Yellowfin Goby (*Acanthogobius flavimanus*)
Ecological Risk Screening Summary

U.S. Fish and Wildlife Service, 2014
Revised, September 2016, November 2018, July 2019
Web Version, 9/17/2019

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1 Native Range and Status in the United States

Native Range

From Froese and Pauly (2018):

"Northwest Pacific: Russian Far East (from Amur to Peter the Great Gulf), Korean Peninsula, Bohai Sea, Yellow Sea and East China Sea of China, and Hokkaido to Kyushu of Japan."

Froese and Pauly (2019) report the species as native in the following countries: China (including Hong Kong), Japan, South Korea, Russia, and Vietnam.

Status in the United States

From Nico et al. (2019):

"Established in coastal and inland waters of central and southern California."

"Introduced to California; the first records in that state were based on two specimens found in the Sacramento-San Joaquin Delta region, San Joaquin County, in early 1963. The first of these fish was trawled from the lower San Joaquin River near Venice Island, and the second specimen was taken from the Stockton Deepwater Channel near the Calaveras River (Brittan et al. 1963; Shapovalov et al. 1981). The species later was found in surrounding areas including Suisun, San Pablo, and San Francisco bays, the Sacramento Delta, the Yolo Bypass, Bolinas Lagoon, Delta-Mendota Canal, and the San Luis Reservoir in Alameda, Contra Costa, Marin, Merced, Napa (possibly), San Francisco, San Mateo, Santa Clara, Solano, and Sonoma counties (Brittan et al. 1970; Moyle 1976; Courtenay et al. 1986; Wang 1986; Sommer et al. 2001). Specimens also were taken in Elkhorn Slough, Monterey County (Kukowski 1972; Wang 1986), and Tomales Bay, Moss Landing Harbor, Golden Gate National Recreation Area, and Point Reyes National Seashore, Marin County (Miller and Lea 1972; Wang 1986; Tilmant 1999). The first records of this species in southern California were from the Los Angeles Harbor area, Los Angeles County, in 1977 (Haaker 1979); subsequently specimens were found in Long Beach Harbor and near the mouth of the Los Angeles River, Los Angeles County; in the San Gabriel River, Upper Newport Bay, and upstream to San Diego Creek, Orange County; and in Ballona Marsh and Mugu Lagoon (Haaker 1979; Allen 1982; Swift et al. 1993). This species was reported as rare or absent from other coastal areas of southern California including Malibu Lagoon, San Onofre, San Mateo, Las Pulgas, and Santa Margarita lagoons, and Morro Bay (Swift et al. 1993). In 1980, the species was reported as occurring in San Diego (perhaps extending as far south as Baja California Norte, Mexico) (Courtenay et al. 1986). Williams et al. (1998) reported them from southeastern San Diego Bay tidal marshes beginning in 1989, but gave the first date for San Diego County as 1984."

"In the San Francisco Estuary system yellowfin gobies are used as a baitfish (both fresh and frozen), being sold with both longjaw mudsucker (*Gillichthys mirabillis*) and staghorn sculpin (*Leptocottus armatus*) under the common names "mudsucker" or "bullhead"."

Means of Introductions in the United States

From Nico et al. (2019):

"Initial and possibly later introductions were probably by way of ballast water carried in transoceanic ships (Brittan et al. 1963). It also is hypothesized that introduced gobies arrived as eggs on fouling organisms, such as oysters, growing on ship hulls (Hubbs and Miller 1965; Eschmeyer et al. 1983). Although first collected in 1963, the yellowfin goby was probably introduced into California in 1959 or 1960, likely about the same time as the chameleon goby (Brittan et al. 1970; Meng et al. 1994). Once established, this species spread in California, probably as a result of its own dispersal abilities, and sometimes with the aid of currents; in addition, dispersal may have resulted from the species' use as a baitfish (Brittan et al. 1970; Courtenay and Hensley [1979])."

Remarks

A previous version of this ERSS was published in 2014.

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From ITIS (2018):

"Kingdom Animalia
Subkingdom Bilateria
Infrakingdom Deuterostomia
Phylum Chordata
Subphylum Vertebrata
Infraphylum Gnathostomata
Superclass Osteichthyes
Class Actinopterygii
Subclass Neopterygii
Infraclass Teleostei
Superorder Acanthopterygii
Order Perciformes
Suborder Gobioidei
Family Gobiidae
Genus *Acanthogobius*
Species *Acanthogobius flavimanus* (Temminck and Schlegel, 1845)"

From Fricke et al. (2018):

"Current status: Valid as *Acanthogobius flavimanus* (Temminck & Schlegel 1845). Gobiidae: Gobionellinae."

