Wakasagi (*Hypomesus nipponensis*)
Ecological Risk Screening Summary

Web Version—07/31/2014

Photo (edited): R. Reyes, Bureau of Reclamation from Fuller (2014).

1 Native Range, and Status in the United States

Native Range
From Saruwatari et al. (1997):

"Asia: Japan to the Korean Peninsula (not confirmed by Saruwatari et al. (1997))."

Status in the United States
From Fuller (2014):

"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)."

"The wakasagi was stocked in California in Sly Park Reservoir (El Dorado County), Dodge Reservoir (Lassen County), Spaulding Reservoir (Nevada County), Big Bear Lake (San Bernardino County), Dwinnel Reservoir (Siskiyou County), Shastina Reservoir (Siskiyou County), and Freshwater Lagoon (Humboldt County) in 1959 (Wales 1962, Moyle 1976a, Courtenay et al. 1984, Dill and Cordone 1997). It was then stocked in Lake Almanor (Plumas County) on the North Fork Feather River in 1972 (Dill and Cordone 1997). It migrated downstream from Lake Almanor to Lake Oroville (Dill and Cordone 1997). It has recently been observed in the lower American River, Cache Slough off the Sacramento River and the

Mokelumne River, and at the Central Valley Project and State Water Project fish salvage facilities in the south Delta (Dill and Cordone 1997). The species can be expected to occur in the lower Klamath, the Sacramento, and possibly other drainages (Moyle 1976a). Most recently, it was found in the Sacramento-San Joaquin Estuary, Suisun Marsh, and the […] Yolo Bypass, Yolo and Solano Counties, (Aasen et al. 1998, Sommer et al. 2001, Matern et al. 2002, Moyle, unpublished)."

Means of Introductions in the United States

From Fuller (2014):

"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)."

Remarks

From Fuller (2014):

"Dill and Cordone (1997) reviewed [this species'] 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)."

Hypomesus nipponensis is sometimes referred to as the Japanese Smelt.

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From ITIS (2011):

"Kingdom Animalia
Subkingdom Bilateria
Infrakingdom Deuterostomia
Phylum Chordata
Subphylum Vertebrata
Infraphylum Gnathostomata
Superclass Osteichthyes
Class Actinopterygii
Subclass Neopterygii
Infraclass Teleostei
Superorder Protacanthopterygii
Order Osmeriformes
Suborder Osmeroidei
Superfamily Osmeroidea
Family Osmeridae
Genus Hypomesus
Species Hypomesus nipponensis McAllister, 1963

Taxonomic Status: Valid."

Size, Weight, and Age Range

From Saruwatari et al. (1997):

"Maturity: Lm ?, range 6 - 7 cm; Max length : 17.0 cm TL male/unsexed; (Page and Burr 1991)."

Environment

From Saruwatari et al. (1997):

"Marine; freshwater; brackish; pelagic; anadromous (Riede 2004)."

Climate/Range

From Saruwatari et al. (1997):

"Temperate."

Distribution Outside the United States

Native

From Saruwatari et al. (1997):

"Asia: Japan to the Korean Peninsula (not confirmed by Saruwatari et al. (1997))."

Introduced

From Saruwatari et al. (1997):

This species is reported as introduced in China (Ma et al. 2003).

Means of Introduction Outside the United States

From Saruwatari et al. (1997):

The reasons listed for the introduction were aquaculture and fisheries (Ma et al. 2003).

Short description

From Saruwatari et al. (1997):

"Dorsal spines (total): 0; Dorsal soft rays (total): 8-10; Anal spines: 0; Anal soft rays: 12 - 19; Vertebrae: 53 - 57. Vomer T-shaped with well-developed posterior process; periphery of glossohyal bone with single row of conical teeth, central part toothless; gill rakers 10(7-11) + 23(20-25) = 32(29-36); pyloric caeca 4(1-6); base of adipose fin less [than] 20% of head length; eye large; adipose eyelid absent."

