MITIGATING THE TREATS OF INVASIVE ALIEN SPECIES IN THE INSULAR CARIBBEAN PROJECT: LIONFISH PILOT PROJECT

Photo: C. Spence

MITIGATING THE TREATS OF INVASIVE ALIEN SPECIES IN THE INSULAR CARIBBEAN PROJECT

Lionfish Pilot Project

END OF PROJECT

TECHNICAL REPORT

Photo: O. Spence

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Executive Summary

Invasive Alien Species (IAS) are a major threat to the vulnerable marine, freshwater and terrestrial biodiversity. IAS are a major interest to Jamaica as they pose a direct threat to the high level of biodiversity. Jamaica's industries are centred on the country's biodiversity. As such a decrease in biodiversity threatens the livelihood of fishers, farmers, and persons employed to the tourism industry. Negative impact on these industries as a result of IAS will result in a significant reduction in Jamaica's gross domestic product (GDP).

The project objective is to mitigate the threat to local biodiversity and economy from IAS. This will be achieved through five main initiatives: increasing the national capacity to address potential risks posed to biodiversity of global significance from invasive alien species; increasing regional cooperation to reduce risk posed to biodiversity of global significance from invasive alien species; strengthening access to data and establishment of best practice, and public awareness of IAS; increasing capacity to strengthen prevention of new IAS introductions; and increased capacity to respond, control and manage IAS impacting globally significant biodiversity. The fifth initiative includes the implementation of a pilot project to control and manage the spread of the Lionfish (*Pterois volitans and Pterois miles*) in Jamaica.

The four components of the Lionfish Pilot Project are:

- Island-wide population tracking;
- Examination of prey preferences of lionfish;
- Examination of a passive capture mechanism
- Formulation of a Lionfish Adaptive Management Plan

This report covers the first three (3) components and also reviews the local and regional training programmes conducted under this project. The Adaptive Management Plan is a stand-alone document and is not included in this Technical Report.

The research and data published here will be replicated and continued through a graduate research currently being conducted through the Department of Life Sciences, University of the West Indies, Mona Campus.

Acknowledgements

The Lionfish Pilot Project is one of three pilot projects under the Mitigating the Threats of Invasive Alien Species in the Insular Caribbean (MTIASIC) Project. This project was made possible by our sponsors the **Global Environment Facility** and the **United Nations Environment Programme** with the support of the regional administrative body- **Centre for Agricultural and Biosciences International** and the local administrative body- **National Environment and Planning Agency** and the **University of the West Indies** for executing the scientific research. We are deeply gratefully for their financial, administrative and technical support.

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1.0 Introduction

Marine Invasive Alien Species (IAS) are a major threat to the marine ecosystem. IAS often cause negative impacts to ecosystems by competing with native organisms for limited resources, and altering habitats (Mack et al. 2000; Kolar and Lodge 2001; Rahel 2002; Olden et al. 2004); they are capable of causing extinctions of native plants and animals (Clavero and García-Berthou 2005) and reducing biodiversity (Olden et al. 2004). Jamaica enjoys a high level of biodiversity that are vulnerable to IAS. Lionfish (*Pterois volitans*) (figure 1) are tropical marine reef fish that belong to the scorpaenidae family. This species is native to the Indian and Pacific Oceans and the Red Sea. Lionfish was first reported in South Florida in the 1980s, where they probably became established after being released from private aquariums. They have since spread along the eastern coast of the U.S. and into the Caribbean (Morris 2009) including the Gulf of Mexico via ballast water and planktonic larval dispersal (Cowen et al. 2006). They are estimated to spread further south of South America within their temperature range (>10°C) (Kimball et al. 2004).

Figure 1. Lionfish (*Pterois sp.*)

With very few natural predators, lionfish is considered to be invasive as it may have significant negative impacts on native reef communities (Morris 2009; Albins and Hixon 2008) including human health (Morris 2009). Lionfish reproduces several times per month (Morris 2009). It is estimated that a single female lionfish can reach sexually maturity at approximately 100mm (total length) and may release over two million eggs annually (Morris 2009). They are mainly piscivorous but have been noted to feed on mollusks and crustaceans such as shrimp and crab. A study conducted by Fishelson (1997) showed that a single lionfish can consume approximately 2.5 – 6.0% of its body weight per day. This coupled with overfishing may have negative impacts on the marine ecosystem, the livelihood of the fishing sector as well as tourism. These invasive species possess venomous spines (figure 2):12-13 dorsal spines, 3 anal and 2 pelvic each containing apocrine-type venomous glands (Morris 2009). The venom contains a toxin called acetylcholine and a neurotoxin which causes neuromuscular dysfunction (Cohen and Olek 1989). The effects of being stung by a lionfish include severe pain, swelling, temporary paralysis, altered breathing and potentially may be fatal.

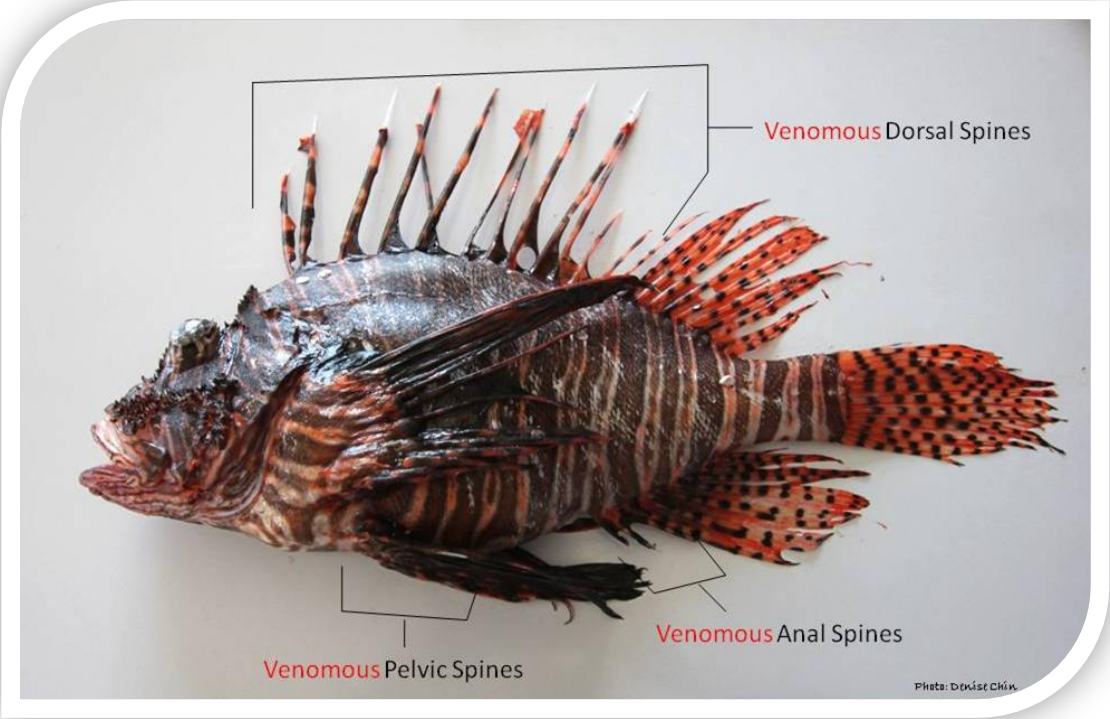


Figure 2. Photograph showing the location of the venomous spines on a lionfish.

Since the invasion of lionfish, the Mitigating the Threats of Invasive Alien Species in the Insular Caribbean (MTIASIC) Project was established in Jamaica (as one of the five pilot countries) to fight against invasive alien species (IAS). The project's objective was to mitigate the threats to the local biodiversity and the economy of countries in Jamaica from IAS. This was achieved through five main initiatives: increasing the national capacity to address potential risks posed to biodiversity of global significance from IAS; increasing regional cooperation to reduce risk posed to biodiversity of global significance from IAS; strengthening access to data and establishment of best practice, and public awareness; increasing capacity to strengthen prevention of new IAS introductions; and increasing the capacity to respond, control and manage IAS impacting globally significant diversity. The fifth initiative included the implementation of pilot projects to control and manage the spread of Lionfish (*Pterois volitans* and *Pterois miles*) in Jamaica. The Project is an arm of the *Mitigating the Threats of Invasive Alien Species in the Insular Caribbean* project which is a collaborative effort of the Global Environment Facility (GEF), United Nations Environment Programme (UNEP), Centre for Agricultural Bioscience International (CABI), National Environment and Planning Agency (NEPA) and the University of the West Indies (UWI).

1.1 Lionfish Pilot Project Objectives

The overall objectives of the Lionfish Pilot Project were to:

1. To conserve globally important ecosystems, species and genetic biodiversity within Jamaica.
2. To mitigate threat to local biodiversity and economy from the marine invasive alien species (IAS), Lionfish within Jamaica.

