INVASIVE SPECIES ASSESSMENT

LIONFISH IN THE BAHAMAS

Photo Source: Eleanor Gibson

ASSESSMENT OF STATUS AND RISK POSED BY THE INDO-PACIFIC RED LIONFISH (*Pterois volitans)* ALONG THE ANDROS COASTLINE

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EXECUTIVE SUMMARY

Red Lionfish *(Pterois volitans)* sightings along the North East Andros coastline have been increasing over the past few years. The invasive lionfish was first found along the East coast of the United States over 10 years ago. Over the past few years, it has become apparent that the lionfish has now become an established invasive species in the Bahamian ecosystem.

Lionfish could prove a threat in the Bahamas through direct predation, competition and overcrowding (Whitfield *et al* 2007). Studies from North Carolina have conducted preliminary genetics data that suggests as little as three females could be responsible for an entire population (Whitfield *et al* 2007). This evidence is worrying as only a couple of lionfish taking up settlement in an area could be enough to establish an entire population.

There are two main concerns surrounding the introduction of this new species. One is the effects the lionfish will have on native species and the ecosystem as a whole. The other is its venomous spines that can give severe reactions if people are stung. In the lionfishes natural range, local people are well aware of the presence and dangers of this fish; however, there is concern that Androsians might not be aware of the venomous nature if the fish. The lionfish has been sighted in shallow areas along the coastline where young children play.

The aim of this report is to document the recent sightings of lionfish along the Andros coastline. There are also recommendations for possible eradication and monitoring programs that could be done in the future. Lionfish sightings in the Bahamas are becoming a common occurrence and effective measures should be put in place as soon as possible if lionfish settlement is to be prevented or controlled.

ACNOWLEDGEMENTS

I would like to thank the staff at FORFAR International Field Station for additional lionfish data and their assistance with the removal of these invasive species. Thanks also to Ryan Stolee, Education Director of FORFAR field station for his help in proof reading this report and his helpful suggestions.

This work could not have been possible without the efforts of the staff and volunteers at Greenforce research station and the staff at FORFAR. Greenforce volunteers John Arthur, Andrew La Niece and Danny Gray helped with collecting the lionfish information during their stay; all of the volunteers at Greenforce have been documenting their sightings as well, thanks goes out to them. At FORFAR, staff have been removing the invasive lionfish from the waters and the lionfish that have been collected can now be passed on for further study and genetic analysis in-situ.

TABLE OF CONTENTS

1 INTRODUCTION

A species that has been introduced into a habitat that is not part of its natural range is known as an introduced species. Many introduced species do not become established, as the new environment is not suitable (Primark 2002). However, some species become abundant and can take over the native species ranges, becoming the dominant species. These are said to have become invasive.

Introduced species are in an area by unnatural means (e.g. human actions); human-induced alterations of environments have enabled hardy species to become established into areas where they would probably not have been able to survive under natural means**.** Natural barriers keep species in native ranges. These can be geographical (e.g. land barriers, temperature controls and substrate controls) (JNCC report). Humans have broken a lot of the barriers and as a result species are increasingly being moved intentionally and unintentionally around the world.

The Lionfish was first documented in the Western Atlantic in 2000 where it was sighted off the coast of North Carolina. Since that time, the Red Lionfish (*Pterois volitans*) has been sighted from Long Island, New York to the Florida Keys and recently into the Bahamas (http 2).

1.1 REDUCTION IN BIODIVERSITY

All of the following concerns about species introductions effectively lead to one major concern - the loss in biological diversity. This can be genetic loss, and/or loss of a native species. As a result, habitats can become altered and whole ecosystems can change over time as a result of one introduction that has become invasive. Introduced species can lead to a cascade of problems and are a key concern to marine scientists in our society today.

Absence of natural predators/ parasites/ competitors

Populations of an introduced species can increase beyond typical numbers in their native range, as without predators or parasites there is no natural population control. For example, the Atlantic sea lamprey (*Petromyzon marinus*) has had a big impact in America's Great Lakes as the absence of natural predators and parasites has given them a strong advantage. Introduced via ballast water, bait and from canals, they attach and feed on a variety of important commercial fishes and as a result the numbers of salmon and trout have been greatly reduced. There was a collapse in the commercial fisheries in the 1950's as a result of this introduced species (http 1). This is causing concern because this parasitic species is having an economic impact on the fisheries.

