

## Update on geographic spread of invasive lionfishes (*Pterois volitans* [Linnaeus, 1758] and *P. miles* [Bennett, 1828]) in the Western North Atlantic Ocean, Caribbean Sea and Gulf of Mexico

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### Abstract

The Indo-Pacific lionfishes (*Pterois volitans* [Linnaeus, 1758] and *P. miles* [Bennett, 1828]: Family Scorpaenidae) are the first non-native marine fishes to establish in the Western North Atlantic/Caribbean region. The chronology of the invasion was reported last year (Schofield 2009) using records from the US Geological Survey's Nonindigenous Aquatic Species database. This article provides an update of lionfish geographic spread (as of October 2010) and predictions of future range.

**Key words:** Lionfish, *Pterois volitans*, *P. miles*, non-native marine fishes, Scorpaenidae

### Introduction

In a previous report (Schofield 2009), information on the invasion chronology of the lionfishes (*Pterois volitans* [Linnaeus, 1758] and *P. miles* [Bennett, 1828]: Family Scorpaenidae) was provided using records from the US Geological Survey Nonindigenous Aquatic Species database (USGS-NAS 2010). Herein, an update on the geographic spread of the species is given.

Lionfishes are the first marine fishes to invade the western Atlantic Ocean and Caribbean Sea, and have potential to add additional stress to an environment already compromised by over-fishing, pollution and global climate change. Because the invasions are relatively new, it is unclear exactly how lionfishes will affect these ecosystems. Importantly, this invasion illustrates the speed with which non-native marine fishes are able to spread through new coastal systems.

### Materials and methods

Data for this paper were obtained from the USGS-NAS database (USGS-NAS 2010). Schofield (2009) provided details regarding the database and its lionfish records. Individuals with information relevant to lionfishes (or other non-native fishes) are encouraged to report their

findings to the USGS-NAS database. It is not clear whether both species (*P. volitans* and *P. miles*) are present at all locations.

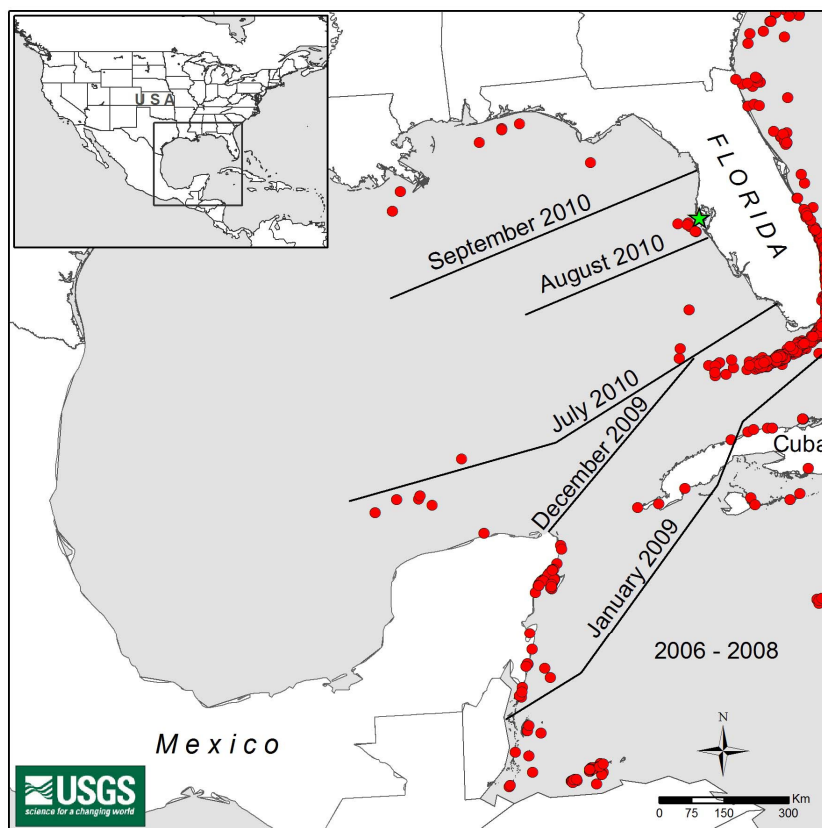
### Results

#### *Locations where lionfishes are established*

All locations where lionfishes were established in 2009 remain invaded in 2010. See Schofield (2009) for details of lionfish establishment in these regions, which include:

- Atlantic Coast of Mainland USA (Miami, Florida to Cape Hatteras, North Carolina)
- Bermuda Islands
- Commonwealth of the Bahamas
- Turks and Caicos Islands
- Cayman Islands
- Republic of Cuba
- Jamaica
- Dominican Republic
- Commonwealth of Puerto Rico
- Mexico (Caribbean coast)
- Honduras
- Republic of Costa Rica

**Figure 1.** Map showing northward movements of lionfish into the Gulf of Mexico. Timelines indicate when lionfishes were first sighted in a particular region. The star indicates an anomalous lionfish record from 2006 thought to be a recent aquarium dump.



*Newly-documented, established populations of lionfishes (since 2009)*

Florida, United States

Florida Keys – Lionfishes were not found in the Florida Keys until relatively recently (January 2009); much later than they were found in significant numbers along the Atlantic coast of Florida north of Miami. The first Florida Keys lionfish was found at Benwood Ledge (near Key Largo) at a depth of 20 m. The specimen was collected within 24 hrs of the sighting. Fifty-three additional sightings of lionfishes in the Florida Keys were reported in 2009. Over 300 additional sightings have been reported in the Keys from January through July 2010. The first lionfish captured inside the boundaries of Everglades National Park (within Florida Bay) was taken in August 2010. Lionfishes were collected just outside Dry Tortugas National Park in September ( $n = 1$ ) and October ( $n = 2$ )

2009. The first reports from inside Dry Tortugas National Park came in June 2010 ( $n = 4$ ).

Gulf of Mexico (Figure 1)

As reported in Schofield (2009), a dead lionfish was retrieved from waters off Treasure Island (Pinellas County), Florida in October 2006 (FWRI 2008). The fish was found during a bloom of the toxic red-tide organism *Karenia brevis*; however, toxicity testing revealed only minimal exposure of the fish to the brevetoxin. Therefore, it appears the fish was only in Gulf coast waters for a short period of time (i.e., probably a recent aquarium dump).

In December 2009, two lionfish were collected in the southern Gulf of Mexico, off the northern Yucatan Peninsula (Aguilar-Perera and Tuz-Sulub 2010). Those records document the first apparent arrival of *P. volitans* into the Gulf of Mexico via larval transport. Additional lionfishes have been collected in this region since.

In July 2010, three specimens were photographed (two were collected) WNW of Key West in the Gulf of Mexico.

In August 2010, the first report of a lionfish off the west coast of peninsular Florida (Cortez, Manatee County, Florida) was verified. Additional reports quickly followed in the same region (Manatee and Pinellas counties).

Verified reports of lionfishes from the northern Gulf of Mexico were received by the USGS-NAS database in September, 2010 (eight fish at five locations: off Pensacola, Florida; Dauphin Island, Alabama; oil and gas platforms along the Louisiana coast and off Sonnier Bank near Louisiana). Additional reports of lionfishes in the northern Gulf of Mexico have followed since.

#### Greater Antilles

**Republic of Haiti** – When Schofield (2009) was published, only five lionfish records were known from Haiti. By November 2010, 13 records have been documented, including two in 2007 that appear to be the first known specimens from the island. Both the 2007 specimens (one from February, one from March) were caught by a local fisherman in a fringe reef off Ile de la Gonave at 9-15 m depth. Those specimens are catalogued at the Fish and Wildlife Research Institute Ichthyology Collection in St. Petersburg, Florida as FSBC 19947 and FSBC 19954. Records from Haiti remain relatively sparse compared to other Greater Antillean islands; however, this is likely due to low reporting from the area. Additionally, most of the recent reports received from Haiti are for multiple specimens at the same site.