1.2 Components of the Project:

The objectives of the Lionfish Pilot Project were achieved under four components. These components included:

Component 1: Island-wide Population Tracking

Component 2: Examination of Prey Preferences

Component 3: Development of a Passive Capture Mechanism

Component 4: Formulation of an Adaptive Management Plan

1.2.1 Component 1: Island-wide Population Tracking

This component collected baseline data which allowed the assessment of the invasion and tracked the population densities and distribution over a 24-month period building on earlier data collected by NEPA, Centre of Marine Sciences (CMS), UWI and other agencies. Other entities on the ground served as data collectors and providers, as well as provided assistance with field work. The data collection methodology was standardized to allow consistency in the data and comparisons among the various sites. Monthly surveys were conducted at selected sites islandwide using belt transects. Data was collected from fishers and dive operators were possible.

1.2.2 Component 2: Examination of Prey Preferences

A comprehensive assessment of the preferences was done at selected sites across the island. This will involved the dissection of lionfish specimens collected and the evaluation of the species and number of individuals consumed.

1.2.3 Component 3: Development of a Passive Capture Mechanism

The development of a low cost capture method with high effectiveness and selectivity will be integral to early detection and control of the invasion of the species into new countries and new areas. It would be preferred that this method be passive, such as a trap, which can be deployed and allowed to catch lionfish with minimal input from diving.

1.2.4 Component 4: Adaptive Management Plan

The Management Plan was written to incorporate the findings from the research conducted during this project. It also takes advantage of the wealth of knowledge generated throughout the region on the species, especially in the control strategies.

This is presented in a separate document.

1.2.5 Training Programmes

A comprehensive training programme was developed under this project, and this covered all aspects relevant to the control of the species in the Caribbean. This was delivered as a "Train the Trainer" model to all sectors in Jamaica, as well as other countries in the region.

2.0 Island-wide Population Tracking

This component collected baseline data which allowed the assessment of the invasion and tracked the population densities and distribution over a 17-month period. Other entities on the ground served as data collectors and providers, as well as provided assistance with field work. The data collection was standardized to allow consistency in the data. Monthly surveys were only conducted at three sites within the Discovery Bay station due to lack of personnel.

2.1 Methods

2.1.1 Study Sites

Five stations (figure 3) were chosen around Jamaica based on accessibility to dive sites and availability of personnel. Of the five stations only one (Discovery Bay) was monitored on a monthly basis along the north coast of Jamaica. These sites are areas that experience spear, line and pot fishing. The sites feature coral reef areas and were assessed using SCUBA.

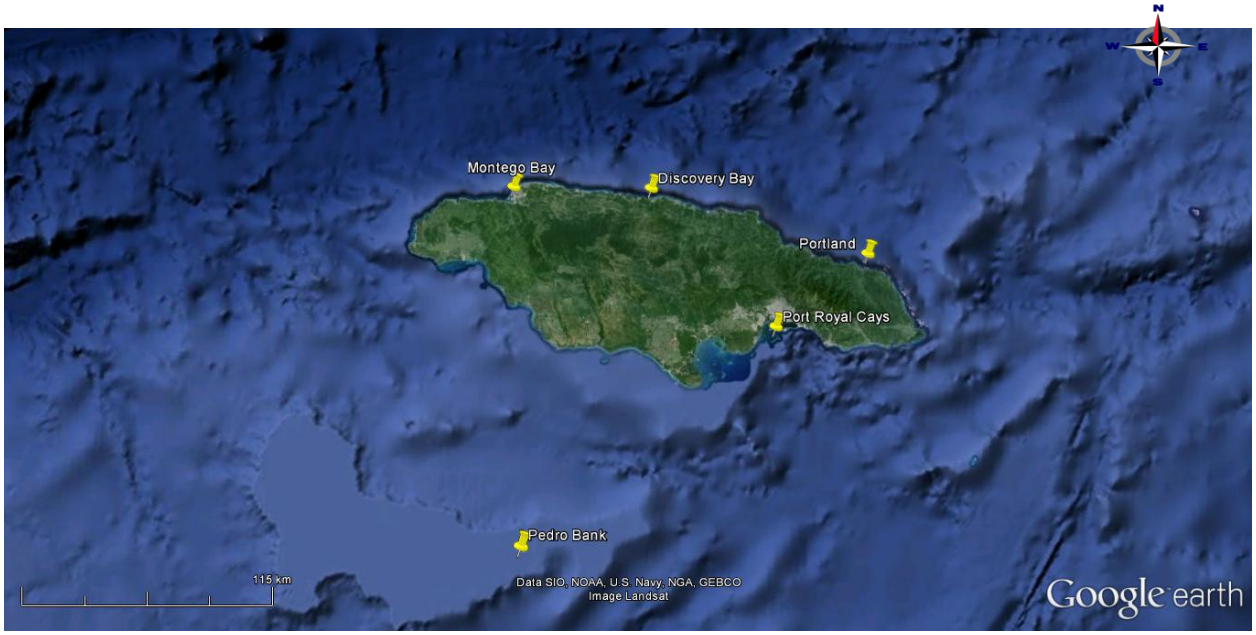


Figure 3. Location of study sites.

2.1.2 Survey Method

Within the Discovery Bay site, three stations [Pear Tree Bottom (PTB), Dairy Bull (DB) and Skeggy Reef (SR)] (figure 4) were assessed monthly.

Figure 4. Survey Stations in Discovery Bay, St. Ann, Jamaica

Stations were accessed by boat from the UWI Discovery Bay Marine Laboratory. Using SCUBA gear, a team of at least two persons used the following equipment (appendix I) to conduct lionfish population density surveys:

- T-bars with slates and pencils attached per surveyor (1 metre wide with 5cm bands)
- 30 metre transect tape
- Pole spear
- Lionfish collection bag

The date, time of dive, name of site and depth were recorded for each site. Transects are usually conducted at a depth of 18.3m (60 feet). Once in at the specified depth, a stratified random sampling method was employed. Six belt transects with dimensions of 10m x 25m each were conducted at each site. Each diver in a buddy pair surveys half of a transect (5m x 25m) swimming in a S-shaped pattern (figure 5) thoroughly searching under crevices.

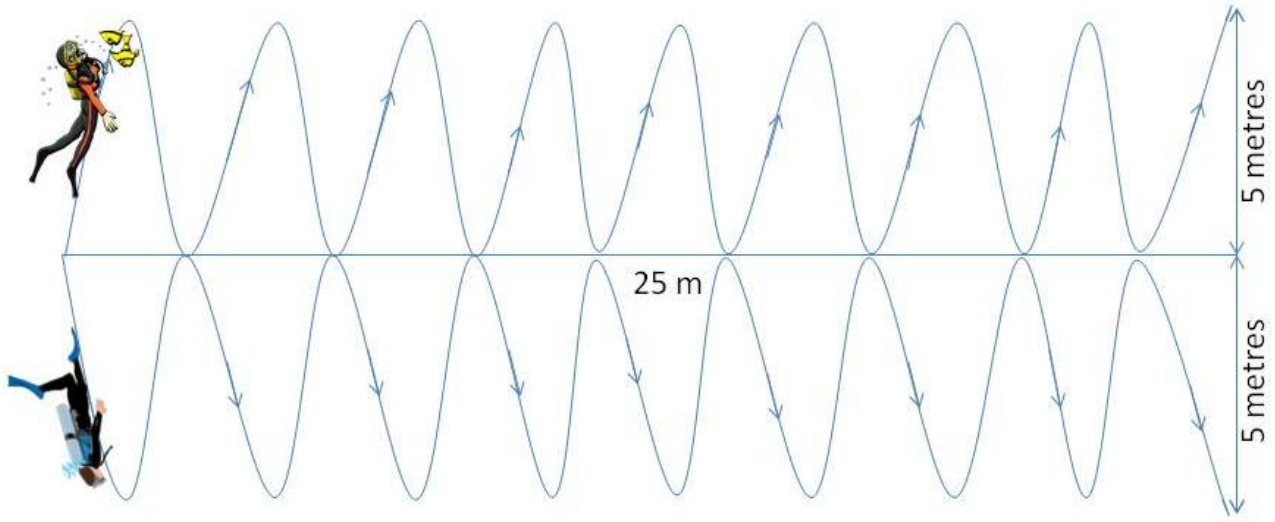


Figure 5. Illustration of Lionfish population density survey swim pattern (Green et al. 2012)

The number of lionfish observed was recorded including an estimation of their total length using the 5cm graduations on the T-bar (appendix I), the location at the time of observation (exposed or hidden) and whether it was solitary or aggregated. Additional observations were noted if necessary. Specimens were collected by using a polespear and transported in a lionfish collection bag for further analysis.

