Devil Firefish (*Pterois miles*)
Ecological Risk Screening Summary

Web Version—07/28/2014

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1 Native Range, and Status in the United States

Native Range
From Eschmeyer (1986):

"Indian Ocean: Red Sea south to Port Alfred, South Africa and east to Sumatra, Indonesia (Fricke 1999)."

Status in the United States
From Schofield et al. (2014):

"Atlantic Coast of USA: Lionfishes have been established from Miami to North Carolina since 2002. They established in the Florida Keys in 2009. Although present in Atlantic waters north of North Carolina, they are not likely to survive cold winter temperatures."

"Gulf of Mexico: Other than the anomalous Treasure Island specimen (see Schofield 2010), the first confirmed specimens of lionfish taken from the Gulf of Mexico were in December 2009. Sightings of lionfishes are becoming common in the northern Gulf of Mexico, especially associated with [artificial] reefs (including oil/gas platforms)."

"Greater Antilles: Lionfishes are established off all islands in the Greater Antilles (Cuba [2007], Jamaica [2008], Hispañola [Haiti and the Dominican Republic; 2008] and Puerto Rico [2009])."

"Lesser Antilles: Lionfish presence has been confirmed throughout the leeward and windward islands. For more details, see Schofield (2010)."

Means of Introductions in the United States
From Schofield et al. (2014):

"The most probable explanation for the arrival of lionfishes in the Atlantic Ocean is via the aquarium trade (Whitfield et al. 2002; Semmens et al. 2004). No one will ever know with certainty how lionfishes gained entry to the coastal waters of the U.S.; however, as they are common aquarium fishes, it is possible they were released pets. The well-publicized report of lionfish establishment due to a breakage of a large aquarium by Hurricane Andrew is probably erroneous."

Remarks
From Schofield et al. (2014):

"The Devil Firefish (*Pterois miles*) is closely related to the Red Lionfish (*P. volitans*). In fact, P. miles and P. volitans have been treated as the same species (i.e., as synonyms) as well as distinct species (Schultz 1986). The Devil Firefish is found primarily in Indian Ocean and Red Sea, but has also migrated through the Suez Canal to the Mediterranean Sea (Golani and Sonin 1992). The two species co-occur in western Indonesia. Although it appears very similar to the Red Lionfish, the Devil Firefish has fewer dorsal- and anal-fin rays (see Identification, above). Genetic work (using mitochondrial DNA) was unable to reveal whether *P. miles* and *P. volitans* are distinct species or two populations of a single species (Kochzius et al. 2003). Hamner et al. (2007) show that about 93% of the Atlantic population of lionfish consists of *P. volitans*, while only 7% is *P. miles*."

"The dorsal- and anal-fin spines of the lionfish contain a potent venom that can administer a painful sting (Steinitz 1959). Regardless, the species is consumed in subsistence fisheries of the Pacific and is a popular aquarium fish despite its venomous spines. The dangerous nature of the spines may contribute to the fact that lionfish have few natural enemies. Larger lionfish are known to consume smaller members of their species (Fishelson 1997). Other than cannibalism, there are few documented natural predators of the lionfish. Bernadsky and Goulet (1991) presented evidence that coronetfish (*Fistularia commersonii*) consumes *P. miles*. Additionally, a few lionfish have been found in the stomachs of native groupers in the Bahamas (Maljkoviæ et al. 2008)."

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From ITIS (2014):

"Kingdom Animalia
Subkingdom Bilateria
Infrakingdom Deuterostomia
Phylum Chordata
Subphylum Vertebrata
Infraphylum Gnathostomata
Superclass Osteichthyes
Class Actinopterygii
Subclass Neopterygii
Infraclass Teleostei
Superorder Acanthopterygii
Order Scorpaeniformes
Suborder Scorpaenoidei
Family Scorpaenidae
Genus Pterois
Species Pterois miles (Bennett, 1828)

Taxonomic Status: Valid."

Size, Weight, and Age Range

From Eschmeyer (1986):

"Maturity: Lm ? range ? - ? cm; Max length : 35.0 cm SL male/unsexed; (Sommer et al. 1996)."

