

Siamese Fighting Fish (*Betta splendens*)

Ecological Risk Screening Summary

U.S. Fish and Wildlife Service, June 2019
Web Version, 11/7/2019



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1 Native Range and Status in the United States

Native Range

From Nico and Neilson (2019):

“Tropical Asia. Native to Southeast Asia including the northern Malay Peninsula, central and eastern Thailand, Kampuchea, and southern Vietnam (Witte and Schmidt 1992).”

From Vidthayanon (2013):

“Endemic to Thailand, from the Mae Khlong to Chao Phraya basins, the eastern slope of the Cardamom mountains, and from the Isthmus of Kra.”

Froese and Pauly (2019) report *B. splendens* as native to Cambodia, Laos, Thailand, and Vietnam.

Status in the United States

From Nico and Neilson (2019):

“Specimens ranging from 1-3 cm were taken from the Thames River drainage in Connecticut (Whitworth 1996). Specimens were collected from Lake Worth Drainage District canal L-15, adjacent to an aquarium fish farm west of Atlantis in Palm Beach County, Florida (Ogilvie 1969; Courtenay et al. 1974), but have not been found at that locality in subsequent years (Courtenay and Hensley 1979). A population became established in a canal south of Holmberg Road in Parkland, northern Broward County. When first discovered in December 1975, it was a dominant fish; however, the population was killed by extremely cold weather in January 1977 (Courtenay and Hensley 1979; Courtenay et al. 1984; Courtenay and Stauffer 1990). A single specimen was collected in the headwaters of Gamble Creek, near Parrish (UF 118475).”

“Failed in Connecticut. Shafland et al. (2008b) list it as a formerly reproducing species based on a recent survey (Shafland et al. 2008a).”

“A supposed report of *Betta splendens* in Hiko Spring, Lincoln County, Nevada, was false (W. Courtenay, personal communication).”

This species is common in trade in the United States. For example, ornamental varieties of *Betta splendens* for sale at Petco (2019) include Baby Boy Betta, Baby Girl Betta, male Black Orchid Betta, male Bumblebee Betta, male Butterfly Betta, male Cambodian Crowntail Betta, male and female Crowntail Betta, male Copper Betta, male Deltatail Betta, male Doubletail Betta, male Red Platinum Dragon, male Dragonscale Betta, male and female Elephant Ear Betta, male and female Halfmoon Betta, male Halfmoon Doubletail Betta, male Halfmoon Doubletail Plakat Betta, male Halfmoon King Betta, male King Betta, male and female Koi Betta, male Paradise Betta, male Rose Gold Betta, male Rose Petal Betta, male and female Veiltail Betta, male Cambodian Veiltail Betta, and male White Opal Betta.

Means of Introductions in the United States

From Nico and Neilson (2019):

“Florida records are the result of probable escapes from local ornamental fish farms (Courtenay and Stauffer 1990). Connecticut records are probably aquarium releases.”

Remarks

A previous version of this ERSS was published in 2014.

From International Betta Congress (2018):

“They are often commonly referred to simply as “betta” or “betta fish” [bet-uh].”

“Bettas have evolved far beyond their original wild type appearance, and are now the primary type of show betta that is seen in pet stores. Sometimes called the “designer fish of the aquatic world”, bettas have been bred over time into many colors and tail types.”

“The beautiful *Betta splendens* pet and show fish we see today were originally selectively bred out of the wild types of *Betta imbellis*, *Betta mahachaiensis*, *Betta samaragdina*, and the original *Betta splendens*.”

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From ITIS (2019):

“Kingdom Animalia
Subkingdom Bilateria
Infrakingdom Deuterostomia
Phylum Chordata
Subphylum Vertebrata
Infraphylum Gnathostomata
Superclass Actinopterygii
Class Teleostei
Superorder Acanthopterygii
Order Perciformes
Suborder Anabantoidei
Family Osphronemidae
Subfamily Macropodinae
Genus *Betta*
Species *Betta splendens* Regan, 1910”

From Fricke et al. (2019):

“Current status: Valid as *Betta splendens* Regan 1910. Osphronemidae: Macropodusinae.”

