Red Lion Fish (*Pterois volitans*)
Ecological Risk Screening Summary

Web Version—07/28/2014

Photo: © J.E. Randall from Froese and Pauly (2014).

1 Native Range, and Status in the United States

Native Range
From Myers (1991):

"Pacific Ocean: Cocos-Keeling Islands and Western Australia (Randall et al. 1997) in the eastern Indian Ocean to the Marquesas and Oeno (Pitcairn group), north to southern Japan and southern Korea, south to Lord Howe Island, northern New Zealand, and the Austral Islands. Replaced by the very similar *Pterois miles* from the Red Sea to Sumatra."

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 volitans (Linnaeus, 1758)

Taxonomic Status: Valid."

Size, Weight, and Age Range

From Myers (1991):

"Maturity: Lm ?, range 16 - ? cm; Max length : 38.0 cm TL male/unsexed; (Randall et al. 1990); max. reported age: 10 years (Hinton 1962)."

Environment

From Myers (1991):

"Marine; reef-associated; depth range 2 - 55 m (Allen and Steene 1988)."

Climate/Range

From Myers (1991):

"Tropical; 22°C - 28°C; 43°N - 40°S, 95°E - 130°W (FLMNH 2005)."

Distribution Outside the United States

Native

From Myers (1991):

"Pacific Ocean: Cocos-Keeling Islands and Western Australia (Randall et al. 1997) in the eastern Indian Ocean to the Marquesas and Oeno (Pitcairn group), north to southern Japan and southern Korea, south to Lord Howe Island, northern New Zealand, and the Austral Islands. Replaced by the very similar *Pterois miles* from the Red Sea to Sumatra."

Introduced

From Myers (1991):

Established populations are present in Bermuda, Belize, Bahamas, Cuba, Turks and Caicos, Haiti, Colombia, Dominican Republic, US Virgin Islands, Cayman Islands, Jamaica, Costa Rica Antigua Barb, Panama, Nicaragua, Curacao, Mexico, Honduras and Venezuela.

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])."

Means of Introduction Outside the United States

From Myers (1991):

The populations in the locations listed above are the result of expansion from species that were first released in Florida. Those releases in Florida are speculated to be the result of aquarium released pets or larvae which might have come in through ballast water of ships from the Indian or South Pacific oceans.

Short description

From Myers (1991):

"Dorsal spines (total): 13; Dorsal soft rays (total): 9-12; Anal spines: 3; Anal soft rays: 6 - 8. Scales cycloid (Myers 1999). Variable in color, usually in relation to habitat. Coastal species generally darker, sometimes almost black in estuaries. Often with large tentacles above eyes (Kuiter and Tonozuka 2001)."

Biology

From Myers (1991):

"Inhabit lagoon and seaward reefs from turbid inshore areas to depths of 50 m. Often solitary, they hide in unexposed places at daytime often with head down and practically immobile. Pelagic juveniles expatriate over great distances and the reason for their broad geographical range (Kuiter and Tonozuka 2001). Hunt small fishes, shrimps, and crabs at night, using its widespread pectorals trapping prey into a corner, stunning it and then swallowing it in one sweep. Dorsal spines are venomous; the sting can be treated by heating the afflicted part and application of corticoids (Cornic 1987). A popular table fish."

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 Myers (1991):

"Fisheries: commercial; 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)."

From Robertson et al. (2014):

Pterois volitans can cause ciguatera fish poisoning (CFP).

"CFP is caused by the consumption of reef fish that have accumulated ciguatoxins […] This acute poisoning syndrome is characterized by a variety of severe gastrointestinal, neurological, and occasionally cardiovascular symptoms that can occur within 4 h and last up to six weeks (Bagnis and Legrand 1987). A chronic phase of CFP lasting many years has also been reported in up to 20% of those acutely exposed (Pearn 2001)."

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 CABI (2014):

"Since the lionfish is listed as invasive species only in the USA and the Caribbean most of the work on their invasiveness has been done in that area. Morris (2009) argued that as a venomous scorpionfish, lionfish are considered invasive by definition because of their probable impacts to native reef fish communities (Albins and Hixon 2008, Morris and Akins 2009) and to human health (Vetrano et al. 2002)."