1.2 KEY CONCERNS

Below are some of the concerns about the effects of an introduced species on an ecosystem. These can be either direct or indirect. Indirect impacts happen as a consequence of the altered habitat that the lionfish inhabits and may not become apparent until sometime after becoming established. With the lionfish being a new addition to the Bahamas marine environment, the impact on the environment is not yet known. Direct impacts can be reduction populations of native species and competition between species. The negative effects of an invasive species have been documented for other species over time and from this, predictions can be made on the effects lionfish will have on the environment. Some of the negative effects are:

- Reduction in biodiversity – loss of native species
- Direct predation
- Competition with native species
- Introduction of new diseases/ parasites
- Habitat alteration
- Habitat degradation

Introduced species can become invasive through direct predation, competition, or introduction of diseases (Primark, 2002). This then leads to a loss in biodiversity, and in turn, to habitat alteration and degradation.

1.3 THE ABILITY TO INVADE – SUCCESSFUL TRAITS

One of the key concerns regarding an introduced species is the consequences it may have on the native biodiversity. Introduced species do not always become invasive and cause detrimental effects; but in some cases they do and the environmental impacts can be severe. Below are some of the concerning traits that aid a species in becoming a successful invader.

- Hardiness
- Fast reproduction rates/ reproductive success
- Ability to colonize
- Opportunistic

These traits can be seen in a successful invader. Table 1 lists some of the invasive characteristics the lionfish has.

Lionfish (*Pterois volitans)*	
Hardiness	• Can tolerate wide temperature ranges • Wide depth range
Reproductive success	• Eggs and pelagic juveniles can be carried over great distances in ocean currents
Ability to colonise	• Occurs in harbours, possible ballast water transport • Inhabits many varied habitats, man made and natural • Aggressive venomous species, can take over native fish territories
Opportunistic	• Opportunistic predator • Quick to adapt to new prey types

Table 1: The successful traits of the introduced lionfish (information adapted from the Global Invasive Species Database).

1.4 PATHWAYS TO INVASION

Accidental transport

Marine species are transported around the world's oceans in ships ballast water and can become invasive if they are released into conditions that are favourable to them. Large ships may hold up to 150,000 tons of ballast water (Primark 2002). The zebra mussel (*Dreissena polymorpha*) was introduced into America's Great Lakes from the Caspian Sea in the 1980's in this way (http 1). Species can also attach themselves onto the outside of ships. The Northern Pacific seastar (*Asterias amurensis*) has been introduced into Australian waters in this way (Dommisse, M. Hough, D. 2003).

Aquarium releases

Lionfish are popular fish species in public and private aquaria. They are seen as an attractive species in an aquarium. The main pathway of introduction for the red lionfish into the West Atlantic region is thought to be from intentional/unintentional aquarium releases (NOAA).

