

Invasive Species of Florida's Coastal Waters: The Red Lionfish (*Pterois volitans*) and Devil Firefish (*P. miles*)¹

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Two species of Indo-Pacific lionfish (*Pterois volitans* and *P. miles*) are the first reported non-native marine fish to become established in the Atlantic Ocean. Genetic studies indicate that lionfish in the Atlantic are likely all descendants of a few individuals, consistent with the widely held belief that lionfish were introduced into the Atlantic as a result of accidental or deliberate release of aquarium pets. Regardless of the method of introduction, the prolific spread of these invasive species in the Atlantic Ocean ecosystem is cause for concern.



Figure 1. The red lionfish (*Pterois volitans*) is spectacular looking but has rapidly invaded marine waters in the Caribbean, off the southeastern United States, and in the Gulf of Mexico. These specimens were collected near Fort Pierce, Florida.

Credits: Jeffrey Hill, UF/IFAS Extension.

Distribution

Currently in the United States, the lionfish is almost continuously distributed in marine waters from the northern Gulf of Mexico to Cape Hatteras, North Carolina. Although the U.S. Geological Survey aquatic invasive species database lists isolated reports of lionfish (*Pterois* spp.) from waters off southeastern Florida in the mid-1980s and early 1990s, these species have since established breeding populations from Florida to North Carolina. Less is known about reproduction of lionfish in the Gulf of Mexico. Lionfish were first reported from the Florida Keys in 2009 and in the northern and eastern Gulf of Mexico in late 2010. Lionfish have been reported from the northeastern United States but do not survive the cold winters in those waters.

Lionfish expanded eastward to Bermuda (2004), the Bahamas (2005), the Turks and Caicos (2008), and the Cayman Islands (2009). By 2012, they had spread throughout the Greater Caribbean region. Found in several locations on the Atlantic coasts of Venezuela, Colombia, Honduras, Costa Rica, Nicaragua, Belize, Panama, and Mexico beginning in December 2008, lionfish are quickly adapting to the diverse habitat types of the western Atlantic Ocean.

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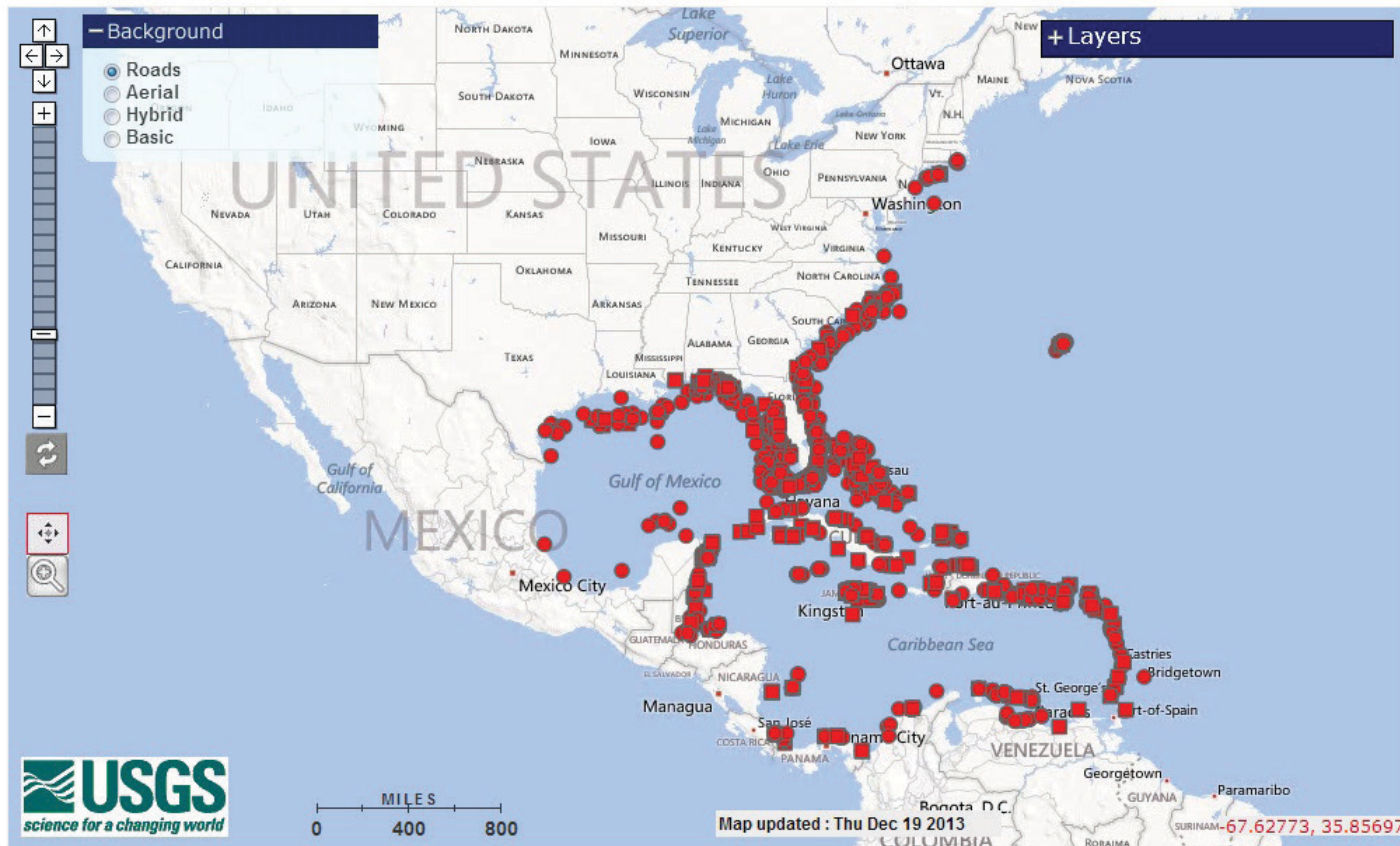