"Hixon et al. (2009) reported that lionfish have the potential to drastically reduce the abundance of coral reef fishes and leave behind a devastated ecosystem. They suggested that with few known natural predators, the lionfish poses a major threat to coral reef ecosystems in the Caribbean region by decreasing survival of a wide range of native reef animals via both predation and competition. While native groupers may prey on lionfish, they have been overfished and therefore unlikely to significantly reduce the effects of invasive lionfish on coral reef communities. Albins and Hixon (2008) conducted a controlled field experiment using a matrix of translocated coral and artificial patch reefs to examine the short-term effects of lionfish on the recruitment of native reef fishes in the Bahamas. They found that lionfish caused significant reductions in the recruitment of native fishes by an average of 79% over the 5 week duration of the experiment. They propose that this strong effect on a key life stage of coral-reef fish suggests that invasive lionfish are already having substantial negative impacts on Atlantic coral reefs. Hixon et al. (2009) on one occasion observed a lionfish consuming 20 small wrasses during a 30 minute period. They also observed that it was not unusual to see lionfish consuming prey up to two-thirds of its own length. Morris et al. (2008) claimed that the lionfish invasion in the northwestern Atlantic and the Caribbean represents one of the most rapid marine finfish invasions in history."

"Ruiz-Carus et al. (2006) reported that lionfish may, directly and indirectly, cause harm to coral reef ecosystems. As aggressive ambush predators with few predators of their own in their introduced range, lionfish can quickly and alarmingly reduce local native reef fish populations to the point where native piscivores (fish predators) cannot compete for these prey animals. This in-turn can cause a reduction in the growth and survival of the native predators."

"Stomach content analyses of lionfish reveal a wide diversity in prey species and size classes. Lionfish eat nearly anything that will fit into their mouths. Their diet consists of numerous shrimp, crabs, and other crustaceans, including juveniles of the commercially important spiny lobster (*Panulirus argus*) (CoRIS 2009). Lionfish are also responsible for great reductions in fish numbers on reefs where they become established. They prey on herbivorous fishes that consume macro-algae and help protect corals from algal overgrowth. In addition to the species listed in the Threatened Species table, lionfish also compete for food with Serranids in the Bahaman archipelago (Morris and Akins 2009). Scientists have concluded that lionfish populations will continue to grow and cannot be extirpated using conventional methods. Due to their fecundity, rapid and wide-spread distribution, adaptability to a variety of shallow and deep habitats, and behaviour, scientists believe the lionfish invasion could become the most disastrous in history, devastating coral reef ecosystems throughout the Americas. As lionfish colonize more territory in the Caribbean, they may have a devastating effect on coral reefs already stressed by climate change, pollution, disease, overfishing, sedimentation, and other stressors (CoRIS 2009)."

4 Global Distribution

Figure 1. Map of known global distribution of *Pterois volitans*. Map from GBIF (2014). Locations in Canada, France and Croatia were not included because they were incorrectly located.

