river begins. The species forms residential forms in some lakes and reservoirs. It feeds on various small planktonic organisms (Bushuev and Barabanshchikov 2012)."

From Fofonoff et al. (2018):

"It needs freshwater or low-salinity brackish lakes to complete its life cycle, but anadromous populations occur and can coexist with resident lake populations (Aasen et al. 1998; Asami 2004; Arai et al. 2006). Sexes are separate. The fish mature in their second year, at a length of 60-70 mm. Most fish in Honshu [Japan] die after their first spawning, but some fish in Hokkaido spawn in their second year. Spawning takes place in freshwater streams where they lay adhesive eggs on rocks and gravel. Eggs take about 12 days to hatch at 14 C (Aasen et al. 1998; Saruwatari et al. 1997; Froese and Paul 2018). Fecundity ranges from 1033 to 44,000 eggs per female (Froese and Paul 2018)."

Fofonoff et al. (2018) report that this species eats copepods, cladocerans, mysids, and rotifers.

Human Uses

From Froese and Pauly (2024):

"Fisheries: commercial; aquaculture: commercial"

From NIES (2024):

"Routinely released for fishing. […] For food and sports fishing."

Diseases

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

Poelen et al. (2014) lists the follow parasites and pathogens for *Hypomesus nipponensis*: *Diphyllobothrium hottai*, *Salvelinema salmonicola*, *Hysterothylacium aduncum*, *Proteocephalus tetrastomus*, *Acanthocephalus*, *Contracaecum aduncum*, *Ichthyascaris biwakoensis*, and *Proteocephalus tetrastomus*.

Threat to Humans

From Froese and Pauly (2024):

"Potential pest [Lever 1996]"

3 Impacts of Introductions

From Yin et al. (2022):

"When the Japanese smelt [*Hypomesus nipponensis*] invaded Lake Erhai and became the dominant species, it had tremendous direct and indirect impacts on the food web, which in turn poses a higher ecological risk to the lake. Additionally, its invasion also significantly affected the biomass of other functional groups in the Lake Erhai ecosystem, including icefish, sharpbelly, bighead carp, and zooplankton."

"The total biomass and catch of omnivorous fish increased by 10.4% and 12.8%, respectively, following the invasion of the Japanese smelt […]. A remarkable result was that the total catches of zooplanktivorous fishes increased by 13.2% after the invasion of the Japanese smelt, although its biomass did not decrease appreciably. For carnivorous and phytoplanktivorous fish, their catches decreased considerably from 21.1% and 29% to 8.8% and 16.2%, respectively, following the invasion of the Japanese smelt […]."

"Moreover, the biomass and EE [ecotrophic efficiency] values of zooplanktivorous fish (Hu et al., 2015; Tang, 2013), such as icefish and sharpbelly, significantly decreased after the invasion of Japanese smelt."

"Previous studies have shown that the introduction of Japanese smelt into Lake Ulungur caused several adverse effects, including a dramatic decline in the population of native fish with similar diets (Zhou et al., 2013)."

From Fuller (2024):

"This species has been found to negatively impact kokanee *Oncorhynchus nerka* and threadfin shad *Dorosoma petenense* (Dill and Cordone 1997). It also is known to hybridize with the native and federally endangered delta smelt *Hypomesus transpacificus*. Hybridization between the two species was suspected by Courtenay et al. (1986), and was later confirmed (Dill and Cordone 1997; Trenham et al. 1998)."

From Fofonoff et al. (2018):

"Wakasagi (*Hypomesus nipponensis*) was considered a largely successful introduction as a forage fish in California reservoirs, at least in the short term. In Lake Almanor (Plumas County), the introduction of Wakasagi led to increased abundance and growth of Coho Salmon (*Oncorhynchus kisutch*), Rainbow Trout (*O. mykiss*), Brown Trout (*Salmo trutta*), and Smallmouth Bass (*Micropterus dolomieu*). However, it also led to decline of a planktivorous gamefish, landlocked Kokanee Salmon (*O. nerka*), and another forage fish, Threadfin Shad

(*Dorosoma petenense*). In the reservoirs the benefits were considered to outweigh the losses (Dill and Cordone 1997)."