Biology

From Saruwatari et al. (1997):

"Found in open water of impoundments and their tributaries, in fresh and brackish water. Primarily a brackish water species. Anadromous (Pietsch et al. 2000)."

From Zhou et al. (2013):

"Of 10 taxonomic or ecological categories of food, cladocerans (54.70%) and rotifers (15.39%) were the most important food items in terms of the index of relative importance (IRI), whereas surface food and chironomid larvae were the most important by weight. Although cladocerans were consistently the most important food, rotifers and copepods, together with surface food and chironomid larvae, substituted when cladocerans were scarcer."

Human uses

From Saruwatari et al. (1997):

"Fisheries: commercial; aquaculture: commercial"

Diseases

This species is a host for the parasite *Ichthyobodo necator* (Nagasawa et al. 1989).

There are no known OIE-reportable diseases for this species.

Threat to humans

Potential pest.

3 Impacts of Introductions

From Fuller (2014):

"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 Trenham et al. (1998):

This study used allozyme markers to identify different smelt species in the Sacramento-San Joaquin Estuary, California, specifically the native, and endangered, delta smelt (*Hypomesus transpacificus*) and the invasive wakasagi (*H. nipponensis*). 280 fish were identified and 2 F_1 hybrids were found, "suggesting that although hybridization does occur, it is not a serious threat to delta smelt at the present time."

From Dill and Cordone (1997):

"The apparent lack of introgression between *H. transpacificus* and *H. nipponensis* suggests that hybrids are either sterile or inviable in the Delta system and, thus, that massive hybrid breakdown is not likely to be a management concern for delta smelt in the immediate future. At present, delta smelt are the dominant *Hypomesus* in the Sacramento–San Joaquin estuary, and almost all fish captured in sampling programs or at the CVP and SWP pumps are the endangered native species. However, these abundances may be changing. One distinct possibility is that *H. nipponensis* is in the process of establishing resident populations in the estuary. Another possibility is that the small concentrations of fish observed in Barker Slough and the Mokolumne River consist of individuals that are periodically flushed out of Folsom Reservoir and are not self-sustaining populations. If populations of *H. nipponensis* are established, competition for food and spawning sites as well as more frequent hybridization can be expected, particularly since recent collections of wakasagi indicate that they can invade the lower portions of the estuary where delta smelt spend much of their life cycle. Regardless of the current level of threat to delta smelt, the dynamic and changing nature of *Hypomesus* species composition in the Sacramento–San Joaquin system emphasizes the need for continued monitoring. Invasion of the Delta by wakasagi is yet another example of the unpredictable consequences of species introductions, or the Frankenstein effect (Moyle et al. 1986), and such consequences are particularly likely for aquatic organisms in California, where watersheds are increasingly interconnected by aqueducts."

4 Global Distribution

Figure 1. Global distribution of *Hypomesus nipponensis*. Map from GBIF (2014).

5 Distribution within the United States

Figure 2. Distribution of *Hypomesus nipponensis* in the US. Map from Fuller (2014).

6 CLIMATCH

Summary of Climate Matching Analysis

The climate match (Australian Bureau of Rural Sciences 2008; 16 climate variables; Euclidean Distance) was high in California, Washington and Oregon, the central plains, the Mid-Atlantic, and in some areas of the Great Lakes region. Medium match covered most of the eastern United States. Low matches covered much of Rocky Mountains, the Great Plains, southern Florida, and the extreme Northeast. Climate 6 match indicated that the contiguous U.S. has a high climate match. The range for a high climate match is 0.103 and greater; climate match of *Hypomesus nipponensis* is 0.274.