Size, Weight, and Age Range

From Froese and Pauly (2019):

“Max length : 6.5 cm TL male/unsexed; [Rainboth 1996]; max. reported age: 2 years [Hugg 1996]”

Environment

From Froese and Pauly (2019):

“Freshwater; benthopelagic; pH range: 6.0 - 8.0; dH range: 5 - 19. [...] 24°C - 30°C [Riehl and Baensch 1991; assumed to represent recommended aquarium temperature range]”

From Pleeing and Moons (2017):

“Jaroensutasinee and Jaroensutasinee (2001) found that the average water temperature in natural betta habitats during breeding season is 29.9 °C ± 1.4, and that pH levels are acidic and range from 5.28–5.80.”

“[...] bettas can survive in water with oxygen levels of as low as 0 - 2 ppm, while other fish die at this concentration (Moore, 1942; Goldstein, 2004).”

Climate/Range

From Froese and Pauly (2019):

“Tropical; [...] 22°N - 8°N, 99°E - 107°E”

Distribution Outside the United States

Native

From Nico and Neilson (2019):

“Tropical Asia. Native to Southeast Asia including the northern Malay Peninsula, central and eastern Thailand, Kampuchea, and southern Vietnam (Witte and Schmidt 1992).”

From Vidthayanon (2013):

“Endemic to Thailand, from the Mae Khlong to Chao Phraya basins, the eastern slope of the Cardamom mountains, and from the Isthmus of Kra.”

Froese and Pauly (2019) report *B. splendens* as native to Cambodia, Laos, Thailand, and Vietnam.

Introduced

From Froese and Pauly (2019):

“Established in the Magdalena watershed [Colombia].”

“established, natural reproduction [...] Species widespread in fish rearing facilities and has presumably escaped into local waters [in Brazil].”

“Established in Jurong Lake and water bodies in the Sembawang area [Singapore].”

“During hurricane 'David', *B. splendens* escaped, presumably from a tropical fish farm or a private aquarist, into the polluted waters of the Rio Ozama [Dominican Republic] where they are now abundant [Lever 1996].”

According to Froese and Pauly (2019), *B. splendens* has also been introduced to Spain, the Philippines, Malaysia, Indonesia, and Canada; establishment in these locations has not been confirmed.

From U.S. Fish and Wildlife Service (2007):

“LOCATION [...] Thermal spring in Banff National Park, Alberta, Canada”

“EXOTIC SPECIES INTRODUCED INTO HABITAT [...] Siamese fighting fish (*Betta splendens*)”

Renaud and McAllister (1988) report that *B. splendens* was introduced into Banff National Park's Cave and Basin Hotsprings or nearby. The introduction occurred at some time prior to 1968; according to the authors, it is unknown when the species was last observed there.

From Hammer et al. (2019):

“The species has recently invaded the Adelaide River floodplain, near Darwin in northern Australia. A very large and extensive population has persisted over consecutive years, with potential for further spread.”

“[...] introductions have been recorded in at least 10 countries including USA, Brazil, Malaysia and Singapore, however no major invasive populations have been noted (Froese and Pauly 2018; Welcomme 1988).”

“The first verified record [of *B. splendens* in northern Australia] was reported in January 2010, based on a photograph of a single individual female collected at Fogg Dam, a small modified area of the Adelaide River floodplain [...]. Subsequent anecdotal evidence suggests it may have been present at the site as early as 2006. Limited searches in Fogg Dam using backpack electrofishing and baited traps by NT Fisheries, in 2010 and 2011 respectively, were made in order to evaluate the presence of *B. splendens* but failed to record any [...]. Two individual fish were again recorded at Fogg Dam through a community report in February 2011. A major shift in detected abundance coincided with early monsoonal rains followed by moderate flooding in January/February of 2014 (after two preceding years with below average rainfall and limited wetland inundation) when large numbers of fish emerged and were readily detected in targeted dip netting, visual searches and by community reports. [...] Lower abundances were observed at additional sites including a culvert at Beatrice Hill and a flooded car park at the boat ramp on the Adelaide River proper [...] The next period of flooding in the 2016/2017 wet season saw a mass of fish at the Adelaide River main channel, with continuous chains of fish (around 100 per minute) close to the shore swimming downstream and high numbers also in flooded edges [...]. Two new detection sites were made east of the Adelaide River indicating further spread, namely a wetland site monitored in 2014 and at Scott Creek via a community report which again has