"The impacts of Wakasagi on reservoir fish populations, described above, suggests potential impacts in the estuary. The impacts on the Delta Smelt are difficult to measure, based on the difficulty of separating the two species in catches. However, Wakasagi reach a larger size, have higher fecundity, have a wider temperature tolerance, a higher salinity tolerance, and a faster swimming speed than Delta Smelt, and thus, a potential competitive advantage (Swanson et al. 2000). In China, competition between introduced Wakasagi and larval Eurasian Perch (*Perca fluviatilis*, native) may have been responsible for the collapse of a perch population in Lake Ulungar (Zhou et al. 2013)."

"Hybridization of Wakasagi and Delta Smelt is a concern. However, in one sample of 280 Delta Smelt, only one F1 hybrid was found (Trenham et al. 1998). Despite their morphological similarity, the two species are genetically distinct, making introgression unlikely (Stanley et al. 1995). In a survey of 384 fish, 125 specimens morphologically identified as Delta Smelt, were genetically identified as Wakasagi. Three fish were F1 hybrids, and two were F2 backcrosses. All the hybrids had Wakasagi as the maternal parent, suggesting that the introgression was occurring from Delta Smelt to Wakasagi, but not in the other direction (Benjamin et al. 2018)."

No species-specific regulations on possession or trade were found within the United States.

4 History of Invasiveness

The History of Invasiveness for *Hypomesus nipponensis* is classified as High. This species was introduced to California as a forage fish where it has now negatively impacted native fish species such as kokanee *Oncorhynchus nerka* and threadfin shad *Dorosoma petenense*. Introductions in China have resulted in changes in fish populations and the overall trophic system. It has also been found to hybridize with the delta smelt *Hypomesus transpacificus*, which is a federally endangered species.

5 Global Distribution

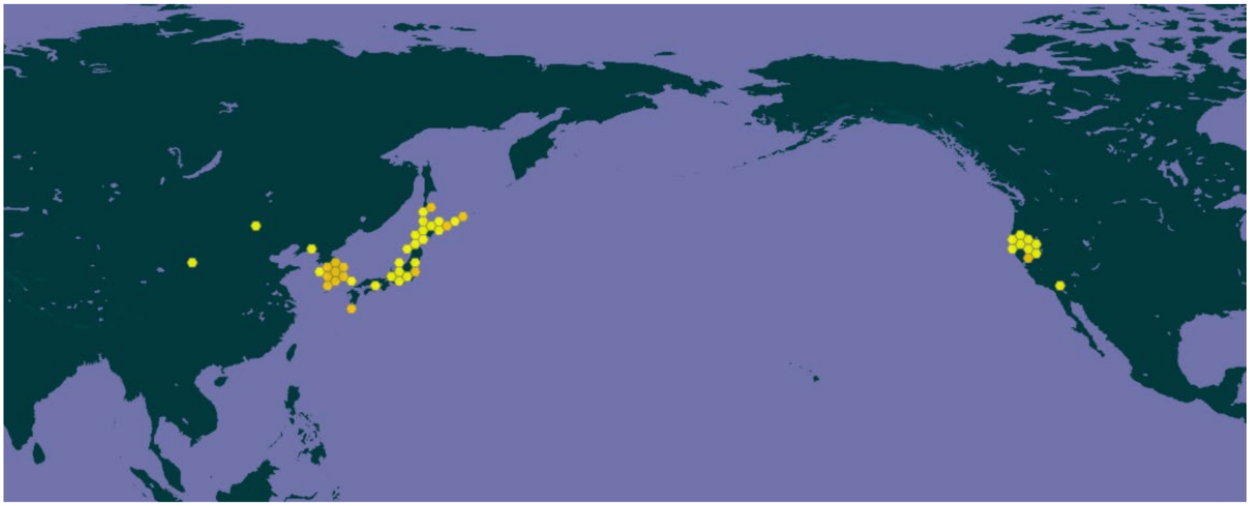

Figure 1. Reported global distribution of *Hypomesus nipponensis*. Map from GBIF Secretariat (2023). Observations are reported from eastern Russia, the Korean Peninsula, Japan, China, and California in the United States. The points in China do not represent established populations and were removed for climate matching.

Yin et al. (2022) gave locations of established populations in China that were used in the climate matching analysis.