Size, Weight, and Age Range

From Froese and Pauly (2018):

"Max length : 30.0 cm TL male/unsexed; [Eschmeyer et al. 1983]; common length : 14.5 cm TL male/unsexed; [Hugg 1996]"

From Fofonoff et al. (2018):

"Male fish mature after one year and females in two years at 190-233 mm length (Suzuki et al. 1989; California Fish Website 2018)."

From Nico et al. (2019):

"In California, yellowfin gobies reach maturity in 2-3 years (Brittan et al. 1963; Baker 1979)."

From CABI (2018):

"The average longevity of *A. flavimanus* is 3 years, but there have been examples of older specimens (Moyle, 2002)."

Environment

From Froese and Pauly (2018):

"Marine; freshwater; brackish; demersal; amphidromous [Riede 2004]; depth range 1 - 6 m [Love et al. 2005]."

"Intertidal to at least 6.5 m [Love et al. 2005]."

From Nico et al. (2019):

"Reproduction does not occur at salinities below 5 ppt, and freshwater populations in the San Joaquin River basin migrate downstream to areas of higher salinity to spawn (Wang 2011)."

"In 1967, a fish kill occurred in the San Luis Reservoir, which receives freshwater from the Sacramento-San Joaquin River Delta. About half of the approximately 10,000 fishes killed in this incident were *A. flavimanus* (Brittan et al. 1970). Apparently another massive die-off occurred in Rodeo Lagoon in 1981 and was thought to be caused by low salinity (<5 ppt) (Wang 1986)."

"Recent drought conditions in California have reduced freshwater outflows and may have allowed this goby to gain an advantage over native freshwater and estuarine fishes less able to tolerate high salinity conditions (Herbold et al. 1992, Meng et al. 1994)."

From CABI (2018):

"Individual fish are commonly found in bays and inlets in water depths between 1 and 14 m (Barnham, 1998)."

"*A. flavimanus* can withstand abrupt changes between fresh and salt water and can survive temperatures greater than 28°C, therefore occupying a broad habitat range from marine to freshwater."

Climate/Range

From Froese and Pauly (2018):

"Temperate; 52°N - 23°N, 116°E - 143°E"

Distribution Outside the United States

Native

From Froese and Pauly (2018):

"Northwest Pacific: Russian Far East (from Amur to Peter the Great Gulf), Korean Peninsula, Bohai Sea, Yellow Sea and East China Sea of China, and Hokkaido to Kyushu of Japan."

Froese and Pauly (2019) report the species as native in the following countries: China (including Hong Kong), Japan, South Korea, Russia, and Vietnam.

Introduced

Froese and Pauly (2019) report the species as introduced and established in Australia and Mexico.

From Fofonoff et al. (2018):

"In 1971, a specimen of *Acanthogobius flavimanus* was collected in Sydney Harbour, New South Wales [Australia]. By 1973, 17 fish had been collected ([…], Hoese 1973). This Goby was found in two locations in New South Wales in the late 1970s, Botany Bay and the Hawkesbury River, in Newcastle (Middleton 1982; Lockett and Gomon 2001). In 1990, it was collected in Port Phillip Bay, Victoria, and was found to be established in the northern part of Bay (Lockett and Gomon 2001). It has not undergone the rapid geographical and population expansion noted in California, perhaps because of warmer temperatures (Lockett and Gomon 2001), and/or of low genetic diversity (Hirase 2017)."

From Bray and Gomon (2019):

"In April 2019, a Yellowfin Goby was photographed in Port Adelaide, South Australia."

From CABI (2018):

"Lever (1996) recorded its presence in Mexico, having spread south to Baja California del Norte."

Means of Introduction Outside the United States

From Froese and Pauly (2019):

"Accidentally introduced with oyster shipments or in ballast water of ships."

From Bray and Gomon (2019):

"The Yellowfin Goby was accidentally introduced to Australia […] when larvae or juveniles were transported in ballast water in ships and the water was released in ports of call."

From CABI (2018):

"Local translocation by recreational craft was suggested as one of several possible mechanisms by which *A. flavimanus* populations in Australia have spread to regions that are not commercial shipping ports (Lockett and Gomon, 2001)."

Short Description

From CABI (2018):

"It has a slender pale-brownish body with a series of dark saddles and spots (Nico and Fuller, 2008). The mid-sides and dorsal fin also have brown patches or spots. Head is of moderate size (28-30% SL), triangular in cross section; interorbital space is narrow and less than eye diameter; mouth oblique, rear end of the jaws just in front and below the middle of eye (NIMPIS, 2002). The arrangement of pores on the head is a key characteristic in identifying this species, with one adjacent to posterior nostril each side, median between rear part of eye, one behind eye, three above each operculum, and two on each preoperculum (NIMPIS, 2002)."