previously been heavily sampled for aquarium fish and bait. Using all recorded distribution points [...], the extent of occurrence of *B. splendens* as of February 2017 was 81 km².”

Means of Introduction Outside the United States

From Froese and Pauly (2019):

“ornamental”

“Species widespread in fish rearing facilities and has presumably escaped into local waters [in Colombia, Brazil, and the Dominican Republic].”

Wright (2002) reports that the introduction of *Betta splendens* to Alberta, Canada, was the result of intentional release by a fish hobbyist.

From Hammer et al. (2019):

“No specific introduction vector was uncovered for *B. splendens* [in the Adelaide River floodplain, Australia], and it is unclear exactly how long they have been present in the area, and if fish were released at Fogg Dam or have dispersed there indirectly from an introduction elsewhere on surrounding floodplains or semi-naturalised populations such as a ponds [*sic*] (Lintermans 2004). Introductions of aquarium fishes are clearly ongoing in the region stemming from Darwin into peri-urban surrounds, and education and response programs are vital for limiting further incursions into remote habitats (Duggan et al. 2006).”

Short Description

From Regan (1910):

“Body moderately elongate, more or less compressed. Jaws with fixed conical teeth; palate toothless. Praeorbital and opercular bones entire. Dorsal without or with a single spine and with 7 to 11 soft rays; origin above the anal; anal without or with 1 to 4 spines and with 20 to 37 soft rays; pelvics inserted below or a little in advance of the pectorals, of a spine and 5 soft rays, the outermost of which is more or less produced. Scales large, regularly arranged; lateral line vestigial or absent.”

“Depth of body $2\frac{5}{6}$ to $3\frac{2}{3}$ in the length, length of head $3\frac{1}{4}$ to $3\frac{3}{5}$. Snout as long as or shorter than eye, the diameter of which is $3\frac{1}{3}$ to 4 in the length of head; interorbital width $2\frac{2}{5}$ to 3 in the length of head. Maxillary extending to the vertical from between the nostrils. Dorsal I 8-9. Anal II-IV 21-24. 30 to 32 scales in a longitudinal series. Dark greenish olive above, red below; all the scales edged with black; a dark oblique stripe from eye to suboperculum; sometimes two dark longitudinal bands, with a pale band between them, from eye to caudal fin; gill-membranes blackish; dorsal rays black, membrane greenish with black undulating stripes; caudal rays red, membrane greenish; pelvics and anal red, with dark edges; pectoral pale.”

From Pleeing and Moons (2017):

“Wild fish have a brown-green color and both sexes are about 5 – 5.5 cm in size (Smith, 1945; Jaroensutasinee and Jaroensutasinee, 2001). Domesticated bettas however, are 6 – 6.5 cm (females are a little smaller), and male fish are bred in almost every imaginable color. Females have less bright colors than males (Smith, 1945).”

From Snekser et al. (2006):

“*B. splendens* [...] are distinctly sexually dimorphic: adult males are distinguished by larger bodies and longer fin length from the smaller, shorter finned females (Bronstein and Jones-Buxton, 1996; Jaroensutasinee and Jaroensutasinee, [2001]).”