Environment

From Eschmeyer (1986):

"Marine; reef-associated; depth range ? - 60 m (Sommer et al. 1996)."

Climate/Range

From Eschmeyer (1986):

"Tropical; 30°N - 36°S, 19°E - 112°E."

Distribution Outside the United States

Native

From Eschmeyer (1986):

"Indian Ocean: Red Sea south to Port Alfred, South Africa and east to Sumatra, Indonesia (Fricke 1999)."

Introduced

From Eschmeyer (1986):

Established populations are present in Bermuda, Jamaica and Puerto Rico. An established population is also believed to be in Israel.

From Schofield et al. (2014):

"Bermuda, Bahamas, Turks and Caicos and Cayman Islands: Lionfishes were numerous in Bermuda by 2004 and established in the Bahamas by 2005, the Turks and Caicos by 2008 and the Cayman Islands by 2009."

"Caribbean coasts of Mexico, Central and South America: Lionfishes are established from Mexico through Venezuela (Mexico [2009], Belize [2009], Honduras [2009], Nicaragua [2010], Costa Rica [2009], Panamá [2009], Colombia [2010], Venezuela [2010])."

"Mediterannean Sea: *Pterois miles* has been reported from the Mediterranean Sea in Israel (Golani and Sonin 1992), Lebanon (Bariche et al. 2013) and Turkey (Turan et al. 2014). The species is reported from popular press articles in Cyprus (Evripidou 2013). These fish are thought to have migrated into the Mediterranean [Sea] via the Suez Canal (i.e., Lessepsian migration)."

Means of Introduction Outside the United States

From Eschmeyer (1986):

The populations in Bermuda, Jamaica and Puerto Rico are the result of expansion from species that were released in Florida. Fish in Florida are speculated to be the result of aquarium released pets. The Israel population is thought to be the result of Lessepsian migration.

Short description

From Eschmeyer (1986):

"Dorsal spines (total): 13; Dorsal soft rays (total): 9-11; Anal spines: 3; Anal soft rays: 6 - 7. Reddish to tan or grey in color, with numerous thin dark bars on body and head; tentacle above eye may be faintly banded. Adults have a band of small spines along the cheek and small spots in the median fins (Kuiter and Tonozuka 2001)."

Biology

From Eschmeyer (1986):

"Lives in coastal waters in muddy habitats (Kuiter and Tonozuka 2001). Fin spines highly venomous, may cause human death (Sommer et al. 1996)."

From Morris et al. (2009):

"Reproduction:

The Pteroines, including *P. miles* and *P. volitans*, are gonochoristic; males and females exhibit minor sexual dimorphism only during reproduction (see Fishelson 1975). Lionfish courtship has been well described by Fishelson (1975) who provided a detailed description for the pigmy lionfish, *Dendrochirus brachypterus*, and reported similar courtship behaviors for *Pterois* sp. According to Fishelson, lionfish courtship, which includes circling, side winding, following, and leading, begins shortly before dark and extends well into nighttime hours. Following the courtship phase, the female releases two buoyant egg masses that are fertilized by the male and ascend to the surface. The eggs and later embryos are bound in adhesive mucus that disintegrates within a few days, after which the embryos and/or larvae become free floating."

"*P. miles* and *P. volitans* ovarian morphology is similar to that reported for *D. brachypterus* (Fishelson 1978) in that these fishes exhibit cystovarian type ovaries (Hoar 1957) with ooctyes developing on stalks or peduncles. The oocytes are terminally positioned near the ovary wall, which secretes the encompassing mucus shortly before spawning. The seasonality of lionfish reproduction throughout their native range is unknown. Invasive lionfish collected off North Carolina and in the Bahamas suggests that lionfish are reproducing during all seasons of the year."