"Juvenile fish have pale-yellow ventral and anal fins, whereas all ages possess yellow ventral fins. There are two dorsal fins, first originating above ventral fin insertions and the second originating just behind the first; first dorsal-fin margin rounded; anal fin origin below and behind second dorsal-fin origin; caudal and pectoral fins with rounded margins; ventral fins fused to form cup-shaped disc, originating below pectoral fin insertions (Gomon et al., 1994; Hoese and Larson, 1994; Lockett and Gomon, 1999)."

"This species is separable from other gobies by the presence of eight to nine spines in the first dorsal fin, 12-14 segmented rays in the second dorsal fin, the top of the head with 24-30 transverse rows of small scales, scaled cheeks and a transverse line of sensory papillae on cheek (Masuda et al., 1984; Hoese and Larson, 1994; Lockett and Gomon, 1999). It is also separable from other gobies that all have clear, white, grey or black ventral fins (Barnham, 1998)."

Biology

From CABI (2018):

"*A. flavimanus* is a bottom dwelling fish inhabiting muddy and sandy bottoms along the shore of bays and estuaries, and sometimes ascending rivers (Froese and Pauly, 2008). […] *A. flavimanus* are usually found in freshwater reaches of streams just above tidal influence during most of the year, and adult fish migrate downstream to spawn in the estuaries during the breeding season in winter months."

"*A. flavimanus* is oviparous, spawning in winter to early spring and during the breeding season, the adults migrate downstream to spawn in the estuaries (Breder and Rosen, 1966). Fecundity ranges between 6000 and 37,000 eggs per individual (Williams et al., 1998). The eggs are constructed in intertidal mudflats and deposited in Y-shaped covered nests (burrows or tunnels), 15-35 cm deep and are ovoid (Masuda et al., 1975). The eggs measure 5.5 mm long and 0.9 mm wide and take around 28 days to hatch into free swimming larvae at optimum temperature (13°C)

(Wang, 1986; Barnham, 1998; Froese and Pauly, 2005). The female may leave the burrow after spawning or may join the male in guarding the eggs (NIMPIS, 2002)."

"*A. flavimanus* larvae are pelagic. Newly hatched larvae swim out of the burrow and remain near the bottom. The larvae remain in the water column until they reach 1.5-2.0 cm long, when they settle out of the water column (NIMPIS, 2002). After the yolk sac is absorbed, the larvae disperse rapidly. The larvae float on the surface of the water column during flood tide and descend to near the bottom while the tide ebbs (Wang, 1986). It is thought that breeding is temperature dependant [*sic*], with no spawning occurring outside of 7-13°C. In Australia, reproduction occurs in winter (June-September) (NIMPIS, 2002)."

"*A. flavimanus* feeds on benthic organisms such as crustaceans, polychaetes and small teleost fish (NIMPIS, 2002). It consumes a large variety of crustaceans such as copepods, amphipods, stomatopods and mysids, and has been reported as aggressively feeding on smaller fish (Barnham, 1998). Wang (1986) reports that, major food items for small juvenile *A. flavimanus* are harpacticoid copepods and other copepods, whereas the large juveniles eat amphipods, mysid shrimp, and small fish."

Human Uses
From Huckstorf (2012):

"Commercial fishing target. Aquarium fish. Used in Chinese medicine (Tang 1987)."

From Nico et al. (2019):

"In the San Francisco Estuary system yellowfin gobies are used as a baitfish (both fresh and frozen), being sold with both longjaw mudsucker (*Gillichthys mirabillis*) and staghorn sculpin (*Leptocottus armatus*) under the common names "mudsucker" or "bullhead"."

Diseases
No OIE-reportable diseases (OIE 2019) have been documented for this species.

From Baxa et al. (2013):

"Myxozoan spores were observed in yellowfin goby *Acanthogobius flavimanus* collected from Suisun Marsh, San Francisco Estuary (SFE). Although histopathological changes associated with the parasite were not observed, the spores formed plasmodia that partially blocked the gastric and intestinal mucosa and gut lumen and may affect the perfomance and survival of the yellowfin goby. Morphological features of the spores resembled *Henneguya* sp. […] The yellowfin goby myxozoan however, is likely an undescribed species based on phylogenetic analysis and morphologic features."

From Yokoyama et al. (2004):

"*Myxobolus buri* Egusa, 1985, is a well-documented myxosporean parasite that causes the scoliosis of cultured yellowtail *Seriola quinqueradiata*. A similar parasite has been described as

Myxobolus acanthogobii Hoshina, 1952, from the brain of the yellowfin goby *Acanthogobius flavimanus*, although this parasite is not associated with skeletal abnormalities in host fish. […] Molecular analysis indicated that small subunit rRNA gene sequences shared 100% identity between the two parasites [*M. buri* and *M. acanthogobii*]. Consequently, it can be concluded that *M. buri* is synonymous with *M. acanthogobii*, and thus this parasite can be reassigned as *M. acanthogobii*."