2.2 Results

Monthly surveys were conducted at three sites within the Discovery Bay station namely: Pear Tree Bottom, Dairy Bull and Skeggy Reef. These surveys were conducted from February, 2012 to July, 2013. Surveys were conducted between 07:00 and 12:00. Additionally, six surveys were conducted in Port Antonio by trained representatives of the Portland Environment Protection Association (PEPA) and one in Pedro Banks.

2.2.1 Discovery Bay

The following results were collected over a 17 month period from February, 2012 to July, 2013. Pear Tree Bottom, Dairy Bull and Skeggy Reef were the three sites at this station. A total of 460 transect covering an actual area of 11.5hectares was surveyed at these sites. A one-way analysis of variance showed no significant difference in the lionfish populations among the three stations: Pear Tree Bottom, Dairy Bull and Skeggy Reef ($\alpha = 0.05$, $F = 1.3161$, $p = 0.2771$). For all three sites with the Discovery Bay station, the ratio of hidden to exposed lionfish was 1:2.

2.2.1.1 Pear Tree Bottom

Pear Tree Bottom is the most eastern of the three stations in Discovery Bay. 172 belt transects were surveyed. The surveys were conducted at an average depth of 17.4 m (57 feet). The lionfish population over the study period ranged from 0 to over 70 lionfish per hectare. Overall, Pear Tree Bottom (PTB) showed a general trend of an increase in the lionfish population over the 17 months (figure 6).

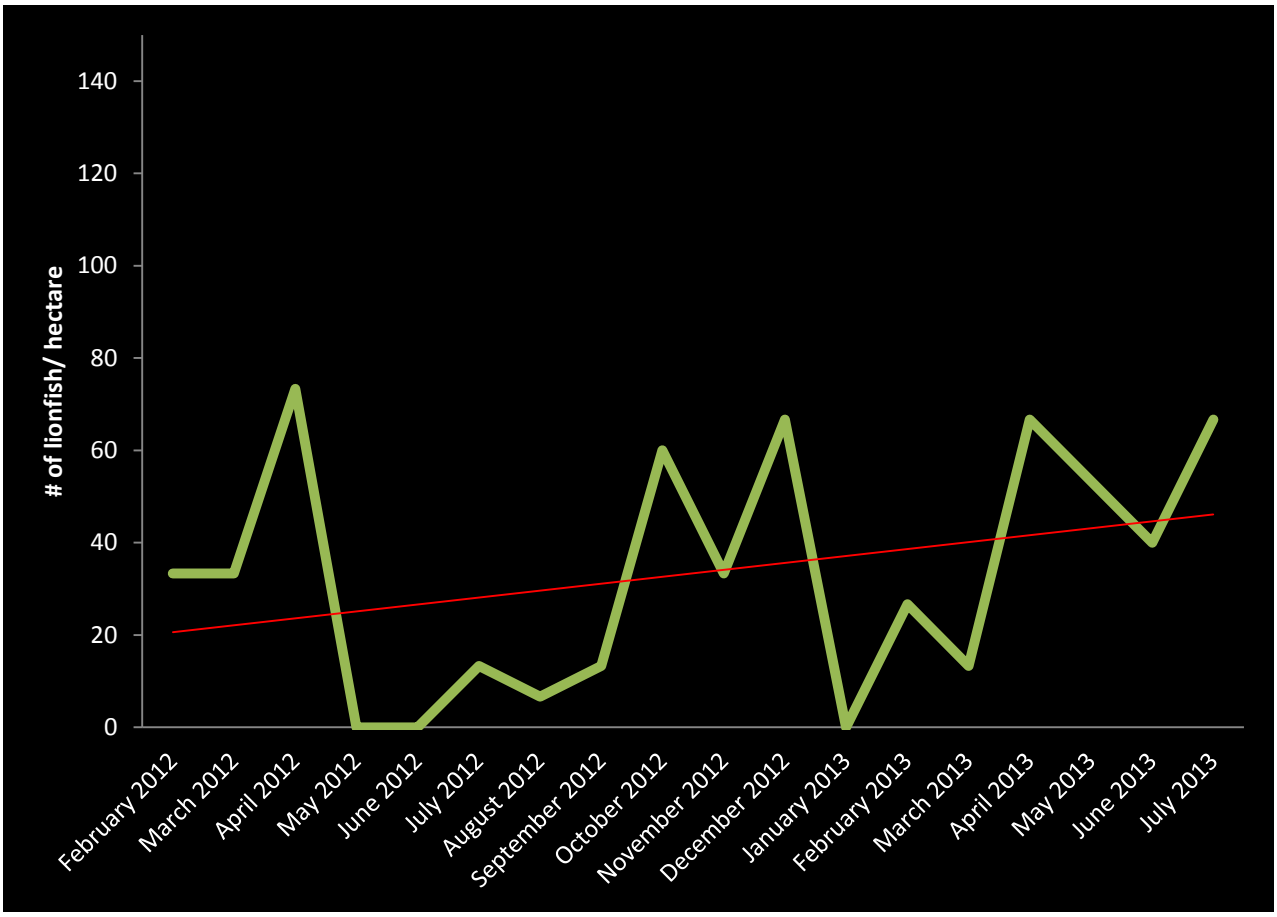


Figure 6. Lionfish population density at Pear Tree Bottom, St. Ann, Jamaica, W.I.

64% of the lionfish observed were exposed (easily seen) and 36% were hidden (observed under overhangs or in crevices) (figure7).

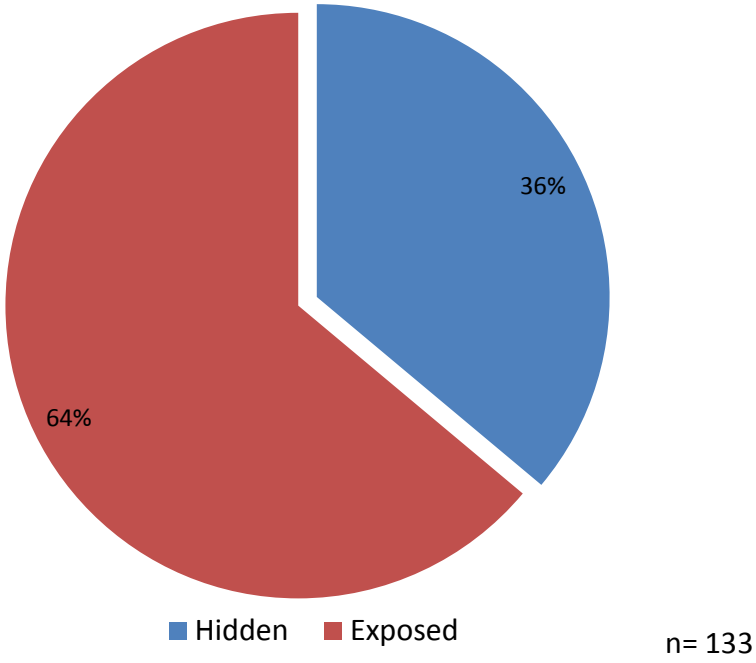


Figure 7. Percentage of lionfish hidden or exposed during surveys at Pear Tree Bottom.

2.2.1.2 Dairy Bull

139 belt transects were surveyed. The surveys were conducted at an average depth of 18.3 m (60 feet). The population of lionfish at Dairy Bull ranged from 0 to 60 lionfish per hectare. Dairy Bull (DB) showed a general decreasing trend in the lionfish population over the 17 months (figure 8).