"Venomology:

Lionfish are venomous with their spines containing apocrine-type venom glands. Each spine of the lionfish (except caudal spines) is venomous including 13 dorsal spines, three anal spines, and two pelvic spines. The spines are encased in an integumentary sheath or skin and contain two grooves of glandular epithelium that comprises the venom producing tissue. Spine glandular tissue extends approximately three quarters the distance from the base of the spine towards the tip (Halstead et al. 1955)."

"Feeding ecology:

In the Red Sea, lionfish (*P. miles*) have been reported to feed on assorted taxa of benthic fishes including damselfish, cardinal fish, and anthias (Fishelson 1975, Fishelson 1997). However, in the Pacific Ocean, *P. lunulata* were observed to feed primarily on invertebrates including penaeid and mysid shrimps (Matsumiya et al. 1980, Williams and Williams 1986). Assessments of invasive lionfish feeding suggests that lionfish are largely piscivorous, but also feed on a number of crustaceans. The particular taxa of highest importance in invasive lionfish diet will likely vary by habitat type and prey availability."

"Feeding, growth, and starvation of *P. volitans* from the Red Sea was investigated by Fishelson (1997) who reported that lionfish stomachs can expand over 30 times in volume after consuming a large meal. This capability supported Fishelson's hypothesis that lionfish were capable of longterm fasting, and demonstrated their ability to withstand starvation for periods of over 12 weeks without mortality. Fishelson (1997) also measured daily consumption rates in the laboratory for six size classes of lionfish ranging from 30 - 300g and found that lionfish consumed approximately 2.5 – 6.0% of their body weight per day at 25 - 26 °C. Preliminary observations suggest that lionfish in their invaded range can consume piscine prey at rates greater than reported earlier by Fishelson (1997). Quantification of the feeding ecology of lionfish including consumption rates and prey selectivity will permit better assessment of the impacts of their predation on local reef fish communities."

Human uses

From Eschmeyer (1986):

"Aquarium: commercial."

Diseases

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

Threat to humans

Venomous.

From Morris et al. (2009):

"The toxin in lionfish venom contains acetylcholine and a neurotoxin that affects neuromuscular transmission (Cohen and Olek 1989). Lionfish venom has been found to cause cardiovascular, neuromuscular, and cytolytic effects ranging from mild reactions such as swelling to extreme pain and paralysis in upper and lower extremities (Kizer et al. 1985). Antivenom of the related stonefish (*Synanceia* ssp.) is highly effective in neutralizing lionfish venom activity (Shiomi et al. 1989, Church and Hodgson 2002)."

3 Impacts of Introductions

From Schofield et al. (2014):

"Research by Albins and Hixon (2008) on small patch reefs in the Bahamas provided the first evidence of negative effects of lionfish on native Atlantic coral-reef fishes. The recruitment of coral-reef fishes was studied during the 2007 recruitment period (July-August) on small patch reefs in the Bahamas with and without lionfish. Over the five week period, net recruitment (i.e., accumulation of new juvenile fishes via settlement of larvae) was reduced by 79% on reefs with a single lionfish compared to reefs with no lionfish. Stomach content analyses and observations of feeding behavior showed that reductions in native fish density were almost certainly due to predation by lionfish. Prey items found in lionfish stomachs included the fairy basslet *Gramma loreto*, bridled cardinalfish *Apogon aurolineatus*, white grunt *Haemulon plumierii*, bicolor damselfish *Stegastes pertitus*, several wrasses *Halichoeres bivittatus*, *H. garnoti* and *Thalasoma bifasciatum*, striped parrotfish *Scarus iserti*, and dusky blenny *Malacoctenus gilli*. Initial examination of crustacean prey suggests that lionfish may also eat the juvenile spiny lobster *Panulirus argus*. The reduction in recruitment of coral-reef fishes suggests that lionfish may also compete with native piscivores by monopolizing this important food resource. In addition, lionfish have the potential to decrease the abundance of ecologically important species such as parrotfish and other herbivorous fishes that keep seaweeds and macroalgae from overgrowing corals."

"Additional research in the Bahamas has documented a marked impact on native fish communities. Green et al. (2012) documented an increase in lionfish populations that corresponded with a 65% decline in the biomass of lionfish prey (42 fish species) over a two-year time period."