From Sohn et al. (2009):

"Fishborne trematode (FBT) metacercariae were investigated in yellowfin goby, *Acanthogobius flavimanus*, collected from Shinan-gun and Muan-gun, Jeollanam-do (province), Korea. […] In all of 15 gobies from Aphae-myeon in Shinan-gun, metacercariae of *Stictodora* spp. (334 metacercariae/fish), *Heterophyes nocens* (153/fish), and *Heterophyopsis continua* (20/fish) were detected. In 2 of 14 gobies from Jido-myeon in Shinan-gun, 8 *Echinostoma hortense* metacercariae in total were detected. In 15 gobies from Haeje-myeon in Muan-gun, the metacercariae of *H. continua* were found in 100%, *Stictodora* spp. in 86.7%, and *H. nocens* in 6.7% of fish examined. The average numbers of metacercariae per infected fish were 23.3 (*H. continua*), 416.0 (*Stictodora* spp.), and 2.0 (*H. nocens*), respectively. […] The above results suggest that yellowfin gobies from 2 localities may be the potential infection sources of FBT. Moreover, it is proved for the first time that the yellowfin goby, *A. flavimanus*, acts as a second intermediate host for *E. hortense*."

According to Poelen et al. (2014), the following parasites have been reported in *A. flavimanus*: *Clavinema mariae*, *Coitocaecum orthorchis*, Cyathocotylidae, *Gyrodactylus* spp., *Heterophyopsis continua*, *Heterophyes nocens*, *Hysterothylacium haze*, *Lecithaster stellatus*, *Polylabris acanthogobii*, *Pseudodactylogyrus haze*, *Pseudogalactosoma macrostoma*, *Pygidiopsis summa*, *Pygidiopsoides spindalis*, *Spirocamallanus pereirae*, *Stellantchasmus falcatus*, *Stictodora fuscatum*, *Stictodora hancocki*, *Stictodora lari*, and *Trichodina* spp. (Hechinger et al. 2011; Strona et al. 2013; Benesh et al. 2017).

Threat to Humans

From Froese and Pauly (2018):

"Harmless"

From Sohn et al. (2018):

"Fishborne zoonotic trematodes (FZT) affect the health of peoples in the endemic areas of the world. A lot of trematode species are known to be participated [*sic*] in human infections."

"By the present study, It [*sic*] was confirmed that ZTM [zoonotic trematode metacercariae] are mainly prevalent in [yellowfin] goby from the western and southern coastal areas of Korea. No ZTM were detected in total 95 gobies from the eastern coastal areas except for 5 ones from Gyeongpo-ho in Gangneung-si, Gangwon-do."

"Conclusively the present study suggests that those who consume raw goby from western and southern coastal areas of Korea are at high risk of getting infected with heterophyid flukes."

3 Impacts of Introductions

From Nico et al. (2019):

"In at least one saltwater location, yellowfin gobies were reported to have partially replaced Pacific staghorn sculpins *Leptocottus armatus* (Brittan et al. 1970). There also is concern that the yellowfin goby might outcompete and possibly eliminate freshwater populations of the small and endangered tidewater goby *Eucyclogobius newberryi* (Moyle 1976). Meng et al. (1994) suggested that environmental disturbances, coupled with the introduction of this and other foreign species, are altering fish communities and hastening declines of native fishes in California. Although Meng et al. (1994) found that the yellowfin goby has an impact on the introduced chameleon goby *Tridentiger trigonocephalus*, recent investigations have shown this species is actually the shimofuri goby *Tridentiger bifasciatus* [a nonnative species] (not the chameleon goby) that occurs in Suisun Bay where the study was conducted (Fleming, personal communication). Hence, it is the shimofuri goby that is affected."

From Brittan et al. (1970):

"At Palo Alto Yacht Harbor specimens belonging to *Acanthogobius flavimanus* have been taken since 1964; this species now heavily outnumbers the staghorn sculpin, *Leptocottus armatus*, formerly the commonest bottom fish (Robert Hassur, verbal communication)."

From Lafferty et al. (1999):

"Several extirpations of tidewater gobies in the San Francisco Bay area followed the invasion of rainwater killifish (*Lucania parva*; Hubbs & Miller 1965; Leidy 1984) and yellowfin goby (*Acanthogobius flavimanus*; Brittan et al. 1970)."

From The State of Victoria (2018):

"Once declared as noxious, people must not bring these species into the state [of Victoria, Australia], nor take, hatch, keep, possess, sell, transport, put into any container or release into protected waters any declared noxious aquatic species (unless otherwise authorised by permit)."