Figure 2. Reported lionfish sightings.

Credits: U.S. Geological Survey website, <http://nas2.er.usgs.gov/viewer/omap.aspx?SpeciesID=963>. U.S. Geological Survey. [2013]. Nonindigenous Aquatic Species Database. Gainesville, Florida. Accessed [10/18/2013].

Biology

Lionfish species are members of the scorpionfish family. Approximately 93 percent of lionfish off the eastern United States are *Pterois volitans*, while 7 percent are *P. miles*. Genetic analysis indicated that all lionfish tested from the Bahamas were *P. volitans*.

Lionfish have venomous spines on their dorsal, pelvic, and anal fins. When these spines penetrate an object, the sheath covering the spine rips, releasing the venom into the wound. The effects of lionfish venom on humans have been well-documented, largely because of the popularity of these fish in the aquarium trade. Aquarium owners are sometimes stung while performing maintenance on their fish tanks containing lionfish. Lionfish stings produce immediate pain, which peaks at 60–90 minutes, but may last for 6–12 hours. Other symptoms of a lionfish sting can include ulceration of the wound site, headaches, nausea or diarrhea. Initial treatment of the wound involves immersing it in non-scalding hot water. Unlike many types of fish, lionfish do not avoid humans, so swimmers and divers need to take care to avoid lionfish in areas where they are present. While lionfish will not attack divers, they usually do not move out

of the way as people approach, so swimmers and divers may accidentally brush against the venomous spines.

Although lionfish have been reported to reach a maximum of 15 inches in native waters, specimens of 18 inches have been found in the Atlantic. There are unverified reports on the Internet of lionfish as large as 22 inches being caught in the Bahamas.

Lionfish in the Atlantic spawn year-round. They may release eggs as frequently as every four days. They become sexually mature at a small size. Male fish as small as 4 inches (100 mm) may be mature, while females mature at about 7 inches (180 mm). A female lionfish may release over two million eggs in a single year. Eggs are released as gelatinous floating egg masses, which may increase their early survival rates. Preliminary data suggest that lionfish larvae may settle after approximately 26 days.

Habitat

From Miami to North Carolina, lionfish are generally found at depths of 100 to 330 feet (30–100 meters). While juvenile

lionfish may be found in shallow, nearshore habitats, adult fish tend to be at deeper reef sites. In the Florida Keys and throughout the Caribbean, lionfish have been found in water as shallow as 3 feet (1 meter). In August 2010, a private submarine diving off the Bahamas filmed a lionfish in 1000 feet of water. In the Caribbean, lionfish have been found in a variety of habitats, including seagrass beds, mangroves, patch reefs and deep reefs. The salinity tolerance of lionfish is not known, but there have only been limited reports of lionfish in low-salinity environments. Those reports are from a salt-wedge estuary, where fresh water tends to float on top of the seawater in a layer that gradually thins as it moves seaward, so the lionfish could easily retreat down into higher salinity water.

Lionfish are able to tolerate water temperatures as low as 50°F (10°C), which probably allows them to survive winters along the southeastern US continental shelf south of Cape Hatteras. They have been found in waters off the northeastern United States. It is believed that larvae are transported to this area by the Gulf Stream, but cannot survive the winter temperatures there.