"Albins (2012) manipulated densities of lionfish and a native predator (coney grouper, *Cephalopholis fulva*) on small patch reefs in the Bahamas over an 8-week time period. Native fishes on patch reefs with lionfish were reduced at a rate 2.5 times greater than patch reefs with the grouper. Concomitant reductions in species richness on lionfish reefs were seen, whereas reefs with grouper did not experience reductions in species richness. Greatest effects on the native community were seen when both lionfish and grouper were present on reefs, a situation that is likely occurring across much of the Caribbean at this time. In summary, this study showed that lionfish have a stronger ecological effect on native prey fishes than equivalent native predators, and may pose a substantial threat to native coral-reef fish communities."

"Long-term effects of lionfish are unknown; however, Albins and Hixon (2012) suggest that direct and indirect effects of lionfish could combine with the impacts of preexisting stressors (especially overfishing) and cause substantial deleterious changes in coral-reef communities."

From Côté et al. (2013):

"Lionfish were first reported off Florida in 1985. Since their establishment in The Bahamas in 2004, they have colonised 7.3 million km^2 of the western Atlantic and Caribbean region, and populations have grown exponentially at many locations. These dramatic increases potentially result from a combination of life-history characteristics of lionfish, including early maturation, early reproduction, anti-predatory defenses, unique predatory behavior, and ecological versatility, as well as features of the recipient communities, including prey naïveté, weak competitors, and native predators that are overfished and naïve to lionfish. Lionfish have reduced the abundance of small native reef fishes by up to 95% at some invaded sites. The ultimate causes of the invasion were inadequate trade legislation and poor public awareness of the effects of exotic species on marine ecosystems. The lionfish invasion highlights the need for prevention, early detection, and rapid response to marine invaders."

4 Global Distribution

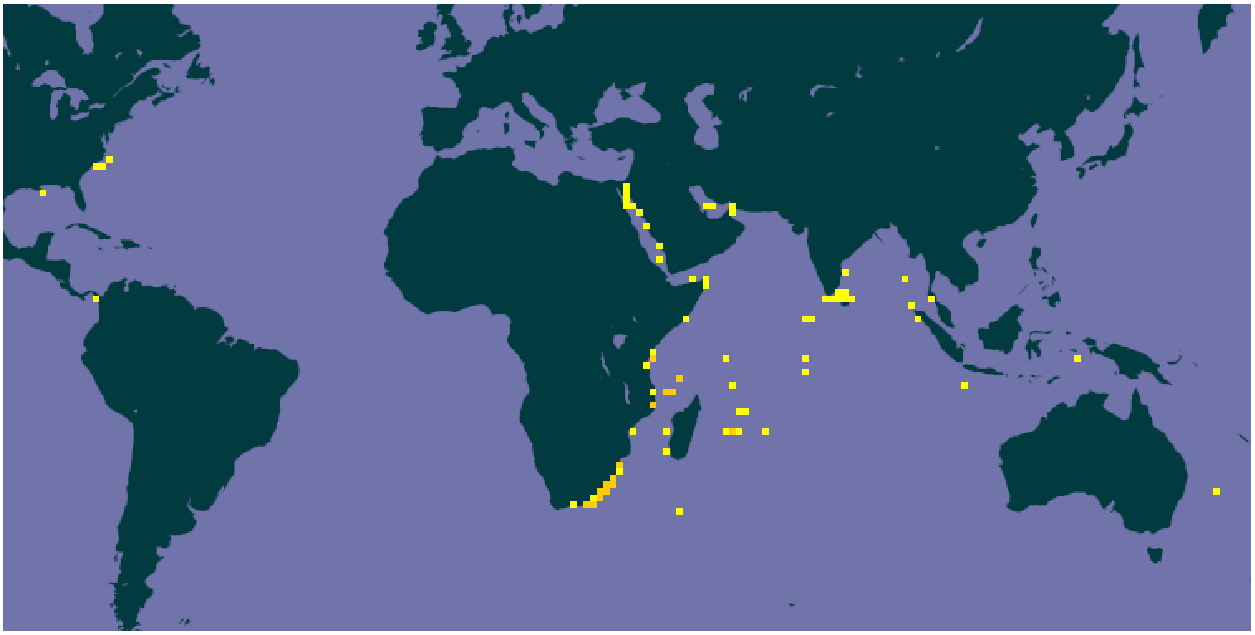

Figure 1. Map of known global distribution of *Pterois miles*. Map from GBIF (2014). Locations in Mexico and South Africa were not included because they were incorrectly located.