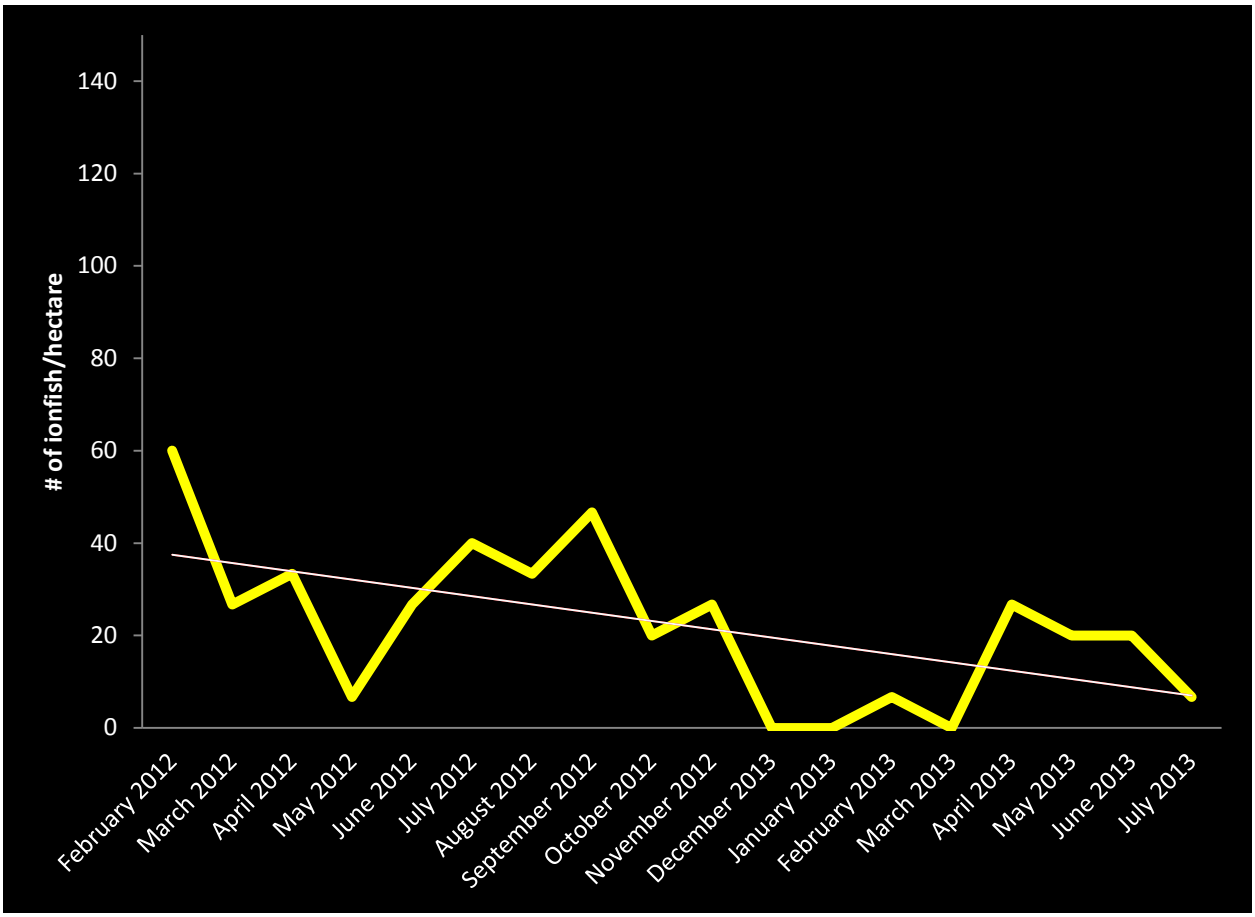


Figure 8. Lionfish population density at Dairy Bull, St. Ann, Jamaica, W.I.

Over survey period, 66% of the lionfish were observed out in the clear sight or exposed (figure 9) while 34% were found under over hangs or in crevices.

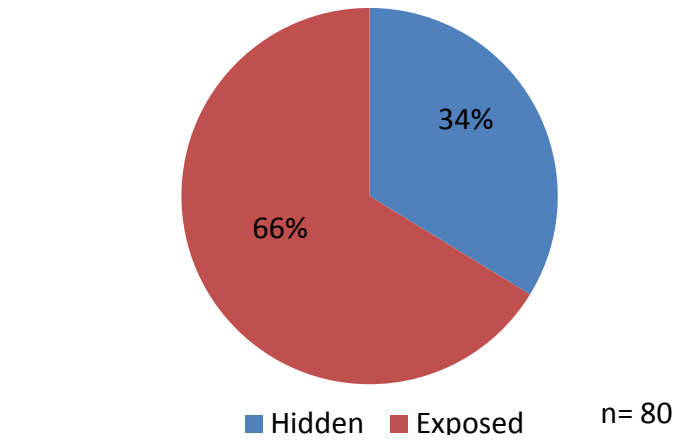


Figure 9. Percentage of lionfish hidden or exposed during surveys at Dairy Bull.

2.2.1.3 Skeggy Reef

Skeggy Reef is the most western site within the Discovery Bay station. 159 belt transects were conducted over a 17 month period at an average depth of 20.1m (66 feet). No surveys were conducted in February and March, 2013 due to poor weather conditions. The population of this marine invasive species ranged from 7 to 107 lionfish per hectare. However, over the 17 months there seems to be decreasing trend in the lionfish population (figure 10) at Skeggy Reef (SR).

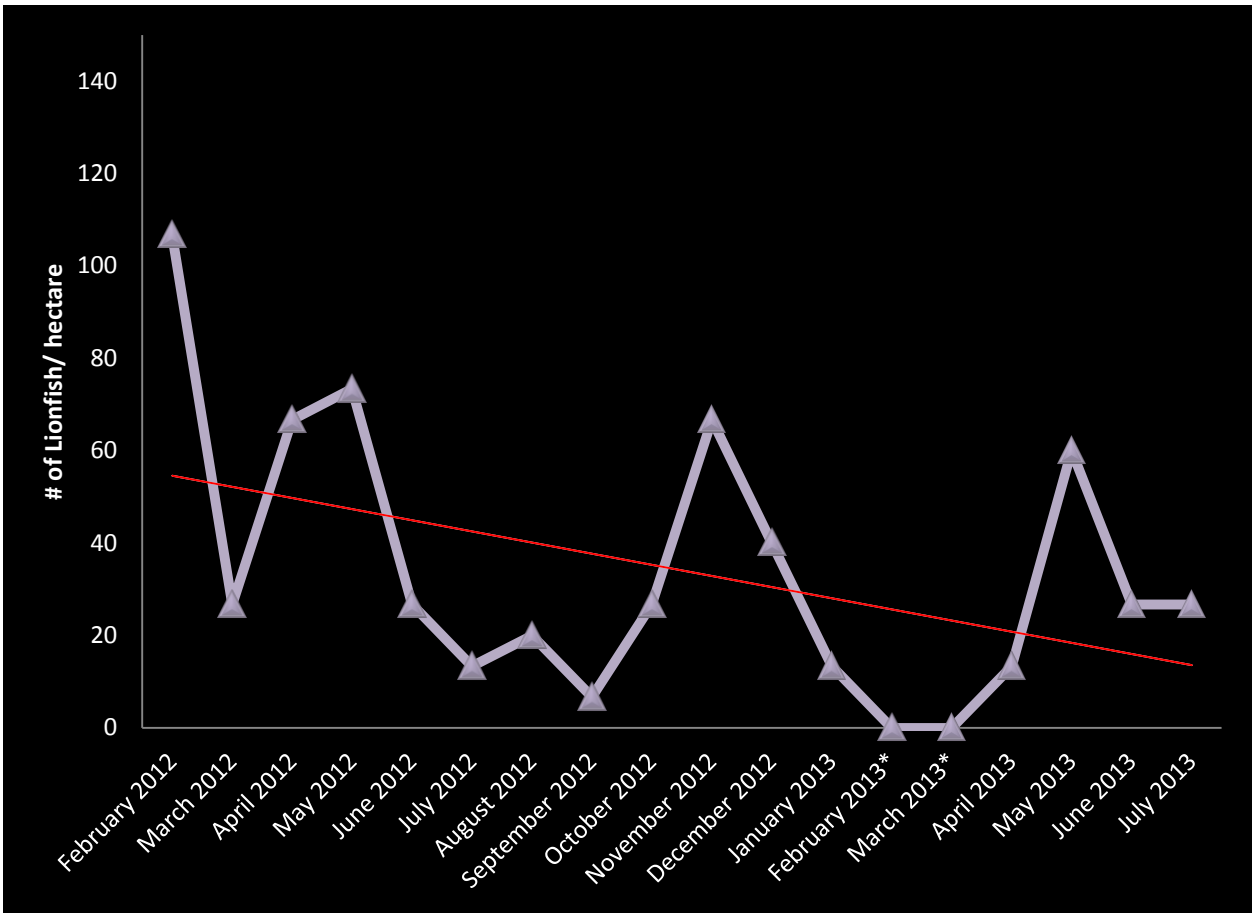


Figure 10.Lionfish population density at Skeggy, St. Ann, Jamaica, W.I. * No surveys were conducted in February and March, 2013.

69% of the lionfish observed were exposed (figure 11) and 31% were hidden (observed under overhangs or in crevices) at Skeggy Reef.