Impacts

In the wake of their rapid and successful establishment in coastal waters of the southeast United States and greater Caribbean region, there is concern that lionfish compete with and eat ecologically and commercially important native fish. Researchers found that when lionfish were introduced to Bahamian patch reefs, recruitment of native fish was reduced by almost 80 percent over five weeks when compared to similar reefs without lionfish.

While smaller lionfish prey more on shrimp and other small crustaceans, stomach content analysis indicates that larger lionfish diets in the Bahamas are comprised largely of bony fishes (78 percent by volume) and crustaceans. Lionfish also have larger impacts on native fishes than some similarly sized native predators such as small groupers. Capable of consuming prey that are almost half their size, lionfish are targeting gobies, basslets, wrasses and blennies—all common prey items for commercially important species such as groupers and snappers.

The explosive nature of the recent lionfish invasion in the Atlantic Ocean means that environmental, economic and social impacts of this invasion have largely not been measured, so there is great concern about potential negative impacts. Many natural resource management agencies in the region have been prompted to move forward with

management actions and discussion of management alternatives.

In January 2010, the South Atlantic Fishery Management Council produced a document titled *Policies for the Protection of South Atlantic Ecosystems from Non-Native and Invasive Species*, which states: “The SAFMC finds the following to constitute potential threats to South Atlantic ecosystems:

1. Potential impacts of the invasion of Indo-Pacific lionfish (*Pterois volitans* and *P. miles*) in South Atlantic waters include reduction of forage fish biomass, increase in algal growth due to herbivore removal by lionfish, and competition with native reef fish.
2. Lionfish have been shown to impact community structure and biodiversity potentially causing cascading trophic impacts on economically important species under SAFMC management.
3. Lionfish competition with native species could hamper stock rebuilding efforts for the Snapper Grouper Complex.
4. Socio-economic impacts of the lionfish invasion could include impacts on commercial and recreational fisheries, the aquarium trade, and coastal tourism industry.
5. Lionfish interactions with humans will continue to increase as lionfish densities increase.”

Many Caribbean governments have developed lionfish management plans, as have Biscayne National Park and the Florida Keys National Marine Sanctuary in Florida. Lionfish are specifically mentioned in the aquatic nuisance species management plans for the states of Georgia and South Carolina. In 2012, the Gulf and Caribbean Fisheries Institute published the book, *Invasive Lionfish: A Guide to Control and Management*.

The US Virgin Islands Lionfish Management Plan states, “It was determined that eradication of lionfish from USVI waters would be impossible given the lionfish’s rapid spread from its presumed origin in Florida through the Bahamas into the Caribbean. Instead the goal would be continuous suppression of lionfish populations through targeted and opportunistic removal.” In the Bahamas National Lionfish Response Plan (2009), “active and ongoing removal of lionfish from selected areas of interest, such as popular beaches and marine parks” was listed as a high priority,

with the goal of minimizing contact between lionfish and the general public.

In 2012, the Florida Fish and Wildlife Conservation Commission issued a temporary rule which waived the bag limit for lionfish as well as the requirement to have a recreational fishing permit when catching lionfish (as long as lionfish-specific harvesting gear are used). In 2013, that rule was made permanent. The Florida Keys National Marine Sanctuary has issued special permits which allow the removal of lionfish from “no harvest” zones within the Sanctuary.

Why are lionfish so successful?

Lionfish are presently more successful in their introduced range of the tropical western Atlantic than they are in their native range. In fact, some researchers have reported densities of over 390 lionfish per hectare in the Bahamas. (A hectare covers an area 100 m x 100 m and equals 2.47 acres.) This is more than eight times higher than densities reported from the lionfish’s native range in the Red Sea. More common densities in the Atlantic are 5–21 lionfish per hectare. It is likely that lionfish are so abundant because the environment is suitable, food is abundant, and reproduction is highly successful. Additionally, natural enemies have limited, if any, impact on the abundance of lionfish.

Lionfish have an unusual feeding behavior that appears to confuse many native Atlantic species and allows for efficient capture of small fishes. As they slowly approach their prey, lionfish produce a jet of water that is directed towards the smaller fish. This causes the fish to turn toward the predator, into the direction of the water flow, which may make it easier for the lionfish to swallow it.