"List of Declared Noxious Aquatic Species in Victoria as Declared under the Fisheries Act 1995 (last amendment 8 July 2010)"

"Scientific name […] *Acanthogobius flavimanus"*

"Common name […] Yellowfin goby"

4 Global Distribution

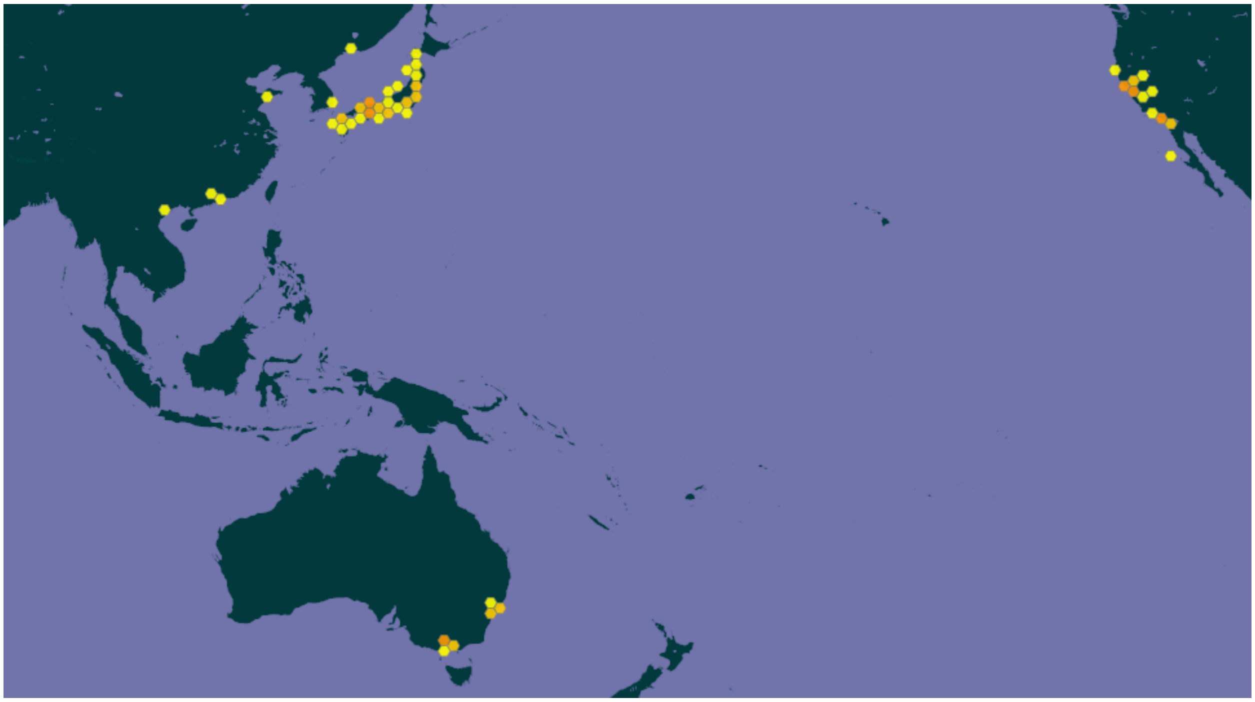

Figure 1. Known global distribution of *Acanthogobius flavimanus*, reported from East Asia, southeastern Australia, and western North America. Map from GBIF Secretariat (2018). Because the climate matching analysis is not valid for marine waters, only freshwater and coastal brackish water occurrences were used in the climate matching analysis. The northernmost reported occurrence in California was not included in the climate matching analysis because the occurrence is incorrectly located according to a verbal description of the collection location.