Biology

From Snekser et al. (2006):

“Male and female *Betta* are aggressive towards each other (Goldstein, 1975) and in nature they disperse to a density of 1.7 fish per m² (Jaroensutasinee and Jaroensutasinee, [2001]). Male *Betta* are well known for their elaborate and stereotyped aggressive displays, which include increased tail beating, biting, and branchiostegal displaying (raising the opercula) (Simpson, 1968; Bronstein, 1981, 1983, 1985; Halperin et al., 1998).”

“Male *Betta* establish territories in which they build bubble nests in which females lay their eggs, and defend these territories against intrusion by other males (Robertson and Sale, 1974; Bronstein, 1981). Males are typically more aggressive toward other males than to females (Simpson, 1968; Robertson and Sale, 1974; Doutrelant et al., 2001), while the converse is true for females (Braddock and Braddock, 1955; Simpson, 1968; Robertson, 1979; Bronstein and Jones-Buxton, 1996).”

From Pleeing and Moons (2017):

“Their natural habitat exists of shallow ponds and rice paddy fields with plenty of vegetation. This vegetation provides cover against fish-eating birds, like egrets, herons and kingfishers (Jaroensutasinee and Jaroensutasinee, 2001). [...] Bettas are carnivorous fish with a diet consisting of mosquito larvae and other water insects, which form a source of protein and fat. It is estimated that adult male fish eat about ten to fifteen thousand larvae per year (Smith, 1945; Goldstein, 2004).”

“Bettas are a member of the family of the Anabantidae, known for their labyrinth organ, which is a pharyngeal diverticulum that enables consumption of oxygen from the air (Liem, 1963; Kang and Lee, 2010; Alton et al., 2012). [...] The labyrinth organ is also responsible for the production of air bubbles for nest building.”

Human Uses

From Froese and Pauly (2019):

“Fisheries: of no interest; aquarium: highly commercial”

From Pleeing and Moons (2017):

“In Thailand, known for its ornamental fish production, *Betta splendens* represents 10% of the annual fish export (Wiwatchaisaet, as cited in Meejui et al. 2005).”

“There are two varieties of domestic bettas, the betta bred for fighting and the ornamental variety (Smith, 1945; Meejui et al., 2005). To the authors’ knowledge, only the ornamental variety with long and colorful fins is kept in Europe.”

This species is common in trade in the United States. For example, ornamental varieties of *Betta splendens* for sale at Petco (2019) include Baby Boy Betta, Baby Girl Betta, male Black Orchid Betta, male Bumblebee Betta, male Butterfly Betta, male Cambodian Crowntail Betta, male and female Crowntail Betta, male Copper Betta, male Deltatail Betta, male Doubletail Betta, male Red Platinum Dragon, male Dragonscale Betta, male and female Elephant Ear Betta, male and female Halfmoon Betta, male Halfmoon Doubletail Betta, male Halfmoon Doubletail Plakat Betta, male Halfmoon King Betta, male King Betta, male and female Koi Betta, male Paradise Betta, male Rose Gold Betta, male Rose Petal Betta, male and female Veiltail Betta, male Cambodian Veiltail Betta, and male White Opal Betta.

Diseases

No OIE-reportable diseases have been documented for this species.

From Froese and Pauly (2019):

“Fin-rot Disease (late stage), Bacterial diseases
White spot Disease, Parasitic infestations (protozoa, worms, etc.)
Fin Rot (early stage), Bacterial diseases
Bacterial Infections (general), Bacterial diseases
Columnaris Disease (e.), Bacterial diseases
Fish tuberculosis (FishMB), Bacterial diseases
Velvet Disease 2 (*Piscinoodinium* sp.), Parasitic infestations (protozoa, worms, etc.)
Edwardsiellosis, Bacterial diseases”

From Pleeing and Moons (2017):

“‘Cotton wool’ disease, caused by *Flavobacterium columnaris*, is a bacterial disease, which is especially pathogenic to betta species (Goldstein, 2004). Infected fish show ulcerative lesions with mucus-like filamentous spots (Decostere [et al.], 1998; Goldstein, 2004).”