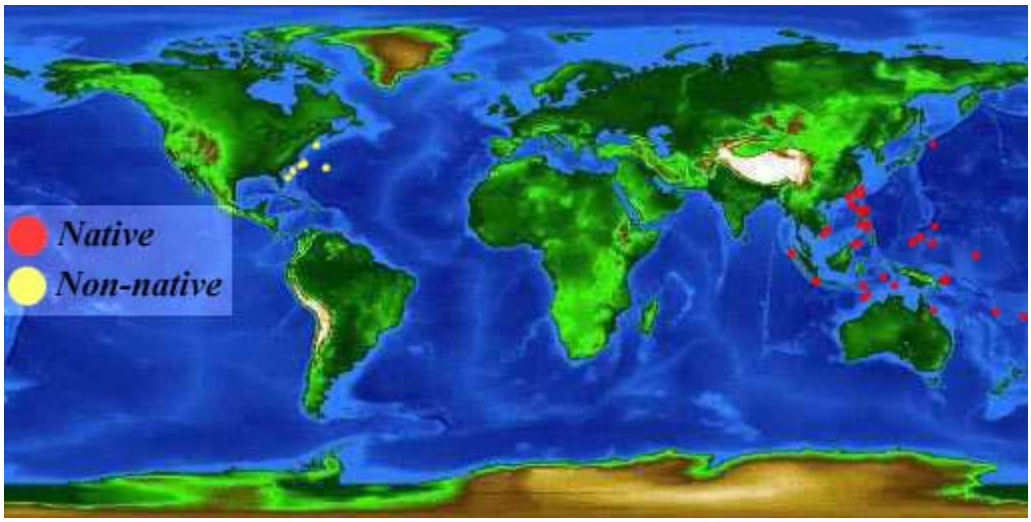
1.5 ECONOMIC CONSEQUENCES

The economic costs of control and eradication attempts of an invasive species can be huge. The Atlantic sea lamprey caused huge economic losses in the commercial fisheries of Americas Great Lakes. The Northern Pacific Seastar has caused economic losses in reduced commercial fisheries and also in the cost of eradication attempts.

The zebra mussel competes with native species for food, settling in high numbers on native mussels, causing suffocation, starvation, and energetic stress leading to death (http 1). Zebra mussels are an encrusting species and can completely cover surfaces. Pipes, dams, power plants, boats and water treatment facilities have all been damaged by this species. Estimates say that keeping water intake pipes clear in the USA will cost over $3 billion in the next ten years (Primark 2002).

The Comb Jelly (*Mnemiopsis leidyi*), is another example of a species that has caused economic disaster. It was introduced into the Black Sea in the 1980's via ballast water from USA. Within 7 years 95% of the Black Sea biomass was the comb jelly (Primark 2002). This led to the collapse of the anchovy fishing industry (Primark 2002). Along with the collapse in the fishery, livelihoods were also lost. Estimates for the total economic cost of the loss of this fishery are US$1 billion a year (Knowler 2005). Though other factors have played a role in the decline, *Mnemiopsis* is estimated to have equilibrated to $250 million alone.

2 THE RED LIONFISH – Concerns for the Bahamas



Map 1: *Pterois volitans* native and non-native range (Florida Museum of Natural History, http4)

Lionfish could prove a threat in the Bahamas through direct predation, competition and overcrowding (Whitfield et al 2007). Studies from North Carolina have conducted preliminary genetics data that suggests as little as three females could be responsible for an entire population (Whitfield et al 2007) This evidence is worrying as only a couple of lionfish taking up settlement in an area could be enough to establish an entire population.

The red lionfish (*Pterois volitans)* is an Indo-Pacific predatory species with venomous spines (http1). It has few natural enemies and is becoming established in the West Atlantic region, out of its natural range. They were first sighted along the South East coast of the United States around 10 years ago (Whitfield et al 2007). They are thought to have been released accidentally from aquariums and have found the West Atlantic region favourable to breed. In the past few years, lionfish have been reported in the Bahamas area since 2005 (Whitfield et al 2007), with sightings in Andros increasing dramatically during 2006 and into 2007. The lionfish is a commercial fish species in its natural range, however its main value is for the aquarium trade.

2.1 BEHAVIOUR AND ECOLOGY

Lionfish eat small fish, shrimp and crabs and are an ambush predator. The lionfish is thought to be a nocturnal species, hiding under rocks and remaining relatively motionless during the day, however it could be that species that have just eaten remain motionless until they need to hunt again (http1).

Reproductive ability

Lionfish breed by producing a pelagic egg mass and the planktonic larvae get carried by water currents for up to 40 days (http 1). During this time, it is possible that larvae could get carried by ocean currents around the Bahamas region, and ships ballast waters could also be a carrier for planktonic larval dispersal from the United States to the Bahamas (personal comment). Lionfish sexually mature at 2 years and they spawn multiple times producing anything in the region of 30,000 eggs a time (http 3).

The Lionfish grows to a maximum length of 300 – 370 mm. Natural predators of the Lionfish are not thoroughly known, cornetfishes are predators of the lionfish and also sharks may prey on them (http4).

- Effects on ecosystem:
  There are no documented effects as of yet, however as the numbers of lionfish increase, damaging effects to local biodiversity could be noticed when it's too late.

2.2 DANGER TO HUMANS

The lionfish is venomous and if stung can cause severe pain in humans, with varying symptoms from nausea and vomiting to paralysis and loss of consciousness. The lionfish can be an aggressive species if threatened and great care should be taken if they are sighted. If stung the area should be treated by pouring hot water (to 45 degrees centigrade) to inactivate the venom, professional medical attention should also be sought (http3). In the lionfishes natural range, local people are well aware of the presence and dangers of this fish, however in areas like Andros, there is concern that local people might not be aware of the venomous nature of the fish. The lionfish has been sighted in shallow areas along the coastline where young children play. Recently dead fish can also cause a sting; therefore if fish are removed, they should be taken away or buried not left on the beach.