5 Distribution Within the United States

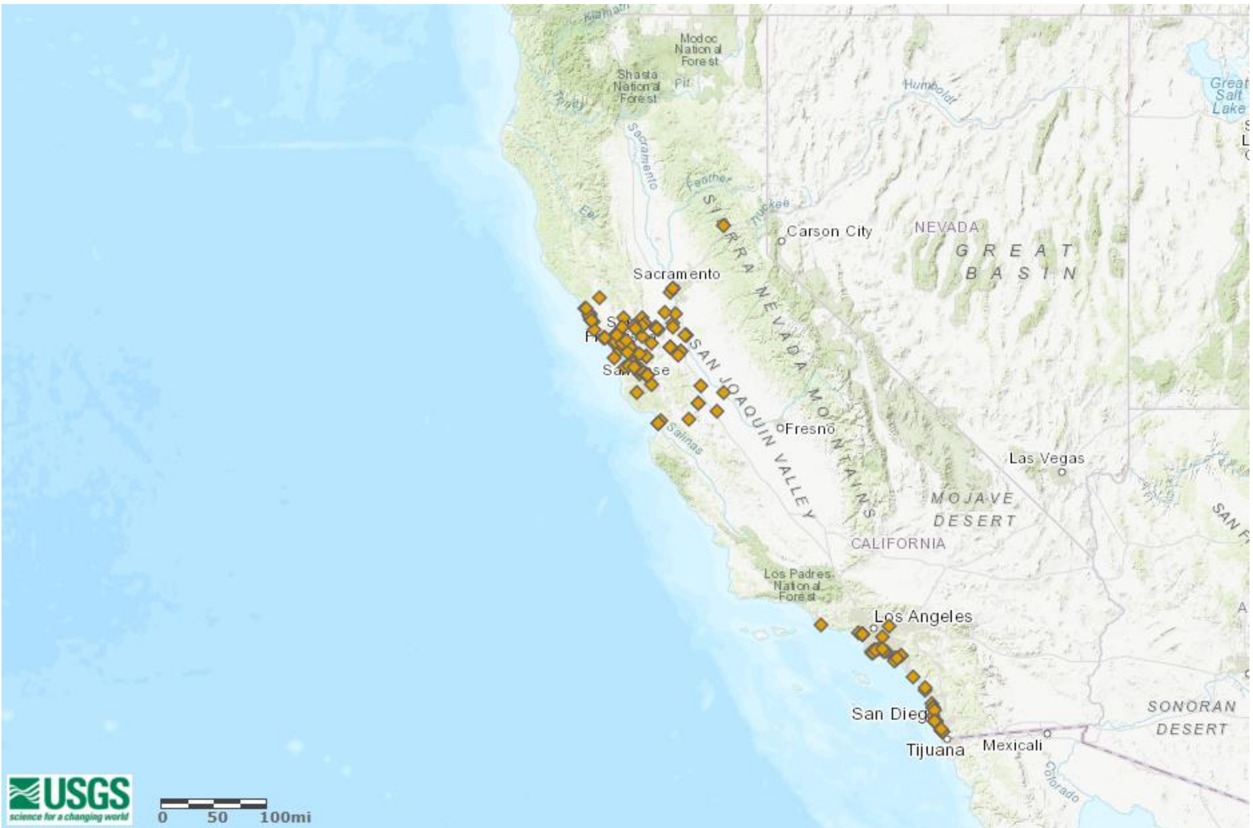

Figure 2. Known distribution of *Acanthogobius flavimanus* in the United States. Map from Nico et al. (2018). All points represent established populations and were used in the climate matching analysis, except for the occurrence reported in the Sierra Nevada Mountains, for which the georeferenced location and the verbal description of the location (near Stockton, California) did not match.

6 Climate Matching

Summary of Climate Matching Analysis

The Climate 6 score (Sanders et al. 2014; 16 climate variables; Euclidean distance) for the contiguous United States was 0.36, which is classified as a high climate match. (Scores of 0.103 or greater are classified as high.) The areas of highest match were along the West Coast and in the north-central United States, although areas along the Appalachian Mountains and in parts of the Southeast also had medium-high match. The climate match was medium across much of the contiguous United States. Low matches occurred in coastal New England, in parts of the Southeast, western Washington, and in the Interior West. Only the States of Louisiana, Maine, Mississippi, New Hampshire and Rhode Island had low climate scores. Because *Acanthogobius flavimanus* requires a salinity of at least 5 ppt for reproduction, the climate match is only representative of where the species will likely survive, not necessarily where it can successfully reproduce.