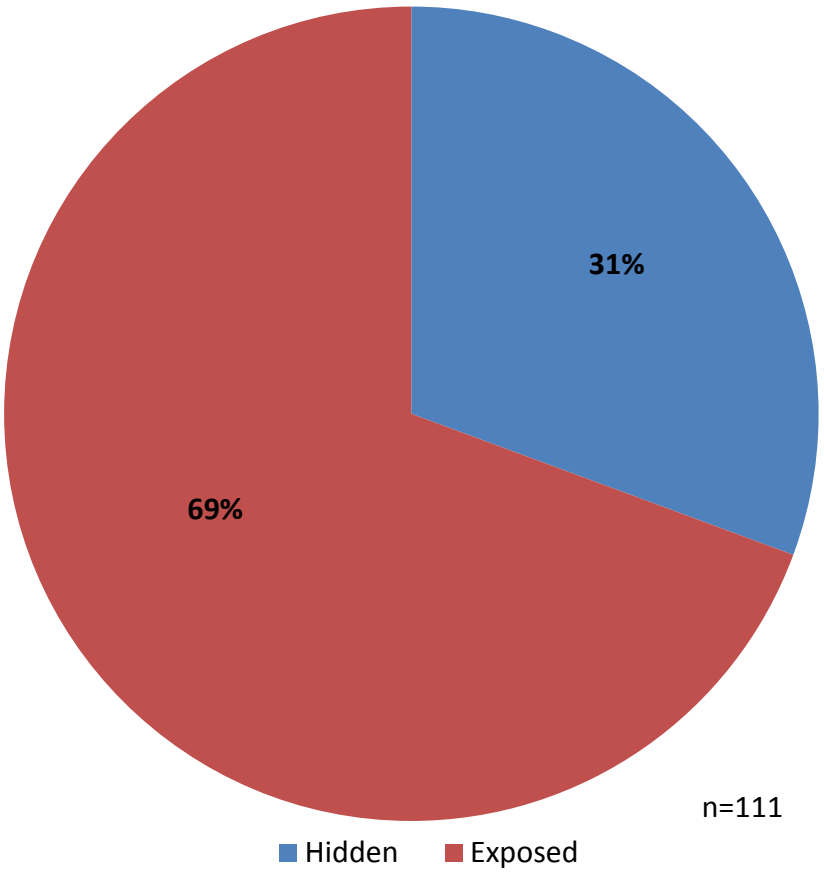


Figure 11. Percentage of lionfish hidden or exposed during surveys at Skeggy Reef.

2.2.2 Portland

Two sites (Port Antonio and Manchoneil) within the Portland station were surveyed. Six surveys were done at Port Antonio. Three surveys were conducted in Manchoneil.

2.2.2.1 Port Antonio

Six surveys were carried out in Port Antonio, Portland (table 1). All surveys were conducted in 2012 at an average depth of 14.6m (48 feet).

Table 1. Lionfish population densities at Port Antonio, Portland, Jamaica, W.I.

DATE	LIONFISH/ HECTARE
February,2012	80
March, 2012	27
April, 2012	13
May, 2012	147
August, 2012	40
December, 2012	40

2.2.2.2 Manchoneil

Three surveys were executed in Manchoneil, Portland (table 2). The surveys were conducted at an average depth of 15.2m (50 feet). The surveys were done in March to April, 2012.

Table 2. Lionfish population densities at Manchoneil, Portland, Jamaica, W.I.

DATE	LIONFISH/HECTARE
March, 2012	0
April, 2012	13
May, 2012	20

2.2.3 Pedro Bank

Only one survey was done at Pedro Banks over the period of March 21-29, 2011. Surveys were conducted at eight stations: South- south-west of Bird Cay (N16 57.567 W77 50.432), Four fathom Edge (N17 02.886 W77 43.018), South-east of Bird Cay (N16 59.162 W77 47.806), Close to Bird Cay (N16 58.133 W77 48.624), Middle Cay Edge (N17 00.565 W77 46.988), Shannon (Inside) (N17 01.696 W77 40.862), Shannon (Outside) (N17 00.985 W77 39.631) and Top Cay Point (N17 02.106 W77 45.281).

Shannon (Outside) had the most lionfish of the 8 sites surveys on Pedro Bank (figure 12). 110 lionfish / hectare were observed at SSW of Bird Cay. Four Fathom Edge and the site close to Bird Cay had approximately 50 lionfish per hectare within the areas surveyed. No lionfish were observed at Top Cay Point, Shannon (inside), Middle Cay Edge and SE of Bird Cay.

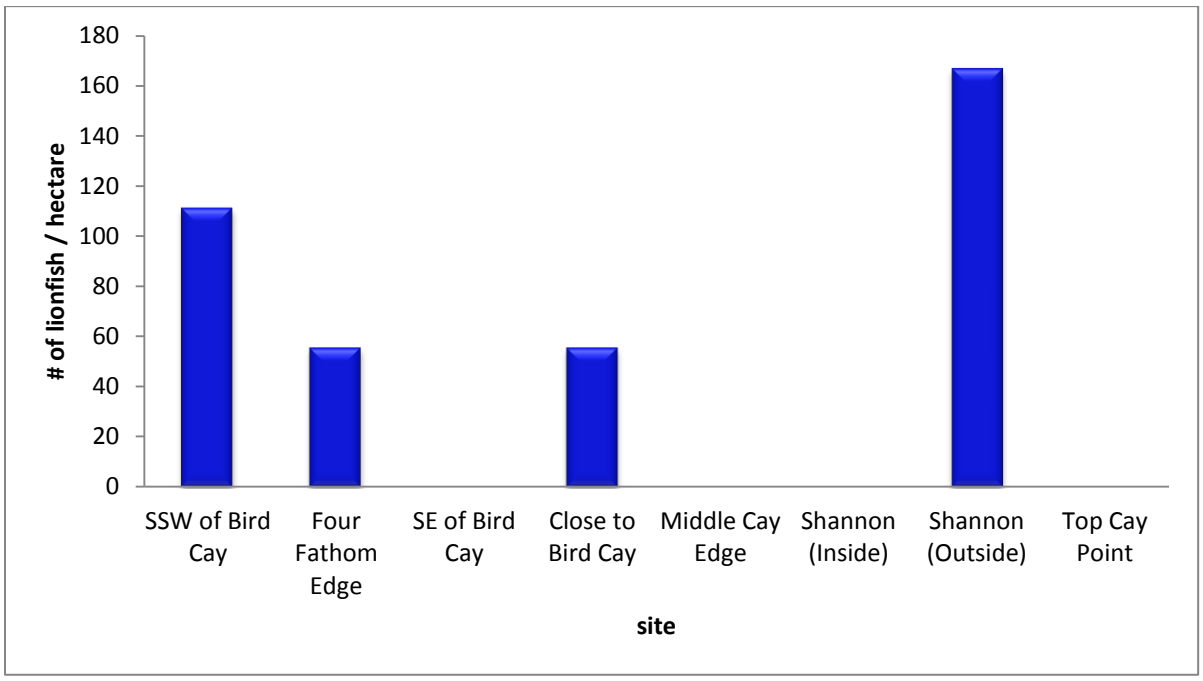


Figure 12. Lionfish density surveyed at Pedro Banks on March, 2011.

2.2.4 Montego Bay

Only two surveys were conducted at the Montego Bay site. The population of surveyed area was estimated to be 130 lionfish / hectare in October, 2011. On the second survey, the population was estimated to be 80 lionfish / hectare in January, 2013. Both surveys were done at an average depth of 18.3m (60').

2.2.5 Port Royal Cays

Only one survey was conducted in May, 2012. South-east Cay, Lime Cay, Drunkenman's Cay and Wreck Bay were surveyed for lionfish. Only 2 juvenile lionfish were observed at Wreck Bay.

2.3 Discussion

This discussion will make reference only to the Discovery Bay station since monthly surveys were conducted over a 17 month period.

Pear Tree Bottom was the only site within the Discovery Bay station that saw an increasing trend in the lionfish population over the sample period. This site is used by the hotels within the area which offers SCUBA diving as a paid attraction. However, the increase in the lionfish population could be caused by less fishing pressure at this site by spear, line and pot fishing in comparison to Dairy Bull and Skeggy Reef. This site has a high relief with more overhangs that may provide more shelter for lionfish. Lionfish tend to shelter and sometimes aggregate under over hangs, in crevices, close to coral heads and barrel sponges.

Both Dairy Bull and Pear Tree Bottom showed and general reduction in the lionfish population densities. This may be due to constant fishing pressure especially by spear and pot fishers. It was observed that these two sites saw more fishing activities than Pear Tree Bottom. Overall, Dairy Bull had the least lionfish population density. This may be due to the relief and habitat complexity at the depth surveyed. Dairy Bull is the closest surveyed site from the close by Fort Road and Alloa fishing beaches which have approximately 46 registered fishers (Ministry of Agriculture and Fisheries, Jamaica, 2014). Overall, it seems that the lionfish populations are being reduced. This may be attributed to the constant fishing pressure at these depths on the lionfish.