5 Distribution within the United States

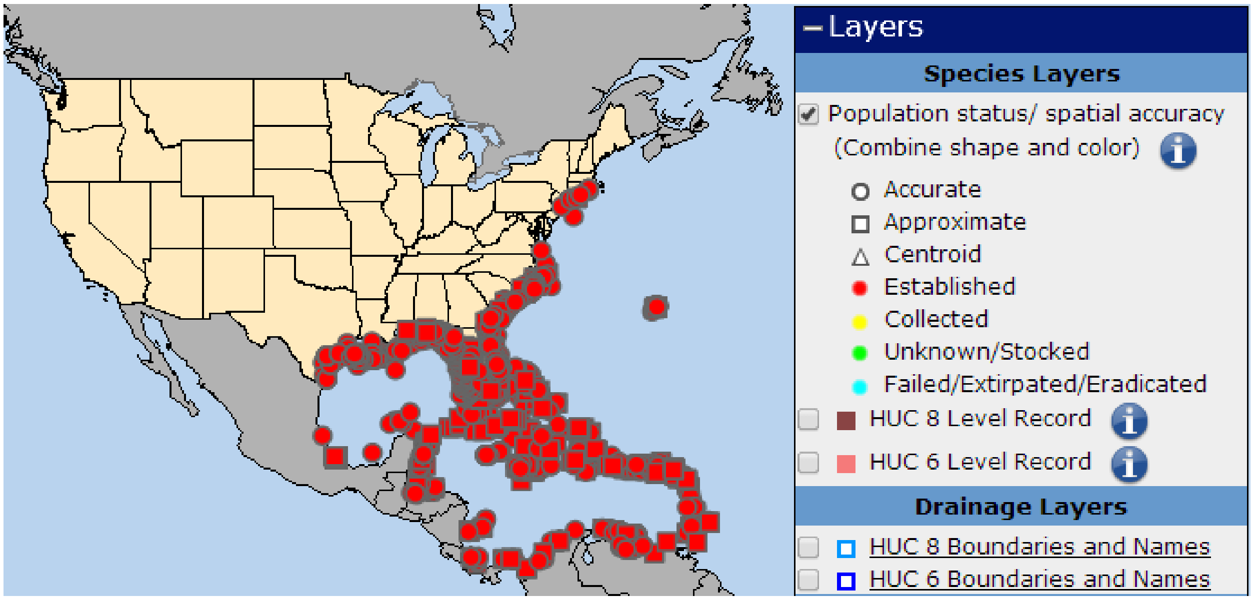

Figure 2. Distribution of *Pterois miles* in the United States. Map from Schofield et al. (2014).

6 CLIMATCH

Summary of Climate Matching Analysis

The climate match (Australian Bureau of Rural Sciences 2008; 16 climate variables; Euclidean Distance) was high along the entire Atlantic and Gulf Coasts. Medium match was found along most of the California coast and in Puget Sound. Low match was found in Washington, Oregon, and Northern California. Highest match was along the Atlantic and Gulf Coasts. Climate 6 proportion 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 *Pterois miles* is 0.530.