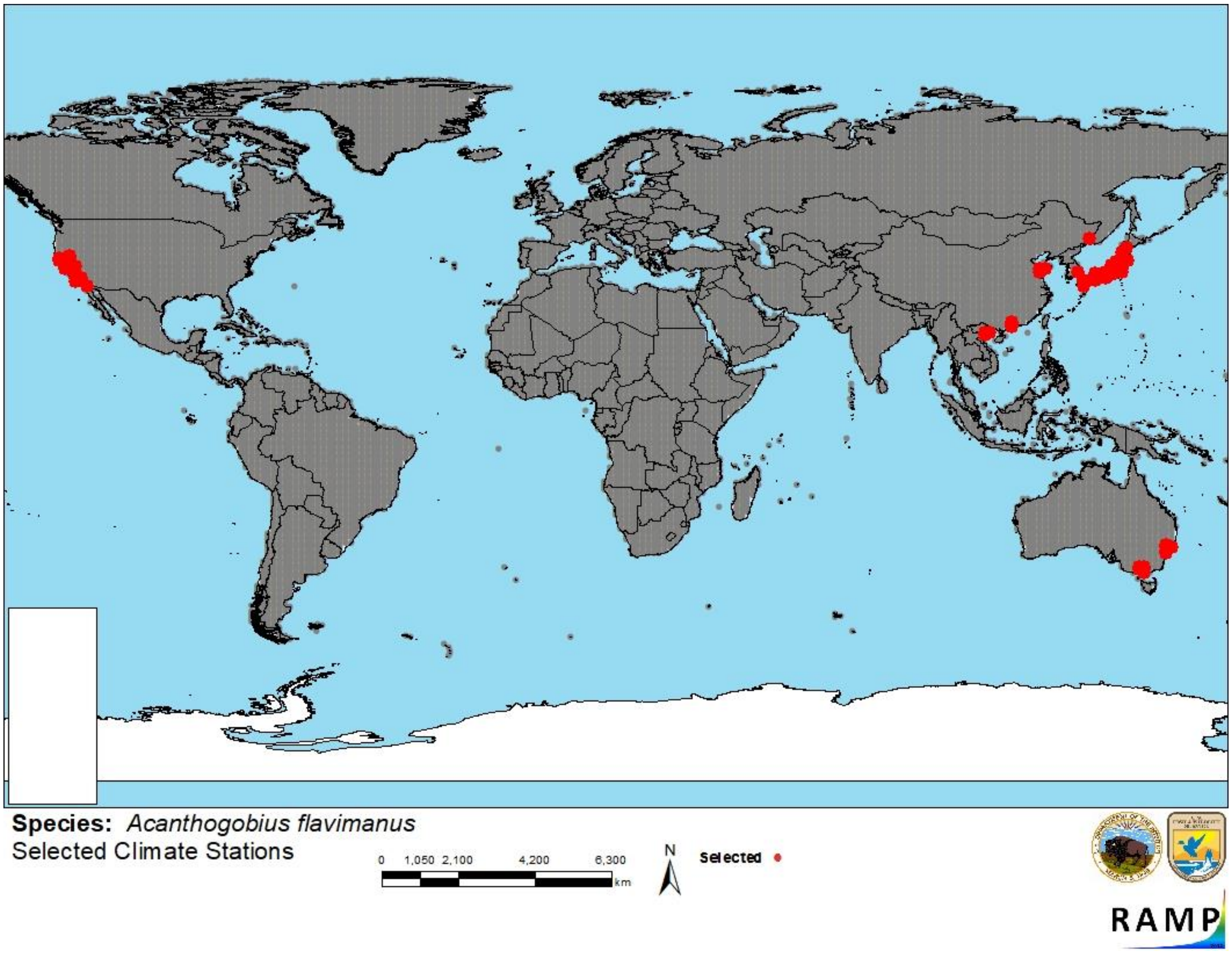

Figure 2. RAMP (Sanders et al. 2014) source map showing weather stations selected as source locations (red; United States, Japan, Russia, South Korea, China, Vietnam, Australia) and non-source locations (gray) for *Acanthogobius flavimanus* climate matching. Source locations from GBIF Secretariat (2018) and Nico et al. (2018).