Although this study implies that the lionfish populations are declining, lionfish have a high reproductive rate (every 4 days, year-round) with a female having the ability to produce up to 2 million eggs annually (Morris, 2009). Furthermore, it should be noted that lionfish are being observed at deeper depths (21.2m / > 70'). There has been no observation of lionfish being preyed upon unless speared by a diver. Also of concern is the feeding rate of lionfish, studies have suggested that a lionfish can consume up to 6% of its body weight per day (Fishelson, 1997). 14 juvenile fish were observed in one lionfish stomach during this research. This could further deplete fish stocks and reduce fish recruitment (Albins and Hixon, 2008). Therefore, it is recommended that the continuous removal efforts are supported with increased public awareness campaigns such as the "Let's Eat It to Beat It".

2.4 Conclusion

Lionfish (*Pterois volitans* and *Pterois miles*) are found around mainland Jamaica and was also observed on the off shore at Pedro Bank. The population within the Discovery Bay sites seem to show a decline over a 17 month study period. The decline may be due to a combination of increased public awareness including that the fish is edible creating a niche market. This may have propelled the constant fishing pressure of the lionfish in this area. However, it must be noted that the surveys were limited to the depth of 18.3m (60'). Lionfish has been observed > 21.3m (70') deep. Lionfish removal efforts should be continued to reduce the population.

3.0 Examination of Prey Preferences

A comprehensive assessment of the preferences was done at selected sites across the island. This will involved the dissection of lionfish specimens collected and the evaluation of the species and number of individuals consumed.

3.1Methods

Lionfish samples were collected from culling activities of trained divers as well as pot fishers.

3.1.1 Laboratory Data Collection

Specimens collected were analysed in the laboratory. The date, site, depth at which Lionfish was collected were noted. Various morphometric and meristic data were collected. In addition, otoliths were removed from each fish when possible.

3.1.2 Morphometric and Meristic Data Collection

Wearing puncture proof gloves, total length (length from the most anterior end to the end of the longest caudal fin ray) (figure 13);

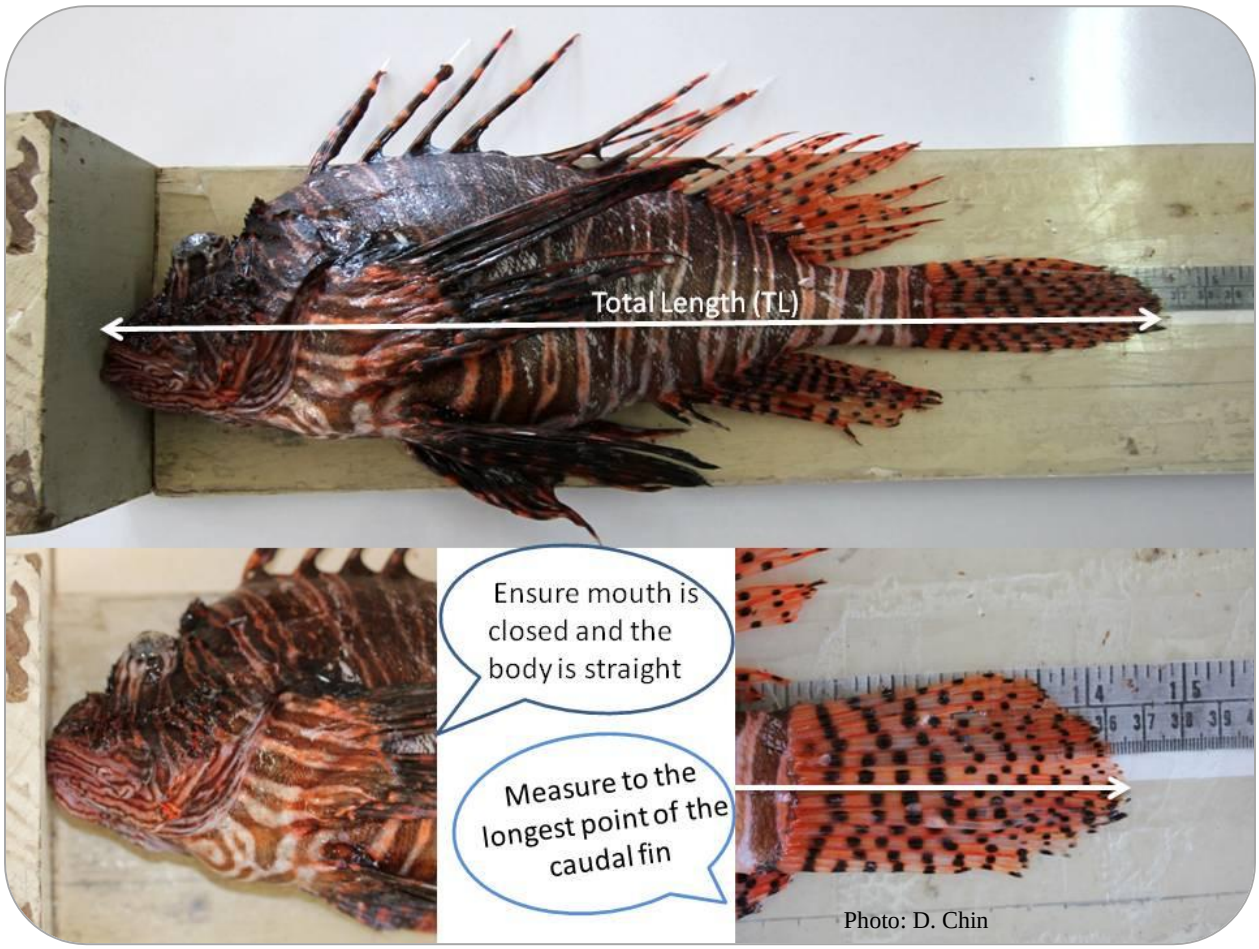


Figure 13. Photographs showing how to measure the total length of *Pterios sp.*

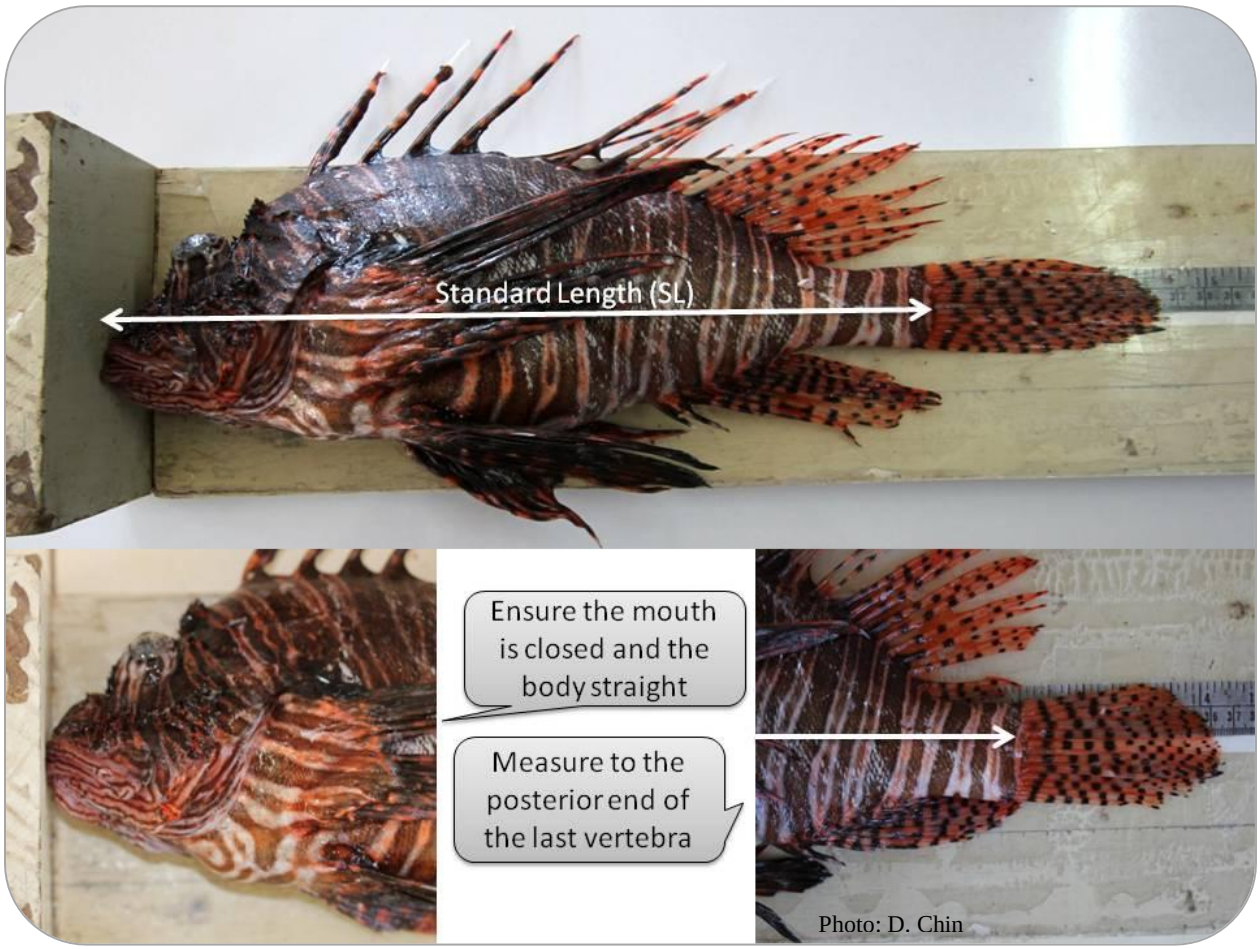


Figure 14. Photographs showing how to measure the standard length of *Pterios sp.*

standard length (length from the most anterior end to the end of the last vertebra) (figure 14) for each lionfish was measured and weighed (figure 15).