“Another condition considered to be important for bettas is ‘velvet’ disease (Goldstein, 2004). This disease is caused by a dinoflagellate, *Piscinoodinium* spp. Young fry is especially sensitive

for infection and the development of clinical disease. The parasite is abundantly present and flourishes in water of poor quality. Skin and gills become infected, resulting in hyperplasia, hemorrhage, osmoregulatory compromise and necrosis (Roberts et al., 2009).”

“Finally, mycobacteriosis is the most common cause of death in bettas on breeding farms in Thailand, and it also poses risks for humans. In fish, it is a slowly progressive disease accompanied by the formation of granulomas in the liver, spleen and kidneys of infected fish (Puttinaowarat, 1999; Zanoni et al., 2008). Other symptoms are extreme anorexia, exophthalmia, keratitis and skeletal deformities (Zanoni et al., 2008; Chansue et al., 2009).”

Threat to Humans

From Froese and Pauly (2019):

“Harmless”

From Pleeging and Moons (2017):

“Finally, mycobacteriosis is the most common cause of death in bettas on breeding farms in Thailand, and it also poses risks for humans. [...] In humans, the main clinical signs of this zoonotic disease are limited to skin lesions and ulcers (Gray et al., 1990; Speight and Williams, 1997).”

3 Impacts of Introductions

From Nico and Neilson (2019):

“The impacts of this species are currently unknown, as no studies have been done to determine how it has affected ecosystems in the invaded range. The absence of data does not equate to lack of effects. It does, however, mean that research is required to evaluate effects before conclusions can be made.”

From Hammer et al. (2019):

“*Betta splendens* is rapidly expanding its distribution in the tropical wetlands of the Adelaide River in the Northern Territory. The biological impacts of the invasion remain to be determined and ecological studies are warranted to better understand these aspects.”

“Future ecological studies should be focused on potential impacts and understanding dispersal. The introduced fish could be carriers of disease and parasites (Humphrey et al. 1986). Aggressive interaction and competition for space and food is likely to occur between *B. splendens* and small native fishes and tadpoles in local concentrated refuges, especially considering the sheer noted abundance.”

4 Global Distribution



Figure 1. Known global distribution of *Betta splendens*. Map from GBIF Secretariat (2019). The following points were excluded from the extent of this map and from the climate matching analysis: points in India and southeast Australia were excluded because they represent captive specimens; a point in Russia was excluded due to coordinate error; points in the United States (Florida), Colombia, and Taiwan were excluded because they do not represent confirmed established populations of *B. splendens*.