6 Distribution Within the United States

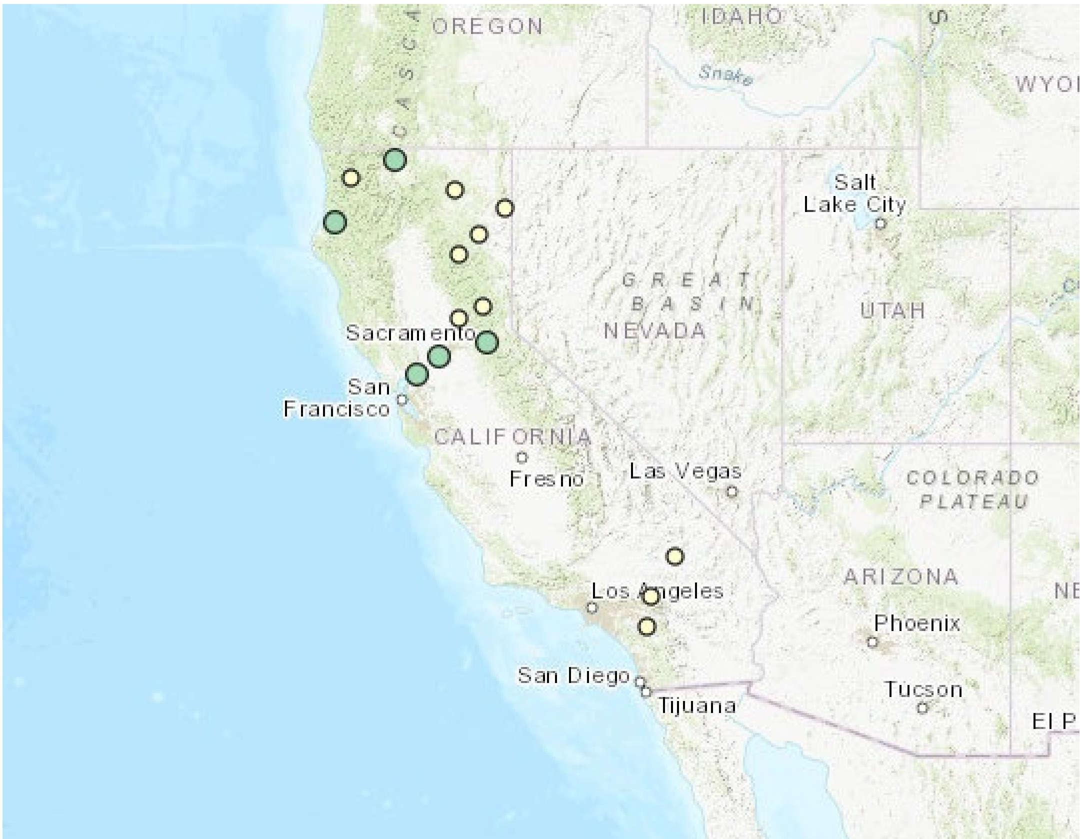

Figure 2. Reported distribution of *Hypomesus nipponensis* within the United States. Map from Fuller (2024). Observations are recorded in California.

7 Climate Matching

Summary of Climate Matching Analysis

The climate matching analysis for *Hypomesus nipponensis* to the contiguous United States found mostly medium to high matches. The Western Mountains, Northern Pacific Coast, Great Basin, and California regions had high climate matches. Small areas of low match were found in areas of the Southern Plains, Louisiana, and eastern New England regions. The rest of the country had medium matches. The overall Climate 6 score (Sanders et al. 2023; 16 climate variables; Euclidean distance) for the contiguous United States was 0.812, 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 2023). This species migrates between fresh and brackish water environments. Because not all locations in the United States are conducive to such migration, establishment of this species may be limited according to habitat connectivity.

Projected climate matches in the contiguous United States under future climate scenarios are available for *Hypomesus nipponensis* (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.