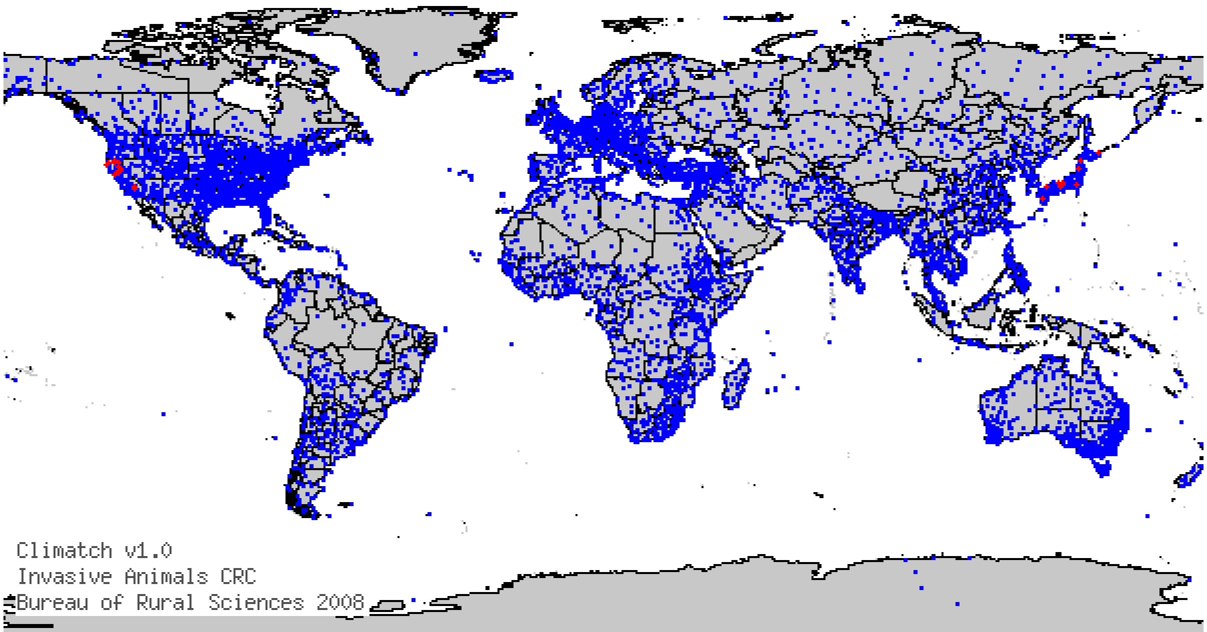

Figure 3. CLIMATCH (Australian Bureau of Rural Sciences 2008) source map showing weather stations selected as source locations (red) and non-source locations (blue) for *Hypomesus nipponensis* climate matching. Source locations from GBIF (2014) and Fuller (2014).