5 Distribution within the United States

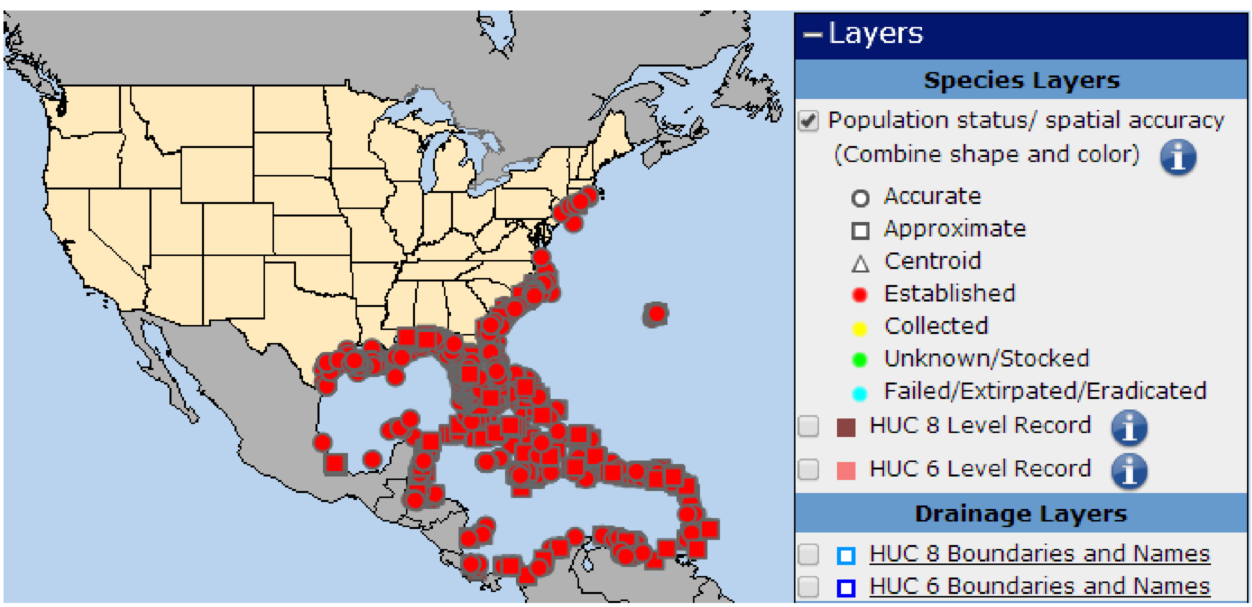

Figure 2. Distribution of *Pterois volitans* in the United States and nearby waters. Map from Schofield et al. (2014).

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 of the contiguous U.S. Medium match was found along most of the California coast and in Puget Sound. Low match was found in northern California and Oregon and Washington. 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 volitans* is 0.851.

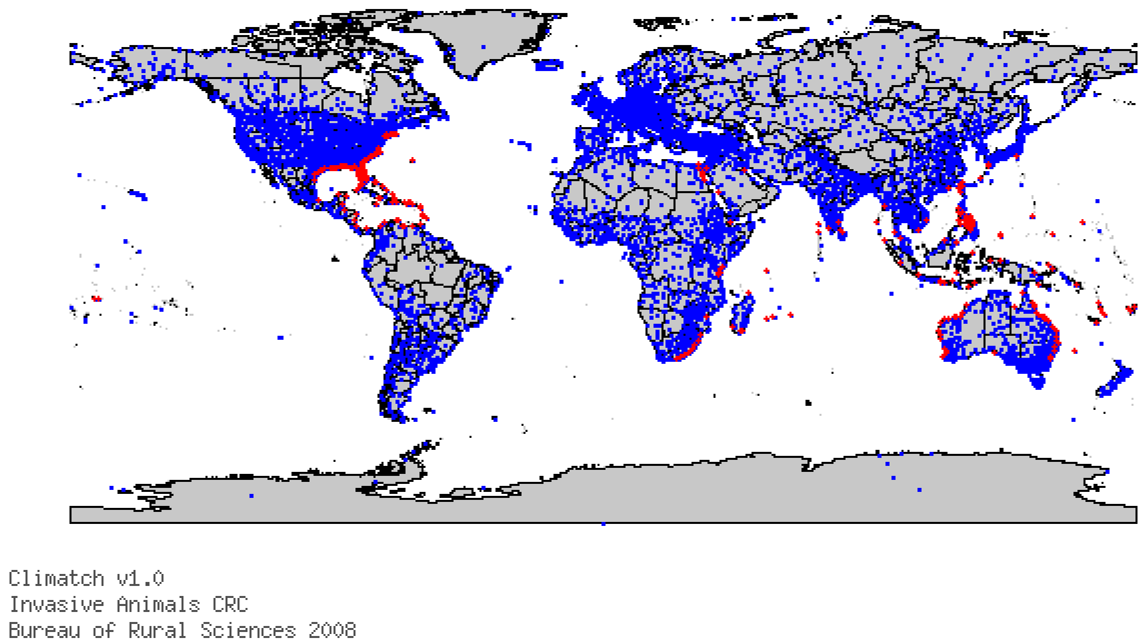

Figure 3. CLIMATCH (Australian Bureau of Rural Sciences 2008) source map showing weather stations selected as source locations (red) and non-source locations (blue) for *Pterois volitans* climate matching. Source locations from GBIF (2014).