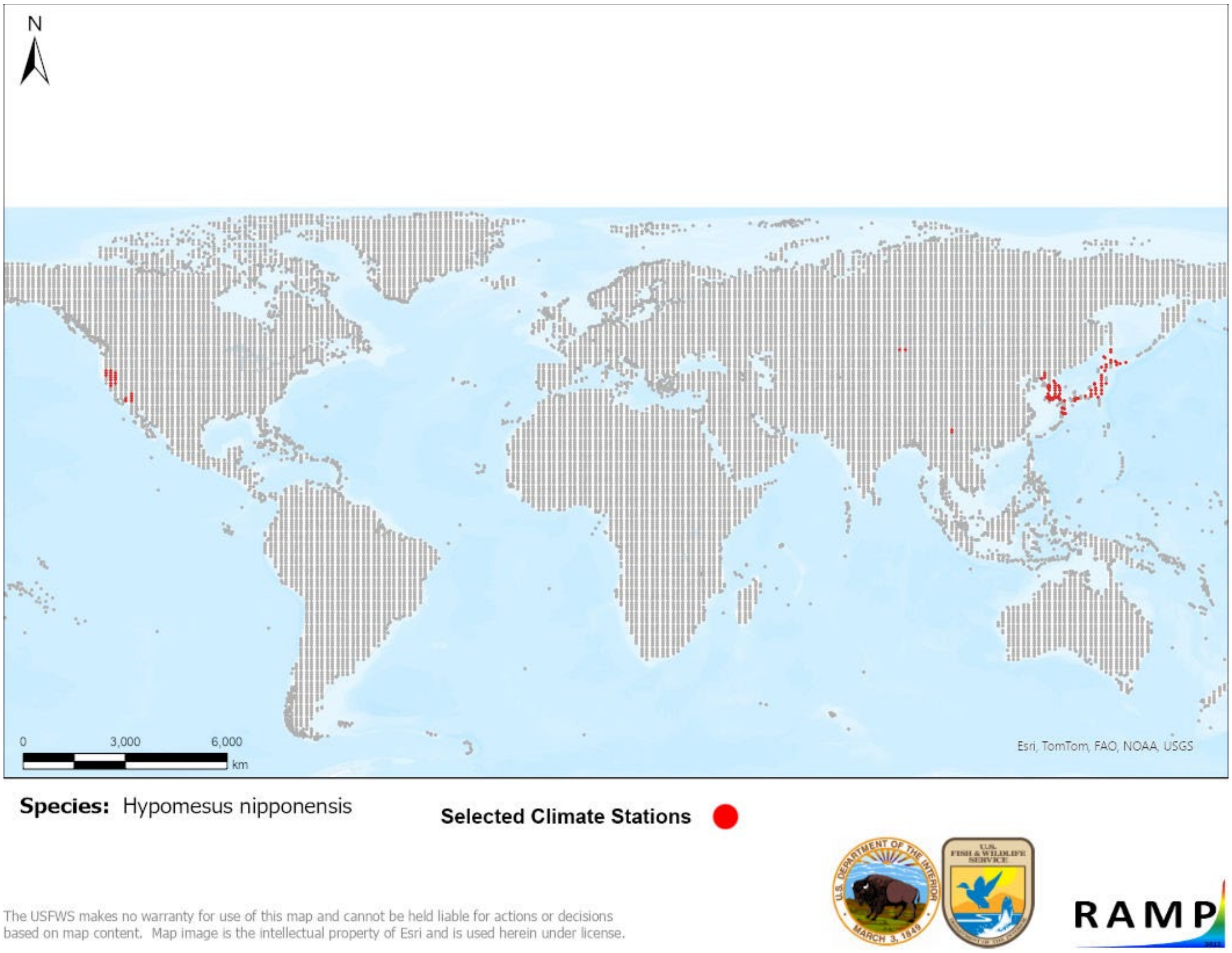

Figure 3. RAMP (Sanders et al. 2018) source map showing global weather stations selected as source locations (red; United States, Japan, Korea, China, Russia) and non-source locations (gray) for identifying climate matching of *Hypomesus nipponensis*. Source locations from GBIF Secretariat (2023) and Yin et al. (2022). Selected source locations are within 100 km of one or more species occurrences, and do not necessarily represent the locations of occurrence themselves.