5 Distribution Within the United States

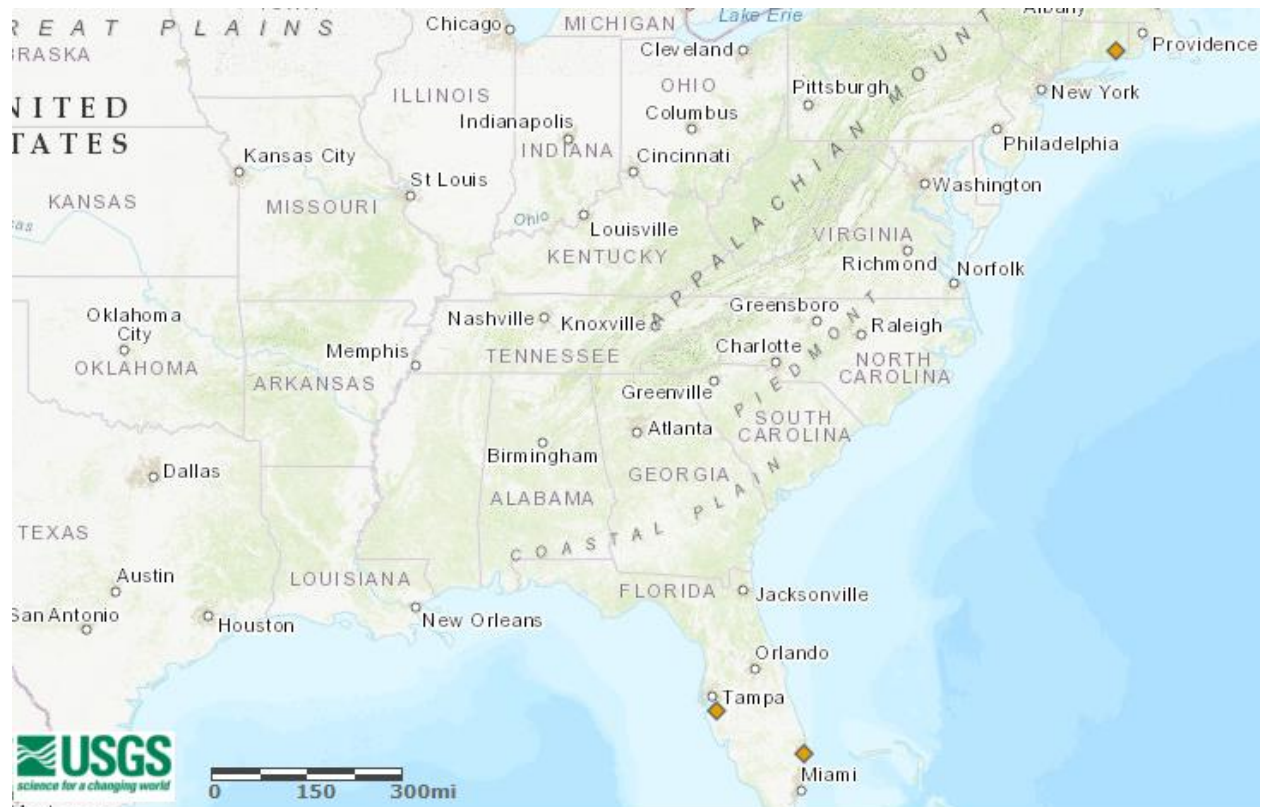


Figure 2. Known distribution of *Betta splendens* in the eastern United States. Map from Nico and Neilson (2019). All points represent failed populations.

6 Climate Matching

Summary of Climate Matching Analysis

The Climate 6 score (Sanders et al. 2018; 16 climate variables; Euclidean distance) for the contiguous United States was 0.0, indicating a low overall climate match. Climate 6 scores of 0.005 or below are classified as low match. There were some areas of medium climate match in southern Florida and Texas, but the rest of the contiguous United States had a very low climate match.