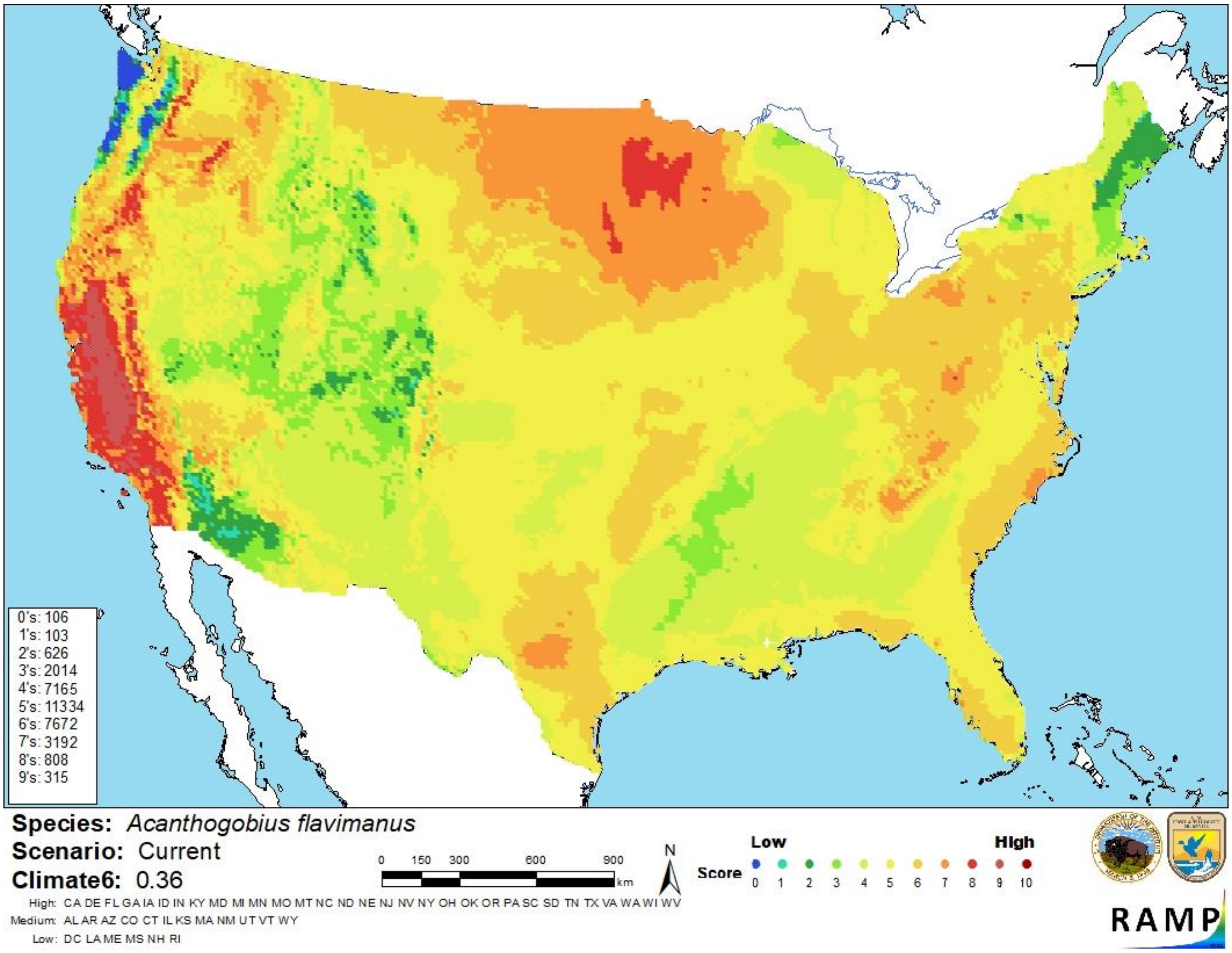

Figure 4. Map of RAMP (Sanders et al. 2014) climate matches for *Acanthogobius flavimanus* in the contiguous United States based on source locations reported by GBIF Secretariat (2018) and Nico et al. (2018). 0= Lowest match, 10=Highest match.

The “High”, “Medium”, and “Low” climate match categories are based on the following table:

Climate 6: Proportion of (Sum of Climate Scores 6-10) / (Sum of total Climate Scores)	Climate Match Category
0.000≤X≤0.005	Low
0.005<X<0.103	Medium
≥0.103	High

7 Certainty of Assessment

Information on the biology and distribution of this species is readily available, but information on impacts of the species is sparse. No peer-reviewed publications were found that directly tested the impacts of *A. flavimanus* on native organisms or ecosystems where the species has been introduced. There is additional uncertainty because the climate match does not account for the salinity requirement (≥5 ppt) for reproduction of *A. flavimanus*, and thus predicts where the species can survive but not necessarily where it can reproduce. The certainty of this assessment is low.

8 Risk Assessment

Summary of Risk to the Contiguous United States

Acanthogobius flavimanus, the Yellowfin Goby, is a freshwater fish native to eastern Asia that inhabits marine, brackish, and fresh waters. This species has been introduced and is now established in Australia, Mexico, and the United States. Long-distance introductions have occurred via ballast water, while the use of *A. flavimanus* as bait has contributed to local spread. Globally, *A. flavimanus* is commercially fished and also is present in the aquarium trade and Chinese medicine. *A. flavimanus* has established populations in estuaries in California, where the species is suspected of competing with native sculpins and the endangered tidewater goby (*Eucyclogobius newberryi*), leading to reduced abundance and extirpations. Supporting evidence for these impacts of introduction is limited to a single sentence in two scientific papers. Without more rigorous scientific evidence, history of invasiveness remains "none documented." This species has a high climate match with the contiguous United States, especially in the upper Midwest and along the West Coast. Because *A. flavimanus* requires salinity of at least 5 ppt to reproduce, this climate match is best interpreted as showing the areas where the species can survive in the contiguous United States, rather than the areas where establishment is possible. Further information is needed to determine whether this species is having a negative impact where introduced, so the certainty of this assessment is low. The overall risk assessment category for this species is uncertain.

Assessment Elements

- **History of Invasiveness (Sec. 3): None Documented**
- **Climate Match (Sec. 6): High**
- **Certainty of Assessment (Sec. 7): Low**
- **Overall Risk Assessment Category: Uncertain**

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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