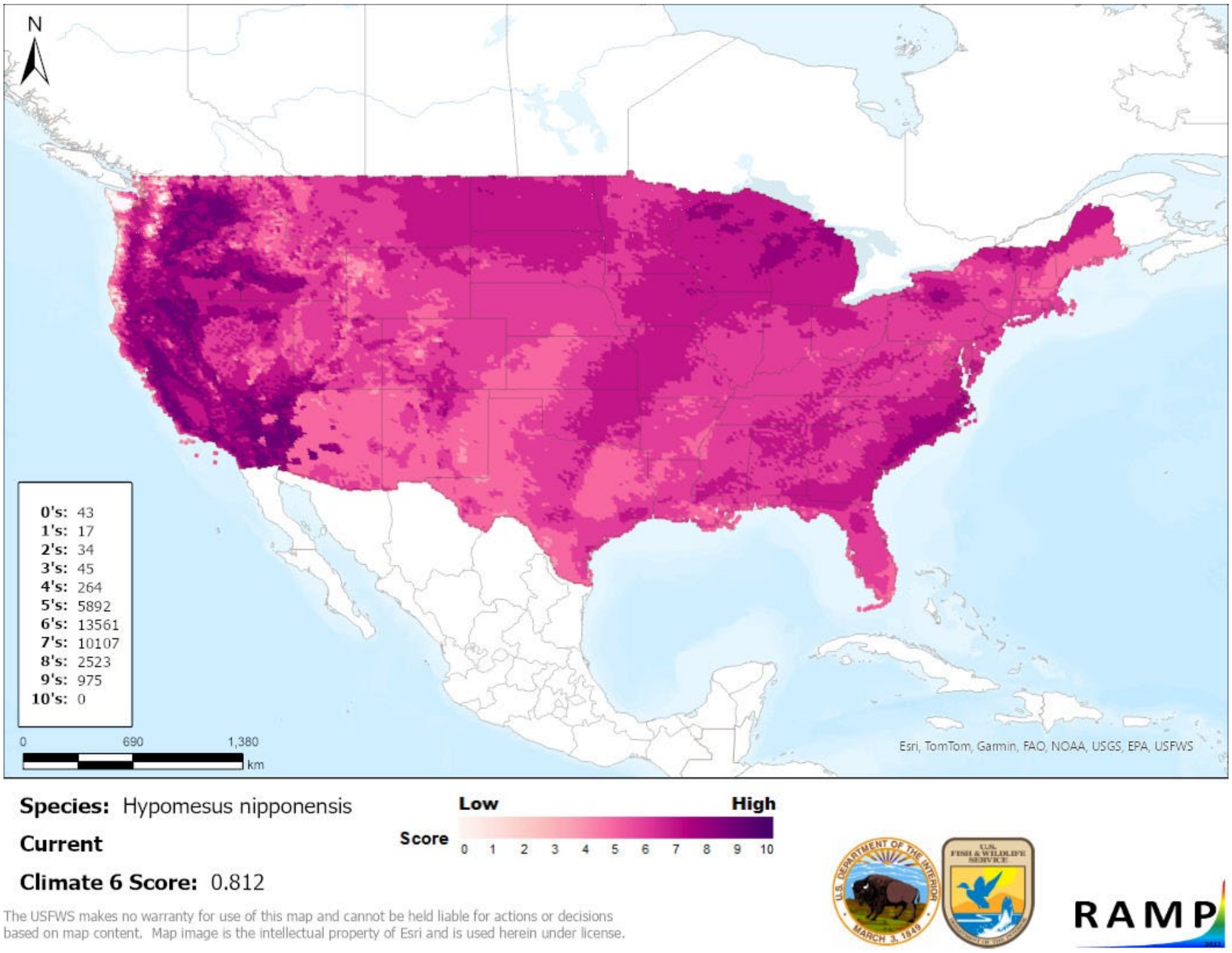

Figure 4. Map of RAMP (Sanders et al. 2023) climate matches for *Hypomesus nipponensis* in the contiguous United States based on source locations reported by GBIF Secretariat (2023) and Yin et al. (2022). Counts of climate match scores are tabulated on the left. 0/Pale Pink = Lowest match, 10/Dark Purple = Highest match.

8 Certainty of Assessment

The Certainty of Assessment for *Hypomesus nipponensis* is classified as High. Information on the biology and distribution of this species was available. Records of introduction, establishment, and impacts were available from multiple sources. The species' introduced distribution in China may be underrepresented in the climate matching analysis but it is not thought that this impacts the interpretation of the analysis as indicating establishment concern.