#### Lesser Antilles – Leeward Islands

**US Virgin Islands** – The first lionfish records from the US Virgin Islands were from a diver who saw and photographed several individuals at two sites off the north shore of St. Croix in June 2008. The first confirmed report of lionfish from St. Thomas was in January 2010 (between Dutchcap Cay and Savana Island). Two months later (March 2010), the first lionfish from St. John was captured (Leinster Bay inside Virgin Islands National Park). Lionfishes are now established around all three islands, and have been taken from inside the boundaries of Buck Island National Monument and Virgin Islands Coral Reef National Monument.

**British Virgin Islands** – This area is likely under-reported, as there are only two records in the USGS-NAS database for the British Virgin Islands, one from October 2008 (Guana Island) and one from October 2010 (Anegada).

**Netherlands Antilles** – The Leeward Antilles (off the coast of Venezuela) were invaded by lionfishes in 2009 (Antigua in September, Bonaire and Curacao in October). Lionfishes were quickly classified as established, with sightings increasing greatly in number over only a few short months (September  $n = 1$ , October  $n = 5$ , November  $n = 32$ ). The portion of the Netherlands Antilles within the Leeward Islands (east of the US Virgin Islands, including Barbuda, Saba and Sint Maarten [Saint Martin]) was invaded by lionfishes in July 2010.

**Other Leeward Islands** – Lionfishes expanded throughout the Leeward Islands in 2010. Lionfishes were first reported from Saint Martin in July 2010, from Anguilla in August 2010, from Guadeloupe in September 2010 and from St. Kitts in October 2010.

#### Lesser Antilles – Windward Islands

At the time of this publication (November 2010), no lionfishes have been reported from the Windward Islands (Martinique, Saint Lucia, Barbados, Saint Vincent and the Grenadines, Grenada, Trinidad and Tobago).