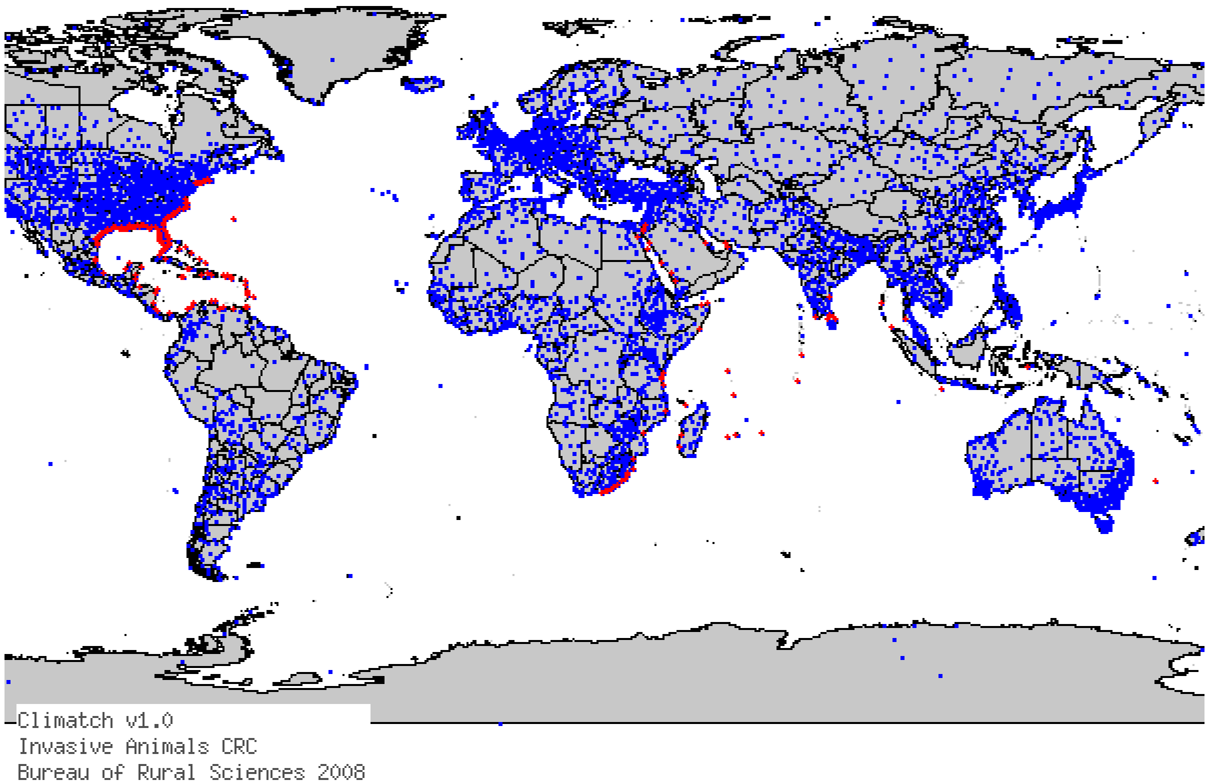

Figure 3. CLIMATCH (Australian Bureau of Rural Sciences 2008) source map showing weather stations selected as source locations (red) and non-source locations (blue) for *Pterois miles* climate matching. Source locations from GBIF (2014).