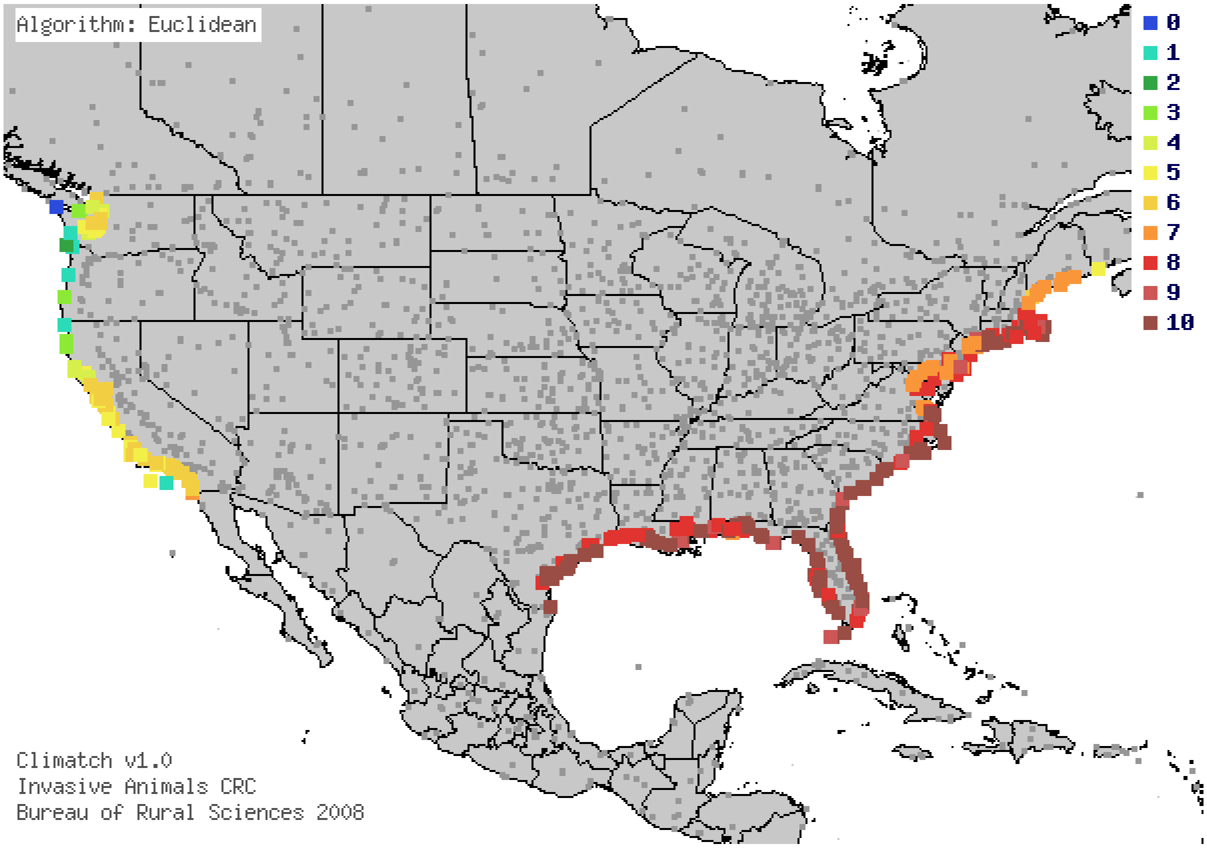

Figure 4. Map of CLIMATCH (Australian Bureau of Rural Sciences 2008) climate matches for *Pterois volitans* in the contiguous United States based on source locations reported by GBIF (2014). 0= Lowest match, 10=Highest match.

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	2	5	1	8	7	26	43	44	60	21	111
Climate 6 Proportion =		0.851									

7 Certainty of Assessment

Negative impacts from introductions of this species are adequately documented in the scientific literature. No further information is needed to evaluate the negative impacts the species is having where introduced. Information on the established range of this species is also adequate. Certainty of this assessment is high.

8 Risk Assessment

Summary of Risk to the Contiguous United States

Pterois volitans is a marine species native to the Indo-Pacific. It is found from the Cocos-Keeling Islands and Western Australia in the eastern Indian Ocean to the Marquesas and Oeno (Pitcairn group), north to southern Japan and southern Korea, south to Lord Howe Island, northern New Zealand, and the Austral Island. *Pterois volitans* inhabit lagoon and seaward reefs from turbid inshore areas to depths of 50 m. Often solitary, they hide in unexposed places at daytime often with head down and practically immobile. Pelagic juveniles expatriate over great distances and the reason for their broad geographical range. The species hunt small fishes, shrimps, and crabs at night, using its widespread pectorals trapping prey into a corner, stunning it and then swallowing it in one sweep. *Pterois volitans* has fin spines which are venomous and it may cause ciguatera fish poisoning. Introductions of this species to the United States have resulted in established populations. Those introductions have also resulted in the spread of the species to numerous other locations both north and south. Impacts from those introductions include reduced populations of prey fish, reduction in recruitment of endemic species and deleterious changes in coral-reef communities. Climate match with the contiguous United States is high, with the Atlantic and Gulf of Mexico coasts likely habitat. 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 and potential for ciguatera poisoning
- **Overall Risk Assessment Category: High**

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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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