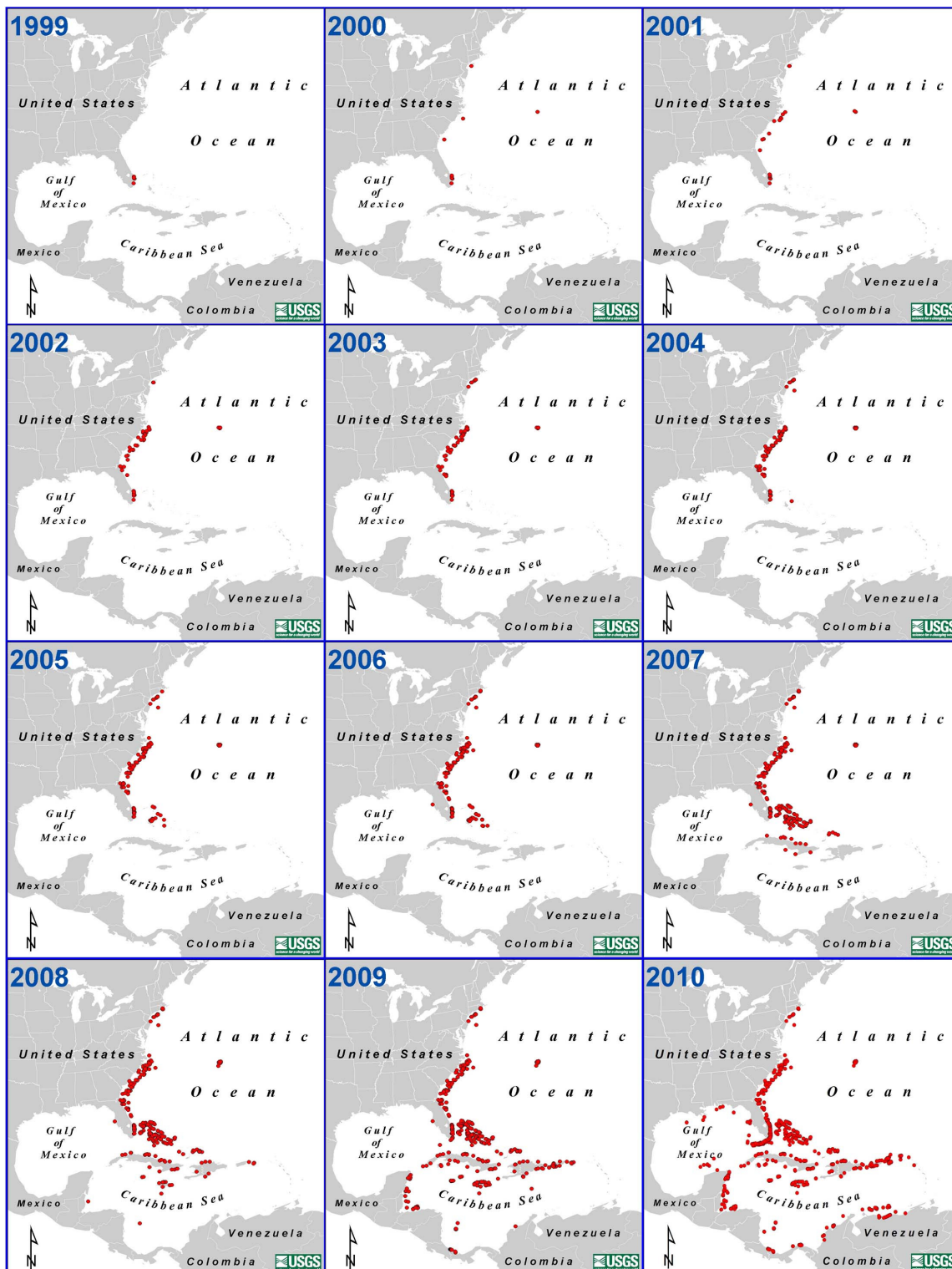
#### Caribbean coast of Central and South America

**Mexico** – Lionfishes were found established off the Caribbean coast of Mexico in 2009 (Schofield 2009).

**Belize** – There was an unconfirmed report of a lionfish sighting in Belize from September 2001. The first confirmed report was a single specimen taken in December 2008 from Turneffe Atoll. Subsequently, lionfishes have been seen at many locations along the coast of Belize.

**Guatemala** – There are currently no records of lionfishes from Guatemala.

**Honduras** – The first lionfish known from Honduras was a specimen captured in May 2009 off the island of Roatán inside the barrier reef about 200 m from shore in 7 m of water (Schofield 2009). Numerous additional sightings were reported from the islands off the Honduran mainland (e.g., Roatán, Utila, Cayos Cochinos) during 2009 and 2010. Individuals from the Roatan Institute of Deepsea Exploration have recorded lionfish sightings from as deep as 400



**Figure 2.** Confirmed lionfish occurrences in the Western North Atlantic and Caribbean Sea (USGS-NAS 2010). The first panel displays all lionfish records in the database through December 1999 ( $n=5$ ). Each subsequent panel displays cumulative occurrences of lionfish for each calendar year. The panel for 2010 includes data through October 2010. All data are available online via the USGS-NAS database (<http://nas.er.usgs.gov>). Alternately, this [direct link](#) is available.

feet. Lionfishes have not been recorded from the mainland as of this writing (November 2010).

**Nicaragua** – The first reported lionfish from Nicaragua were seen in November 2009 off Little Corn island. Only five reports exist for Nicaragua; however, that is probably due to low reporting. Many lionfishes have been reported from adjacent areas (e.g., the nearby archipelago of Los Roques [Columbia], Honduras and Costa Rica).

**Costa Rica** – Lionfishes were first seen in Costa Rica in April, 2009 at the Manzanillo Wildlife Refuge ( $n=3$ ; Schofield 2009). Additional specimens were seen the following month at two nearby locations (Puerto Viejo and Cahuita National Park). Many additional reports of lionfishes were collected in 2009 and 2010.