Greenforce has been producing educational material (see section 3.1) to inform the local residents about the dangers of lionfish.

3 LIONFISH INVASIVE SPECIES MONITORING

GREENFORCE

At the beginning of January 2007, Greenforce started monitoring and collecting data on the numbers of lionfish species seen around the area. There has been a dramatic increase in the sightings of lionfish in the past year. Currently there are resident populations in the coastal areas around the Greenforce camp. These are removed once they have been sighted and observed. During dives on the reef, Lionfish are regularly spotted. Juvenile Lionfish (< 50mm) have also been sighted indicating that conditions are favourable for them to breed. Greenforce have begun removal of lionfish at some inshore locations.

FORFAR

FORFAR have also been collecting information and are also actively removing lionfish from sites during dives. During snorkel excursions in September 2006, college students were spotting lionfish at nearly every site. FORFAR interns have been removing the fish and after contacting environmental groups and realizing its widespread nature, began gathering data and site coordinates. Fish have been spotted and removed in shallow wading areas as well as deeper reef sites.

3.1 EDUCATION

Greenforce have included lionfish information on their current newsletters that are posted throughout the communities around Andros. This information includes what they look like, where they may be seen and warns that they are venomous.

Index to photographs

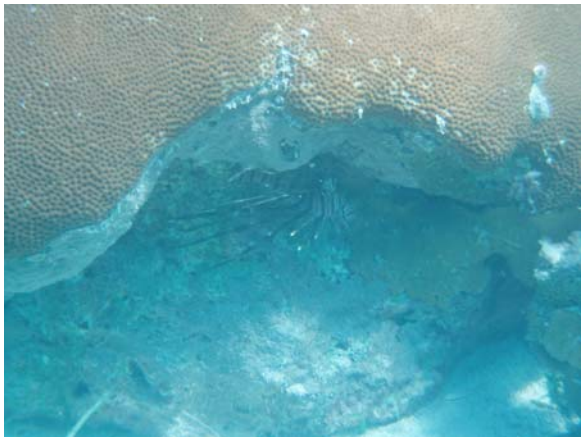
- 1a Lionfish found on Calabash Cay, hiding under coral, 80 mm TL, in 3 meters of water, was removed from site.
- 1b Same lionfish as 1a, lionfish was inverted
- 1c Same as 1a, 1b, different angle
- 2a Lionfish found at inshore tree channel marker, hiding in roots, 100mm TL, in 1 meter of water
- 2b Same as 2a, in surrounding habitat
- 2c Tree roots habitat for lionfish 2a, 2b

TL = Total Length

Removed Lionfish

Lionfish that have been removed are currently in a freezer at FORFAR field station. These are available for further study and analysis.

Red lionfish in their invasive habitats



1a

1b

1c

2a

2b

2c

Photo source: 1a, 1b, 1c Eleanor Gibson. 2a, 2b, 2c Andrew La Niece

4 RESULTS

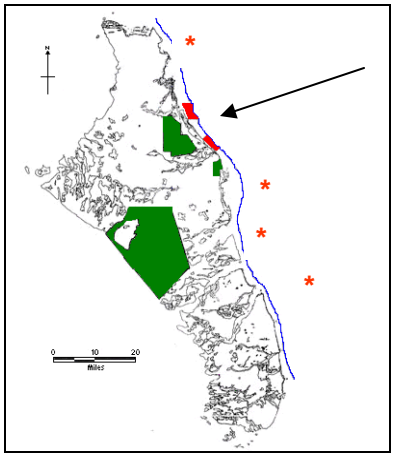


Fig 1

* = From discussions with locals, lionfish have been sighted all along the coastline from Morgan's Bluff to Cargill Creek

Lionfish have been frequently sighted along the area used by Greenforce and FORFAR. The map in fig 2 shows the sites lionfish have been sighted at in the Northern MRA survey area, they have also been sighted further north and south of this area.