Figure 15. Lionfish (*Pterois sp*) being weighed.

The number of venomous dorsal (hard) spines, soft dorsal rays and anal rays (figure 16) were recorded.

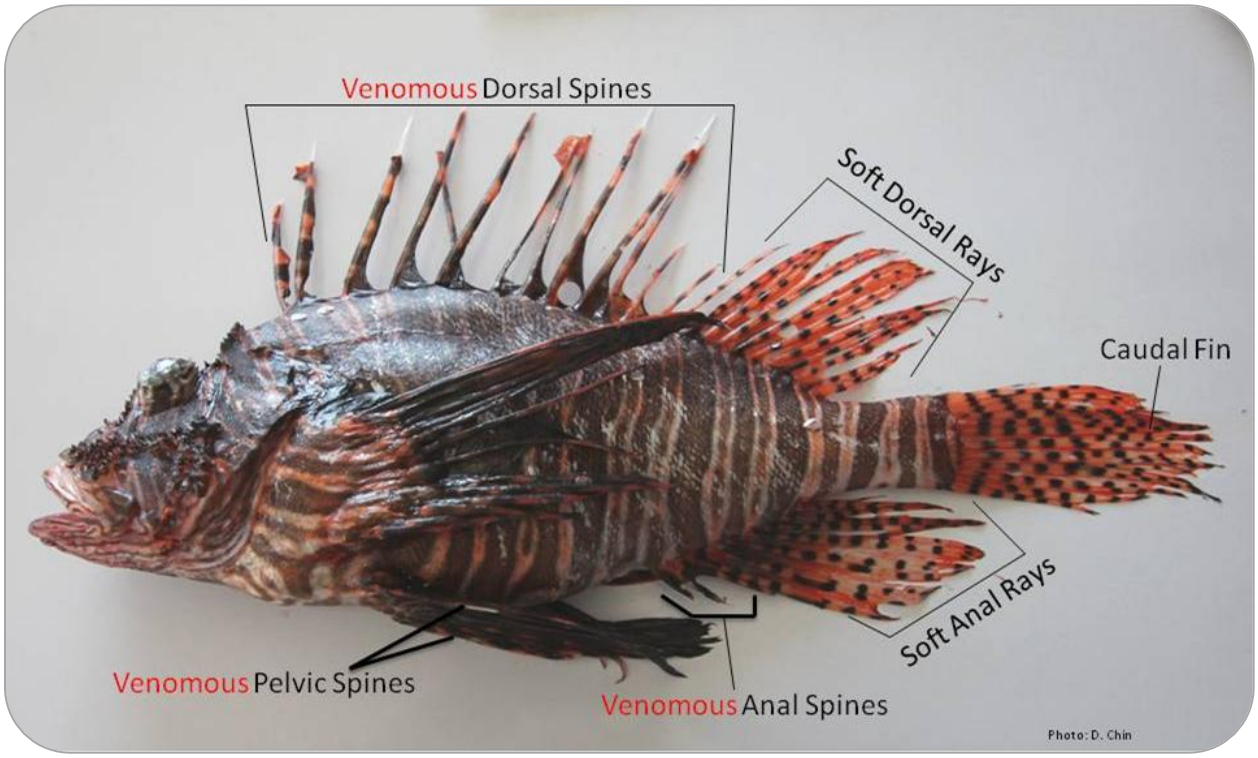


Figure 16. Location of spines and rays on a Lionfish.

For safety, all spines were removed cutting from the tail towards the head using a kitchen shear (appendix II). Spines were disposed of by wrapping in thick layers of paper.

3.1.3 Internal Measurements

To remove its internal organs, a dissecting scissors (pointing away from the body to reduce cutting any internal organs) was used cutting from the urogenital opening towards the operculum cutting through the pelvic girdle. Placing the fish its side, lift the musculature to expose the internal organs. The gonads were observed noting the sex of the fish and the stage of sexually maturity as described by Green et. al (2012).

The stomach was removed cutting from the anterior end ensuring that there are no protruding preys (via the oesophagus). The stomach was opened using a dissecting scissors and its contents identified (to species if possible), measured using a ruler to the nearest mm, weighed and recorded. Partially digested food or empty stomach was also noted. Whole prey items may be preserved in 95% ethanol.

3.2 Results

1494 lionfish stomachs were examined. Twenty teleost families were identified in the diet of these lionfish. The preys of these lionfish were ranked by family except for shrimp which was grouped based on the sub-phylum using frequency of occurrence. Shrimp (sub-phylum: crustacea) had the highest in frequency in their diet. Holocentridae >Labridae > Gobiidae were the top three ranked teleost families based on frequency occurrence (table 3).

Table 3. Top 10 prey observed in Pterois sp. diet in Jamaica, W.I.

Rank	Jamaica
1	Crustacea
2	Holocentridae
3	Labridae
4	Gobiidae
5	Pomacentridae
6	Scaridae
7	Apogonidae
8	Lutjanidae
9	Synodontidae
10	Serranidae

In addition, a single *Sepioteuthis sepioidea* (Mollusca, Cephalopoda) (67mm TL) was observed in the stomach of a lionfish (364mm TL). Overall, the diet of sampled lionfish in Jamaica (n=1494) was found mainly to consist of teleost (69%), crustaceans (19 %), and partly digested unidentified proteinaceous matter (12%) (figure17).

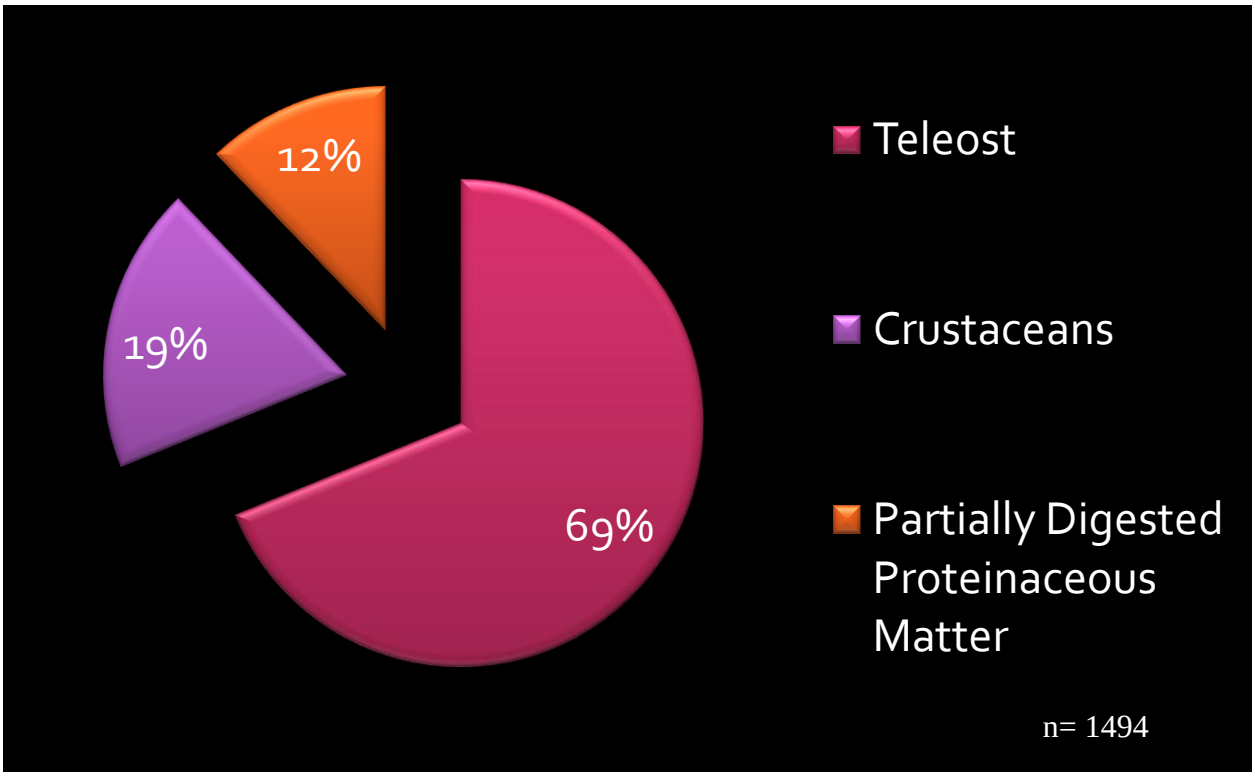


Figure 17. Diet composition of *P.volitans* in Jamaica

The data also showed that across all size classes (using the total length), juvenile and small adult teleost were most abundant in the lionfish stomach contents (figure 18). Crustaceans were also found in most size class except for lionfish exceeding >400mm TL.