9 Risk Assessment

Summary of Risk to the Contiguous United States

The Wakasagi (*Hypomesus nipponensis*) is a freshwater and brackish fish native to Japan, as well as the continental rivers of eastern Russia and the Korean peninsula. *H. nipponensis* can migrate from freshwater to brackish but also has resident populations in freshwater lakes. Spawning occurs in fresh or low brackish waters. In its native range, the Wakasagi supports both commercial and recreational fisheries. In the early 1960s, *H. nipponensis* was intentionally introduced and the species has now established populations across California. This species has also been introduced and established in China related to aquaculture activities. There are documented impacts on native species in both California and China. Impacts include changes in fish populations, trophic structures, and hybridization with the federally listed endangered delta smelt (*Hypomesus transpacificus*) in California. The history of invasiveness is High. No species-specific regulations were found for this fish and no information to quantify trade was found. The climate matching analysis for the contiguous United States indicates establishment concern. The majority of the contiguous United States had a medium climate match with area of high match found in the Northern Pacific Coast, California, Great Basin, and Western Mountain regions. The certainty of assessment for this species is High. The Overall Risk Assessment Category is High.

Assessment Elements

- **History of Invasiveness (see Section 4): High**
- **Establishment Concern (see Section 7): Yes**
- **Certainty of Assessment (see Section 8): High**
- **Remarks, Important additional information: Found to hybridize with the federally listed Delta Smelt (*Hypomesus transpacificus*).**
- **Overall Risk Assessment Category: High**

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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11 Literature Cited in Quoted Material

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.

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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 Yin et al. (2022).

Under the future climate scenarios (figure A1), on average, high climate match for *Hypomesus nipponensis* was projected to occur in California, the Desert Southwest, and Western Mountain regions of the contiguous United States. Primarily in the 2085 time-step, there were areas of low match in the Southern Plains and in patches along the Gulf Coast. The Climate 6 scores for the individual future scenario models (figure A2) ranged from a low of 0.283 (model: UKESM1-0-LL, SSP5, 2085) to a high of 0.747 (model: MRI-ESM2-0, SSP3, 2055). All future scenario Climate 6 scores were above the establishment concern threshold, indicating that Yes, there is establishment concern for this species. The Climate 6 score for the current climate match (0.812, 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 SSP3, 2085 (figure A3). Under one or more time step and climate scenarios, areas within the Southwest saw a large increase in the climate match relative to current conditions. Primarily in time step 2085, areas within California saw a large decrease in the climate match relative to current conditions. Additionally, under one or more time step and climate scenarios, areas within the Colorado Plateau, Great Basin, Great Lakes, Gulf Coast, Northeast, 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. Additional, very small areas of large or moderate change may be visible on the maps (figure A3).