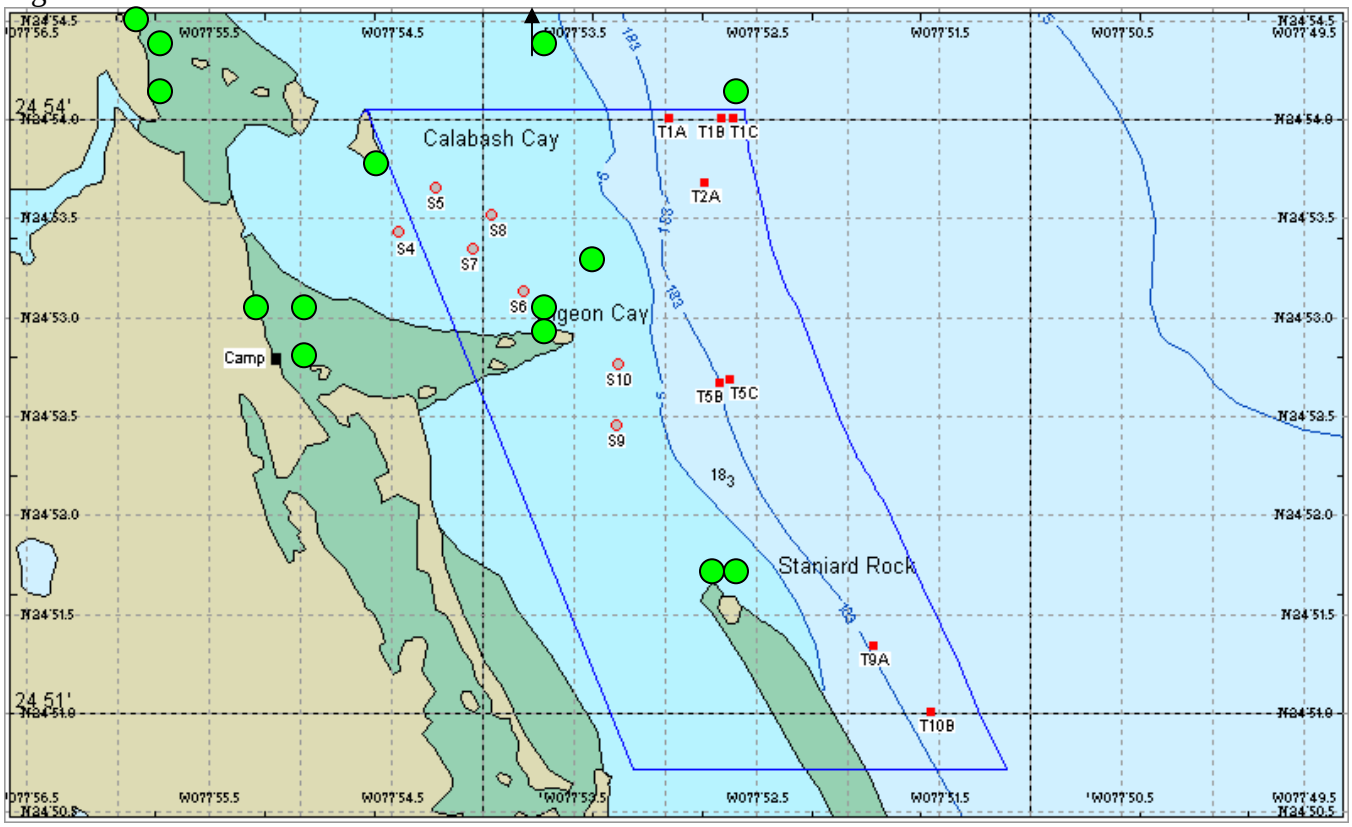


Fig 2 = Lionfish sightings in the Northern Marine Replenishment Area

Location	Date	GPS Coordinates		Habitat type	Depth (m)	Water Temp (0c)	Total Length (TL)mm	Removed?	Solitary/Group
		Latitude (N)	Longitude (W)						S/G
Calabash Cay	29th Jan 07			IC	4	23	155	Y	G
Calabash Cay	30th Jan 07			IC	4	23	180	Y	G
Calabash Cay*	28th Mar 07			IC	3	24	80	N	S
Daves Patch Reef	8th Feb 07	24 53.797	77 53.746	PR	2.3	23	75	Y	S
Jeremys Jungle	17th Mar 07	24 56.291	77 53.716	HPR	20	23	250	N	S
Log, shoreline*	2nd Feb 07			ART	1	24	100	N	G
Log, shoreline*	2rd Feb 07			ART	1	24	35	N	G
Old Forfar Dock	6th Jan 07	24 53 928	77 56.883	ART	0.7	24	125	Y	G
Old Forfar Dock	16th Dec 06	25 53 928	77 55.883	ART	0.7	23	134	Y	G
Pigeon Cay	18th Mar 07			IC	1	24	125	Y	S
Saddleback Cay	29th Mar07			IC	0.5	24	unknown	N	S
Stafford Creek	20th Mar 07	24 54.023	77 56.060	CR	1.3	24	150	Y	S
T5C, survey site	12th Feb 07	24 52.679	77 52.642	LPR	16	23	315	N	S
The Amphitheatre	8th Feb 07	24 51.891	77 52.452	HPR	16	24	300	N	S
The Amphitheatre	15th Feb 07	25 51.891	78 52.452	HPR	14	24	320	N	S
The old jetty, shore	27th Jan 07			ART	0.5	23	140	N	G
The old jetty, shore	28th Jan 07			ART	0.5	23	110	N	G
Three Sisters	9th Feb 07	23 57.736	77 55.824	IC	2.7	23	225	Y	S