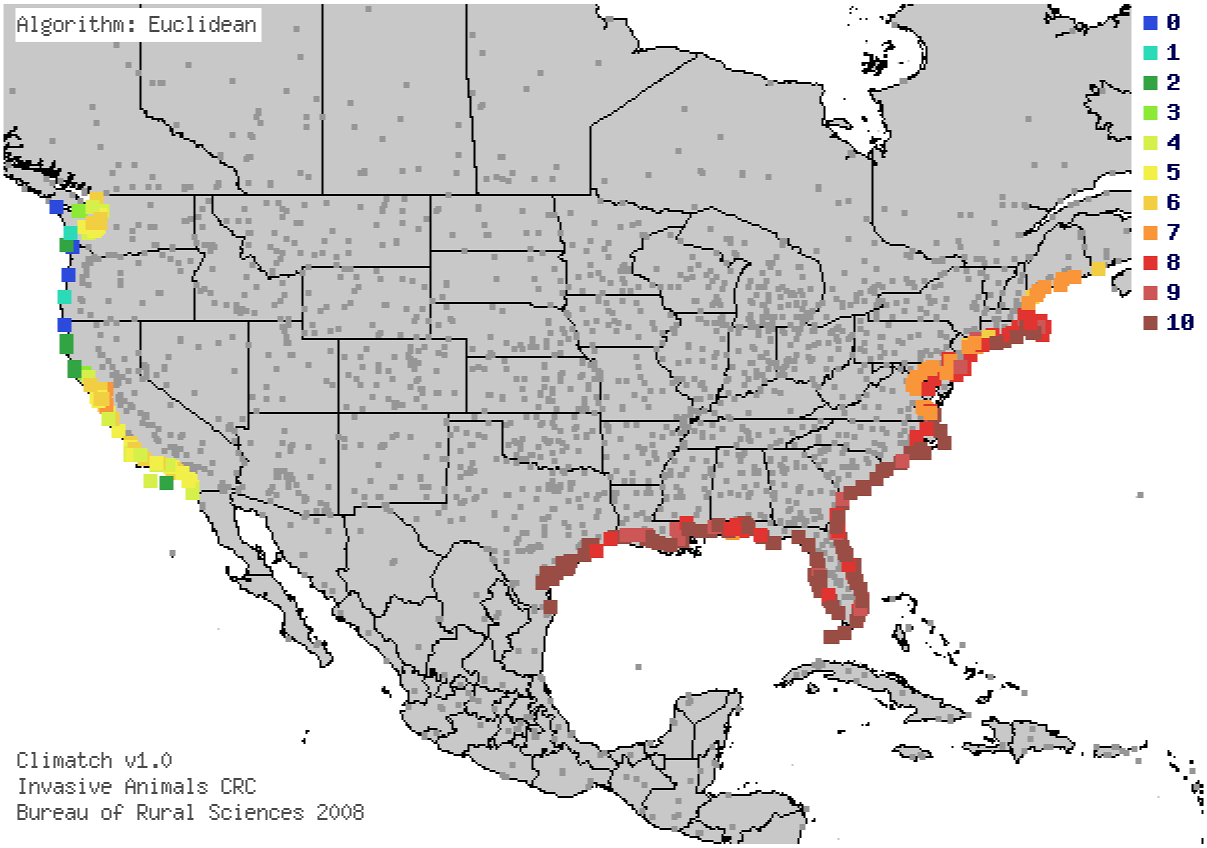

Figure 4. Map of CLIMATCH (Australian Bureau of Rural Sciences 2008) climate matches for *Pterois miles* in the contiguous United States based on source locations reported by GBIF (2014). 0= Lowest match, 10=Highest match.

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

CLIMATCH Score	0	1	2	3	4	5	6	7	8	9	10
Count	19	15	20	16	30	54	67	75	28	1	3
Climate 6 Proportion =		0.530									

7 Certainty of Assessment

Negative impacts from introductions of *Pterois miles* are adequately documented in the scientific literature. No further information is needed to evaluate the negative impacts the species is having where introduced. The range of this species is well-documented. Certainty of this assessment is high.

8 Risk Assessment

Summary of Risk to the Contiguous United States

Pterois miles is a marine species native to the Indian Ocean. It is found from the Red Sea south to Port Alfred, South Africa and east to Sumatra, Indonesia. *Pterois miles* lives in coastal waters in muddy habitats. It feeds on fish. *Pterois miles* has fin spines which are venomous and may cause human death. This species has spread to the Atlantic Ocean and the eastern Mediterranean. Introductions for the species have also been reported in the United States, and have resulted in established populations. Those introductions have also facilitated the spread of the species to Bermuda, Jamaica and Puerto Rico. Impacts from those introductions include reduced populations of prey fish, reduction in recruitment of endemic species, exponential population growth of *Pterois miles* and deleterious changes in coral-reef communities. Climate match with the United States is high, with the entire Atlantic and Gulf of Mexico Coasts likely habitat. No further research is needed to understand the negative impacts from introductions of this species. Certainty of this assessment is high. Overall risk posed by 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** Venomous may cause human death
- **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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