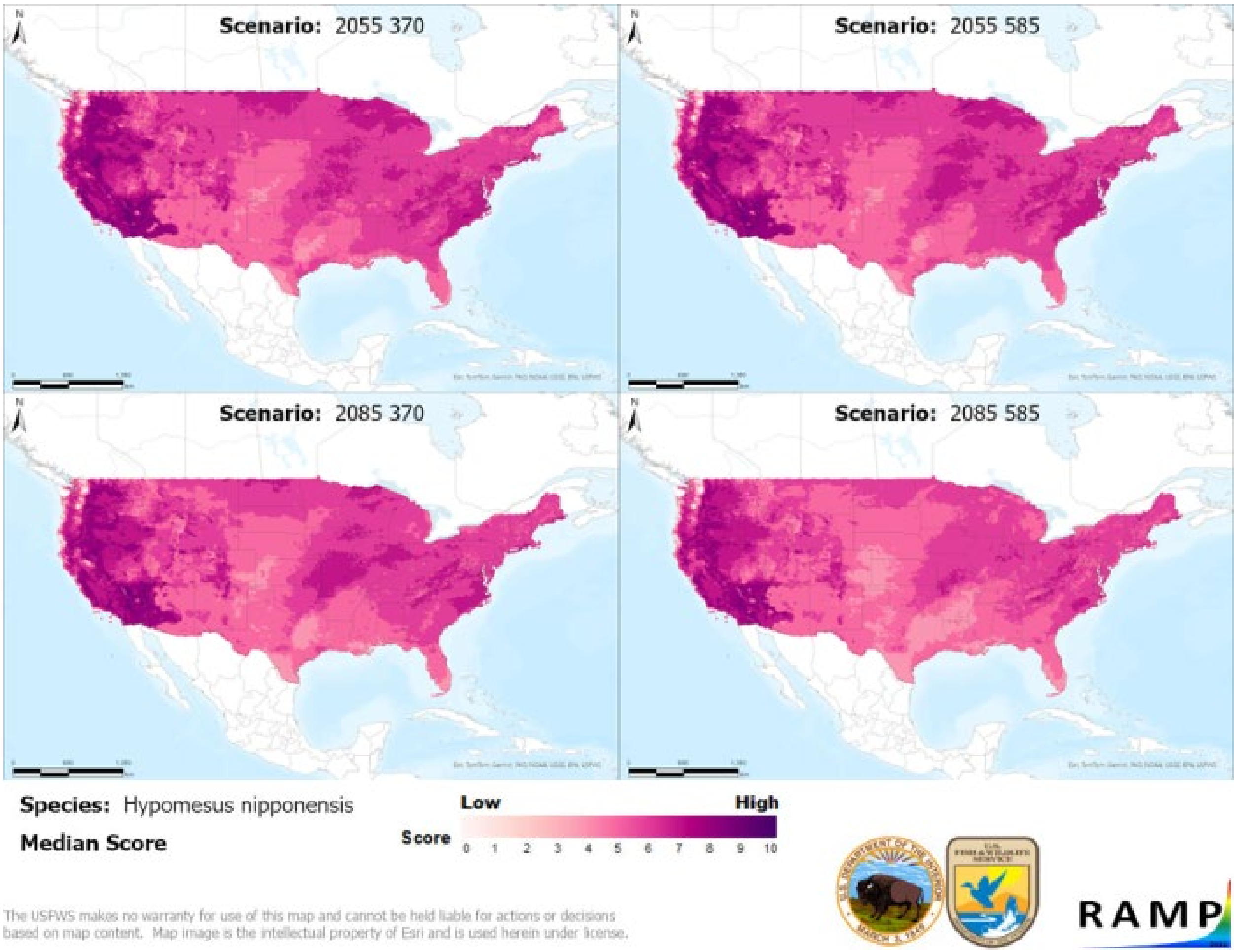

Figure A1. Maps of median RAMP (Sanders et al. 2023) climate matches projected under potential future climate conditions using five global climate models for *Hypomesus nipponensis* in the contiguous United States. Climate matching is based on source locations reported by GBIF Secretariat (2023) and Yin et al. (2022). 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.

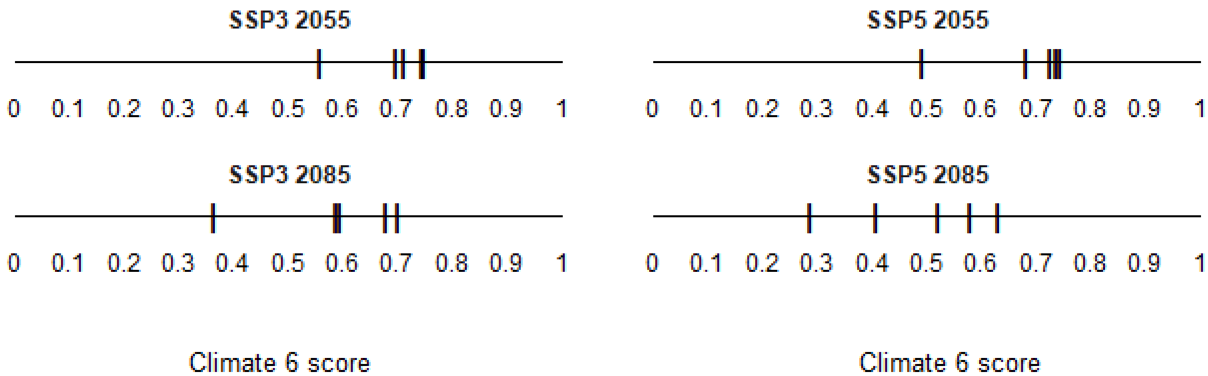

Figure A2. Comparison of projected future Climate 6 scores for *Hypomesus nipponensis* in the contiguous United States for each of five global climate models under four combinations of Shared Socioeconomic Pathway (SSP) and time step. SSPs used (from left to right): SSP3, SSP5 (Karger et al. 2017, 2018;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