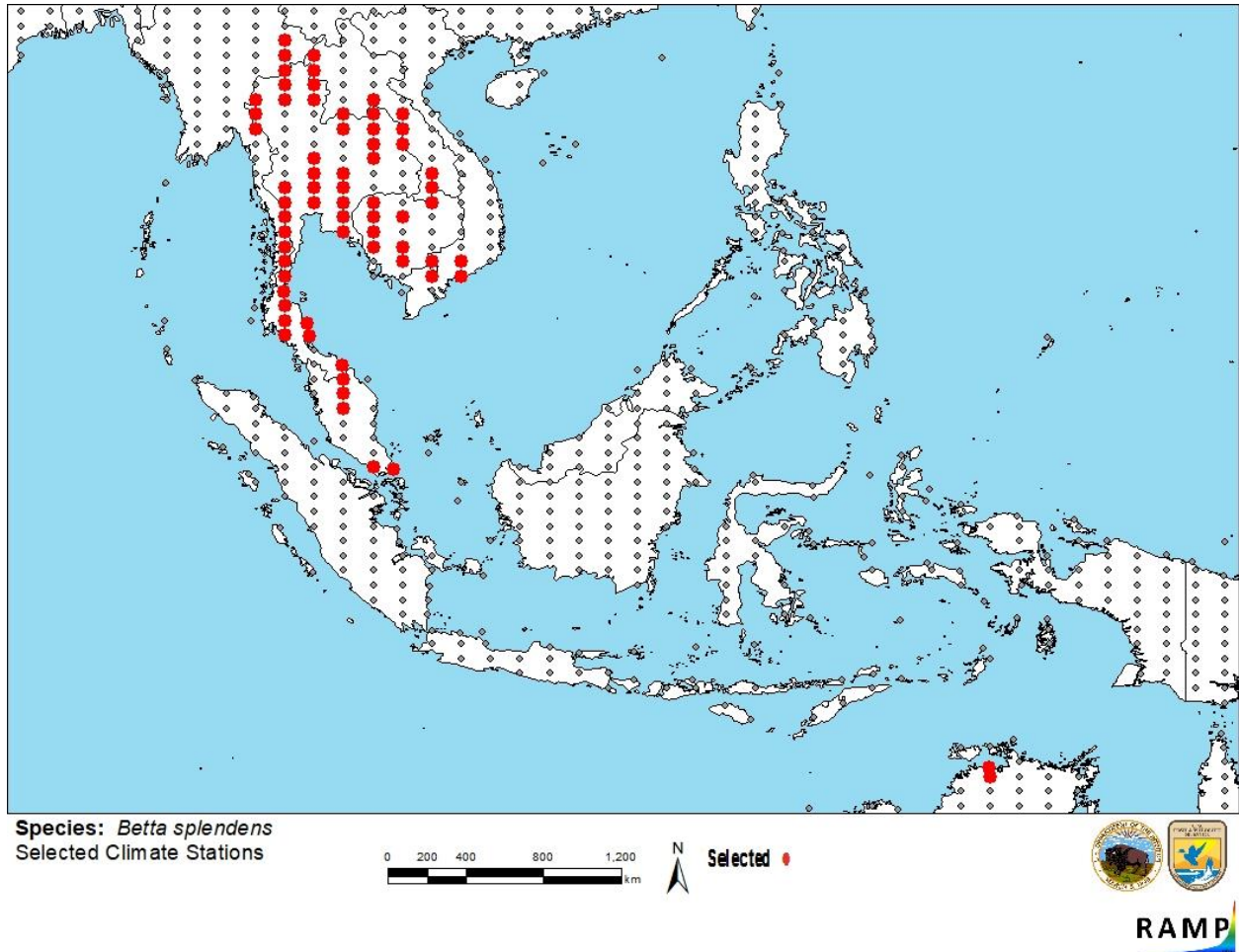


Figure 3. RAMP (Sanders et al. 2018) source map showing weather stations in Southeast Asia and Australia selected as source locations (red; Thailand, Vietnam, Laos, Cambodia, Myanmar, and Australia) and non-source locations (gray) for *Betta splendens* climate matching. Source locations from GBIF Secretariat (2019).