Three Sisters	28th Mar 07	24 57.736	78 55.824	IC	1.7	24	unknown	N	S
Tree channel marker	2nd Feb 07			ART	1.4	24	150	Y	G
Tree channel marker	3rd Feb 07			ART	1.4	24	75	Y	G
Tree channel marker	4th Feb 07			ART	1.4	24	50	Y	G

***** = See accompanying Photograph

The above table lists all of the lionfish sightings so far, including GPS coordinates and sites.

The graph shown in fig 3 shows the relationship between the size of lionfish and the depth it was sighted at. They are also split into two groups; those seen on their own and those seen in groups of or more. There is a positive relationship between size and depth, the deeper the sight, the larger the lionfish. Lionfish that are sighted in a group are smaller and found at shallower depths, indicating these could be breeding and juvenile nursery areas.

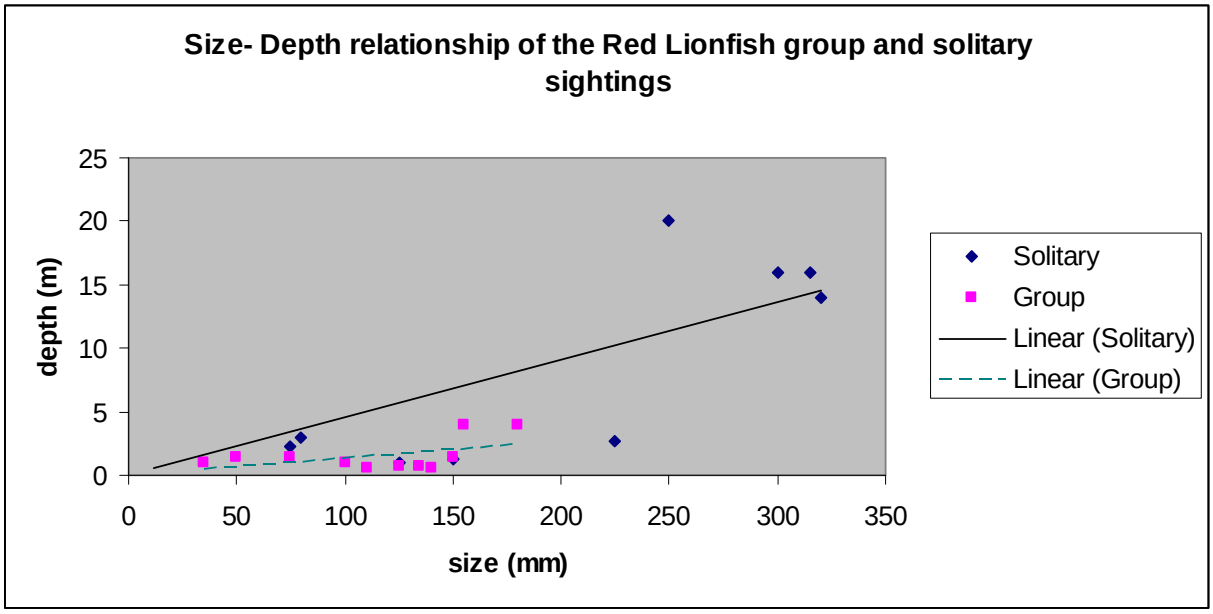


Fig 3

The pie chart in fig 4 illustrates the habitat types the lionfish have been sighted in. The most common habitat is artificial, man-made sites like a jetty, tree, concrete etc. Islands and small Cays are the next most common sight for lionfish. This indicates that lionfish can thrive in man made and shallow water areas around islands, these shallow sights are also nursery and juvenile grounds for juvenile grouper, snapper, conch and crawfish.