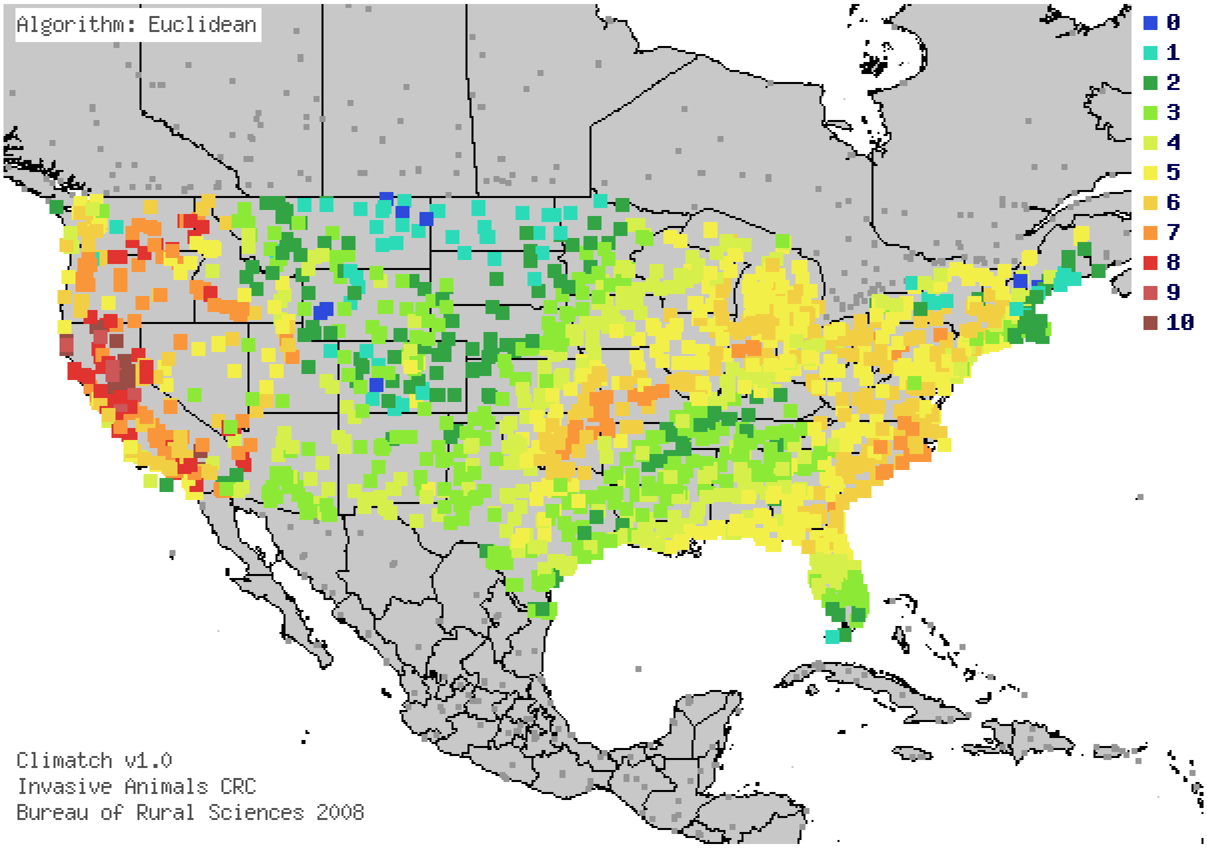

Figure 4. Map of CLIMATCH (Australian Bureau of Rural Sciences 2008) climate matches for *Hypomesus nipponensis* in the contiguous United States based on source locations reported by GBIF (2014) and Fuller (2014). 0= Lowest match, 10=Highest match.

Table 1. CLIMATCH (Australian Bureau of Rural Sciences 2008) climate match scores.

Climatch 6 Score	0	1	2	3	4	5	6	7	8	9	10
Count	10	69	177	388	364	425	327	128	57	7	22
CLIMATE 6 Proportion =		0.274									

7 Certainty of Assessment

Information on the biology, distribution, and impacts of this species is readily available. Certainty of the assessment for this species is high.

8 Risk Assessment

Summary of Risk to the Continental United States

Hypomesus nipponensis is a freshwater and brackish water fish native to Japan. This species consumes plankton and invertebrates. *Hypomesus nipponensis* spread from its original stocking locations in California and is now well established throughout northern California. This species has a high climate match with the US, with many areas of high and medium climate match across the country. There are a few descriptions of negative impacts due to its introduction, including its hybridization with the endangered delta smelt (*Hypomesus transpacificus*). Trenham et al. (1998) confirmed the occurrence of hybridization, but failed to find any resulting negative impacts to the delta smelt population. Therefore, the use of this hybridization as support for *Hypomesus nipponensis*'s history of invasiveness is questionable. Dill and Cordone (1997) found that *Hypomesus nipponensis* negatively impacted kokanee salmon and threadfin shad. Based on this impact and the potential risk to an endangered species, the invasiveness of this species is high. The overall risk for this species is high.

Assessment Elements

- **History of Invasiveness (Sec. 3):** High
- **Climate Match (Sec.6):** High
- **Certainty of Assessment (Sec. 7):** High
- **Remarks/Important additional information** Potential pest
- **Overall Risk Assessment Category: High**

9 References

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

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10 References Quoted But Not Accessed

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

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