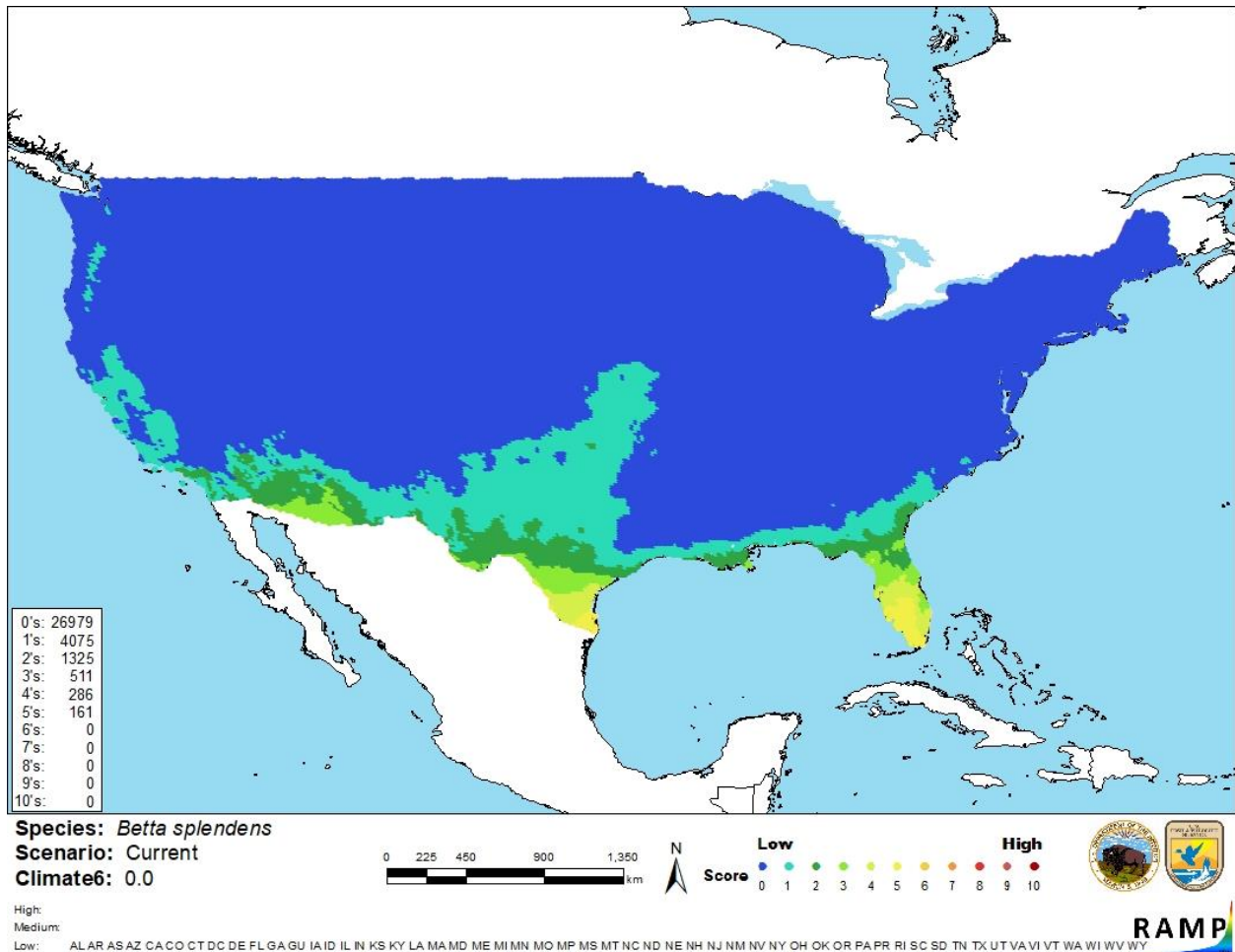


Figure 4. Map of RAMP (Sanders et al. 2018) climate matches for *Betta splendens* in the contiguous United States based on source locations reported by GBIF Secretariat (2019). Counts of climate match scores are tabulated on the left. 0= Lowest match, 10= Highest match.

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
$0.000 \leq X < 0.005$	Low
$0.005 < X < 0.103$	Medium
≥ 0.103	High

7 Certainty of Assessment

The biology and ecology of *Betta splendens* are well-documented. Although this species is established outside of its native range, there is currently no research available assessing impacts of its introduction. Further information is needed to adequately assess the risk this species poses to the contiguous United States, so the certainty of this assessment is low.

8 Risk Assessment

Summary of Risk to the Contiguous United States

Betta splendens, the Siamese Fighting Fish, is a small freshwater fish species native to Southeast Asia. It is ubiquitous in the aquarium trade in the United States and globally. It has been introduced to several countries outside of its native range, and it is currently established and reproducing in Australia, Brazil, Colombia, the Dominican Republic, and Singapore. No research has yet examined the impacts of these introductions, so the history of introduction is “none documented.” *B. splendens* has a low overall climate match with the contiguous United States, with areas of medium climate match in southern Florida and Texas. Further information is needed to fully evaluate the potential risk this species poses to the contiguous United States, so the certainty of this assessment is low and the overall risk assessment category is uncertain.

Assessment Elements

- **History of Invasiveness (Sec. 3): None Documented**
- **Climate Match (Sec. 6): Low**
- **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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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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