Frequent production of large numbers of eggs provides numerous juveniles able to settle into a variety of habitats over a wide geographic range. While a cornetfish preys on lionfish in the Indo-Pacific region, few Atlantic fish seem willing to feed on lionfish. Apart from a few reports of groupers that were found to have lionfish in their stomachs, it seems that many predatory fish avoid lionfish. It may be that native predators, though capable of eating lionfish, do not recognize them as prey. Reports from divers indicate that sharks, groupers, and moray eels may take and eventually learn to steal lionfish from divers in popular spear-fishing locations. Feeding speared lionfish to native fish is not recommended because it could be dangerous for the divers. Unfortunately, large groupers and other potential predators of lionfish are over-fished, resulting in low abundance in many regions.

Non-native species with novel traits such as new and unusual behavior, appearance, size, or other attributes often do well in their introduced range and may cause negative impacts. Overall, lionfish are novel in many ways compared to native Atlantic species. From the venomous spines and their showy fins to their unusual behavior, lionfish are like no other fish in the western Atlantic. All these factors contribute to their success.

What can you do?

Several agencies and environmental groups have programs that allow the public to report lionfish sightings. These programs have allowed scientists to document the spread of lionfish along Florida’s coast, throughout the Caribbean region, and into the Gulf of Mexico. Many locations have hundreds of sightings in the databases, especially in south-east Florida, the Florida Keys, and the Bahamas. The public is especially encouraged to report sightings of lionfish along the Florida coasts north of Sebastian Inlet in the Atlantic and from Florida Bay north through the Florida Panhandle on the Gulf of Mexico coast. Reports of sightings in near-shore coastal waters and in estuaries are most important.

Efforts to control lionfish have had mixed results at best. The prevailing strategy in shallow-water areas in the Caribbean and Florida Keys is to try to prevent infestation by early detection and rapid removal of lionfish using teams of trained divers. The Reef Environmental Education Foundation, or REEF, has been actively working in the Caribbean and Florida Keys for the past several years to train divers to identify and safely catch and handle lionfish. To date, the best method for capturing lionfish has been found to be by divers using spears or nets with plastic sides. In partnership with local governments, REEF sponsors lionfish rodeos, which can result in the capture of over 1000 lionfish in a single day. Lionfish are being marketed as a food fish in several Caribbean locations, and chefs throughout the region are being given opportunities to cook lionfish fillets in hopes that they will create a demand for lionfish meat. People who plan to eat lionfish from some areas of the Caribbean should be aware that, like many other top predatory reef fish, lionfish can accumulate ciguatoxin, which can cause ciguatera poisoning. Local fisheries officials should be able to advise about the safety of consuming lionfish or other reef predators such as grouper, snapper and barracuda from particular locations.

Lobster fishermen in Bermuda and the Florida Keys often find lionfish in their traps. Studies are underway to see if trapping might be an effective method for capturing lionfish. Lionfish have occasionally been caught by anglers

using live shrimp as bait. However, no studies have been published that investigate the use of different bait types to catch lionfish with hook-and-line. In aquaria, lionfish will initially only feed on live prey. They can be converted to frozen or dead food, but this can take some time and effort. This aversion to eating dead prey will likely present a challenge if trying to develop a hook-and-line fishery for lionfish.

Preliminary research into the effectiveness of diver removal efforts indicates that eradication is not possible. Modeling studies suggest that a high proportion of the adult lionfish, anywhere from 27% to 65%, must be removed each year to cause a meaningful decline in lionfish abundance. A continual effort is needed to maintain low lionfish abundance. In addition to reducing local abundance, targeted removal efforts can result in the removal of the larger lionfish, further reducing predation impacts on native fish. Removals are likely most effective when targeted to protect highly vulnerable areas such as marine reserves.

Additional Information Sources

Nonindigenous Aquatic Species Database U.S. Geological Survey <http://nas.er.usgs.gov/queries/FactSheet.aspx?SpeciesID=963> <http://nas.er.usgs.gov/sightingreport.aspx>

NOAA <http://oceanservice.noaa.gov/education/stories/lionfish/welcome.html> <http://ccfhr.noaa.gov/stressors/lionfish.aspx>

Invasive Lionfish: A Guide to Control and Management
Gulf and Caribbean Fisheries Institute <http://lionfish.gcfi.org/manual/> (English) http://lionfish.gcfi.org/manual_esp/ (español)

Policies for the Protection of South Atlantic Ecosystems from Non-Native and Invasive Species South Atlantic Fishery Management Council <http://www.safmc.net/LinkClick.aspx?fileticket=bNFKO%2FIcvHQ%3D&tabid=245>

Regional Strategy for the Control of Invasive Lionfish in the Wider Caribbean International Coral Reef Initiative http://www.icriforum.org/sites/default/files/ICRI_lionfish_Strategy_En.pdf