**Republic of Panamá** – The first lionfish collected from Panama were taken at Bocas del Toro in May ( $n = 1$ ) and July ( $n = 2$ ) 2009. Those specimens were donated to the Smithsonian Tropical Research Institute in Bocas del Toro. Lionfishes have subsequently been collected at many locations along the coast of Panama and off her northern islands (e.g., San Blas islands).

**Republic of Columbia** – In the last report (Schofield 2009) the first lionfish from Columbia was reported from a shallow (5 m) patch reef in December 2008 at Manta City just south of Isla de Providencia in the Seaflower Biosphere Reserve, part of the Archipelago of San Andres (near Nicaragua). The first lionfish from the Columbian mainland were collected in May 2009 at Tayrona National Park, Santa Marta ( $n = 2$ ). At least one of these is deposited in the Museum of Natural History (INVEMAR; González et al. 2009). Numerous lionfishes have been reported from the San Andres archipelago and the Columbian mainland since these initial occurrences.

**Venezuela** – Lasso-Alcalá and Posada (2010) report the first collection of lionfish in Venezuela in November 2009. In total, only four specimens were reported in 2009 (November,  $n = 2$ ; December,  $n = 2$ ). Shortly thereafter, lionfish sightings became more numerous; there are more than 40 reports in the first half of 2010 (through June 2010). Lionfishes are established along the Venezuelan coastline as well as along the northern islands near the Netherlands Antilles (e.g., Parque Nacional Archipiélago de Los Roques (Lasso-Alcalá and Posada 2010).

## Summary

Figure 2 displays lionfish occurrence information by year, summarized below:

**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 considered established there because they are not likely to survive cold winter temperatures.

**Gulf of Mexico:** Other than the anomalous Treasure Island specimen (see above), 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 (Figure 1).

**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.

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

**Lesser Antilles:** Lionfish presence has been confirmed throughout the Leeward Islands. There are no reports of lionfishes from the Windward Islands; however, invasion is likely imminent.

**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], Columbia [2010], Venezuela [2010]). There are no records for Guatemala.

## Future spread of lionfishes

Lionfishes are expected to continue their geographic expansion and eventually close the loop of the Caribbean, including the entire Gulf of Mexico and the island chain from the U.S. Virgin Islands to the south and east through Leeward and Windward islands to Grenada. From there, it is probable that the invasion will spread south through Trinidad and Tobago, Guyana, Suriname, French Guyana and on to Brazil. At this time, it is unclear whether lionfishes will be capable of spreading further south than Brazil or possibly Uruguay. Morris

and Whitfield (2009) projected lionfishes would not invade beyond Uruguay based on current patterns of sea-surface temperatures and experimentally-derived thermal limits of lionfishes (from Kimball et al. 2004). However, it is uncertain how changes to the environment (e.g., through global climate change) and/or potential changes in ecophysiology of lionfishes (e.g., through microevolution to climate) will affect those estimates in the future.

The invasion of lionfishes throughout the western North Atlantic Ocean and Caribbean Sea is unprecedented. Lionfishes are the first non-native marine fishes to establish in the region and they have spread with remarkable speed. Scientists are concerned that predatory lionfishes may have detrimental impacts on native fauna, and many countries are actively involved in controlling lionfish numbers. Research on the impacts of the invasion is needed to evaluate the effect this non-native species is having on native ecosystems. Additionally, more work is needed to find means for controlling their numbers. Although lionfishes are not likely to be eradicated, their invasion of the Atlantic and Caribbean may serve as an example of the relatively short time required by non-native fishes to establish and spread in novel marine waters. Over 30 species of non-native marine fishes (most from the Indo-Pacific) have been documented in the coastal waters off Florida, USA (Schofield et al. 2009). Given the number of non-native marine fish species seen off coastal Florida, it is possible that additional species may become established.

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