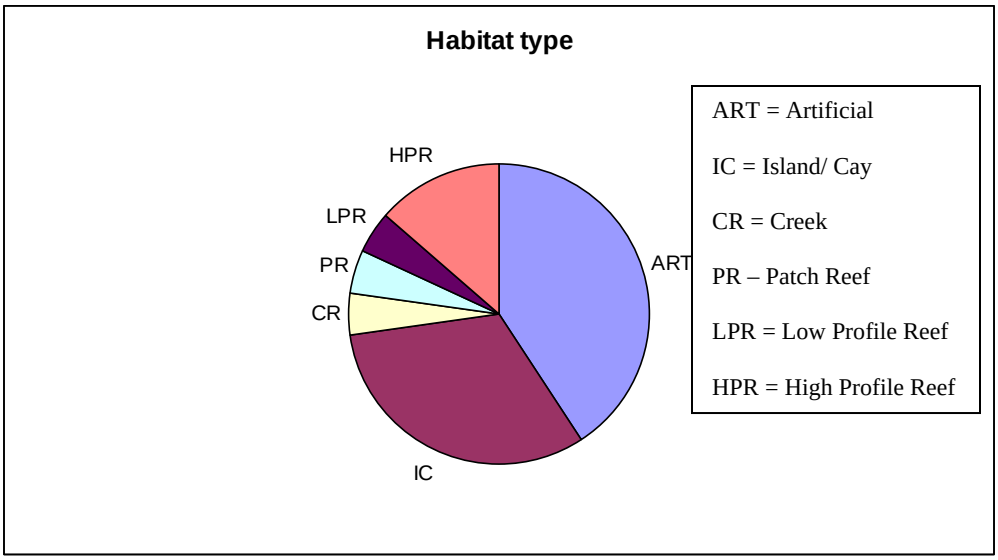


Fig 4

5 CONCLUSION AND RECOMMENDATIONS

Lionfish have very little fishing mortality. With generalist feeding habits, their feeding of smaller fishes could overlap native fishes feeding niches. Lionfish could potentially have a competitive advantage over native species such as grouper (Whitfield et al 2007).

Potential impacts of lionfish establishment could be (adapted from Whitfield *et al* 2007)

- Overlap of feeding niches
- Competitive advantage
- Rapid establishment
- Aggressive tendencies – may cause native species displacement
- Cascading impacts through food chain
- Impacts within an open marine system = largely unknown

SOLUTIONS AND ERADICATION

As explained, an introduced species can have negative effects upon an ecosystem. The Lionfish also poses a threat to humans due to its toxicity. An eradication plan and further research needs to be established in the Bahamas as soon as possible to prevent full establishment of this species.

From scientific findings of similar species, and of the lionfish establishment along the United States coastline a precautionary approach is recommended whereas action should be taken immediately before the lionfish become fully established to prevent the negative impacts that may occur, websites like the Global Invasive Species Database (http1) are excellent sources of information and will allow management solutions to be shared and addressed worldwide.

Mitigation measures like enforcement, regulation and control on what is brought into and out of waters will help in the future but as global mixing of materials and people continue to increase the list of introduced species looks set to rise as well. Future ecosystem health and biodiversity is a key issue that needs full attention to help reduce possible detrimental impacts in the future.

In the Florida Keys, an early detection and rapid response effort has kept lionfish out of the sanctuary (Semmens *et al* 2004).

Lionfish sightings in the Bahamas are becoming a common occurrence and effective measures should be put in place as soon as possible if lionfish settlement is to be prevented or controlled. If eradication is deemed unfeasible, the rate and direction of spread of the invasions should be monitored (http 1). Eradication may be successful in some areas, if invasions are noticed quickly and eradication efforts are swift.

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