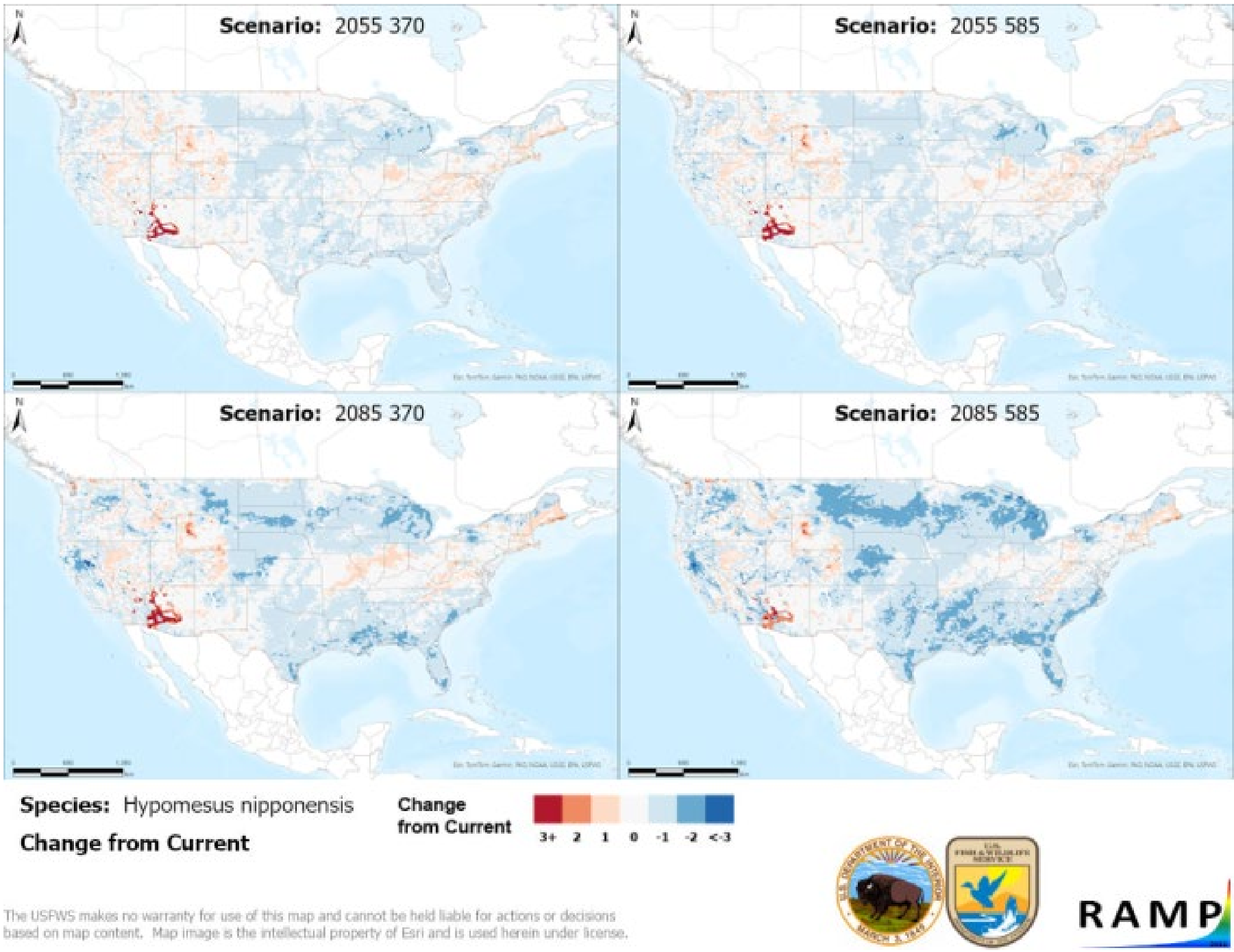

Figure A3. RAMP (Sanders et al. 2023) maps of the contiguous United States showing the difference between the current climate match target point score (figure 4) and the median target point score for future climate scenarios (figure A1) for *Hypomesus nipponensis* based on source locations reported by GBIF Secretariat (2023) and Yin et al. (2022). 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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