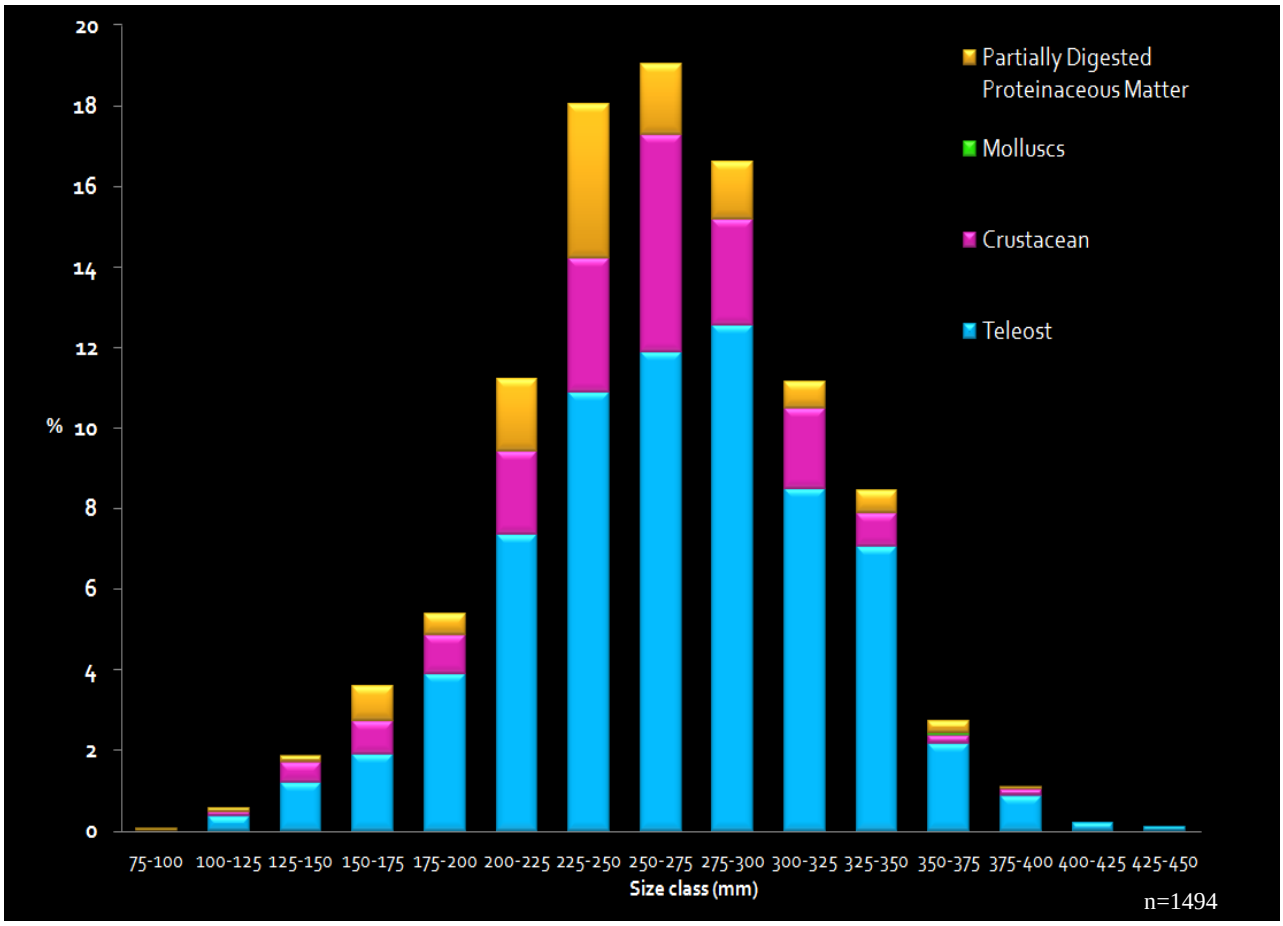


Figure 18. Diet of lionfish across size classes.

3.3 Discussion

This study found up to 20 different teleost families in the 1494 lionfish stomachs. Some the prey identified included commercially important species such as snappers, parrotfish and groupers. Lionfish (*Pterois* sp.) are known to consume juvenile and small adult fish (Côté, 2013), crustaceans and molluscs (Morris and Akins, 2009; McCleery, 2011; Higgs, 2009; Albins and Hixon, 2011). Morris (2009) noted a laboratory study done by Fishelson in 1997, that lionfish are

able to consume up to 2.5- 6% of their body weight per day 25 - 26 °C. This may have serious implications on the fisheries.

Of the top 10 preys indentified, scaridae ranked sixth. This family is known as one of the important grazers aiding with algal reduction on coral reef systems. The scaridae family is also one of the popular seafood choices around the island of Jamaica.

Lionfish consumed mostly teleost across all size classes. This was also seen in the Bahamas by Higgs (2009). Other studies showed that juvenile lionfish consumed more crustaceans such as shrimp than juvenile and small teleost and changed their diet preferences as they get larger by consuming fewer crustaceans (Morris, 2009; Mcleery, 2011).

Overall, from the lionfish stomachs examined the results would suggest that there is a preference for juvenile and small teleost. This may further reduce the fish stocks and may lead to other cascading effects including increased algal cover further degrading our coral reefs.

3.4 Conclusion

Lionfish has a wide diet. They tend to prey heavily on juvenile and small adult teleost although crustaceans and mollusc also consumed. This may have negative impacts on fisheries by reducing the fish stocks and may have other cascading effects leading to the degradation of the marine ecosystems.

4.0 Development of a Passive Capture Mechanism

The development of a low cost capture method with high effectiveness and selectivity would be integral to early detection and control of the invasion of the species into new countries and new areas. It would be preferred that this method be passive, such as a trap, which can be deployed and allowed to catch lionfish with minimal input from diving.

4.1 Examination of bait and soak time using local fishing practises

Since the invasion of the Lionfish in Jamaica, fishermen are reporting lionfish as a part of the catch. Fishermen traditionally use the Antillean Z- traps (figure 19) with a few using the rectangular traps (figure 20) or a combination of both. This study observed normal pot-fishing activities and the capture of lionfish as non-target fish in Discovery Bay, St. Ann and Oracabessa, St. Mary.

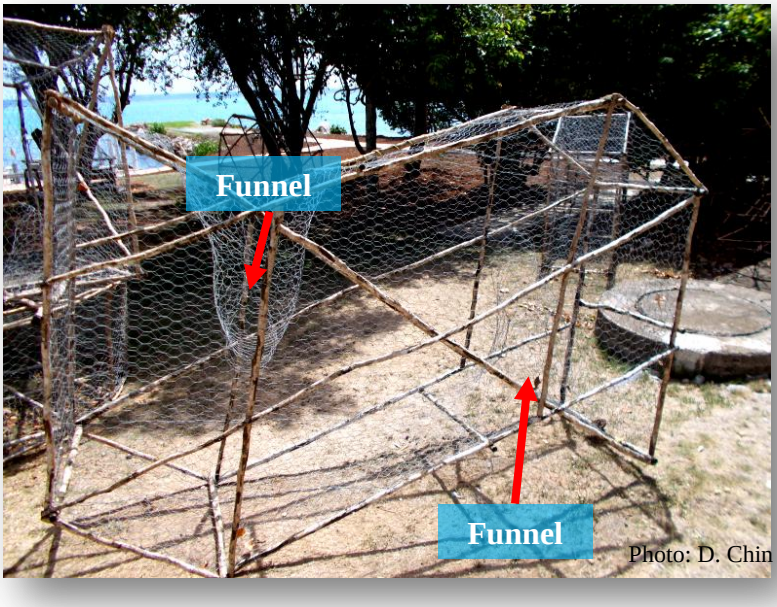


Figure 19. Antillean Z- Trap

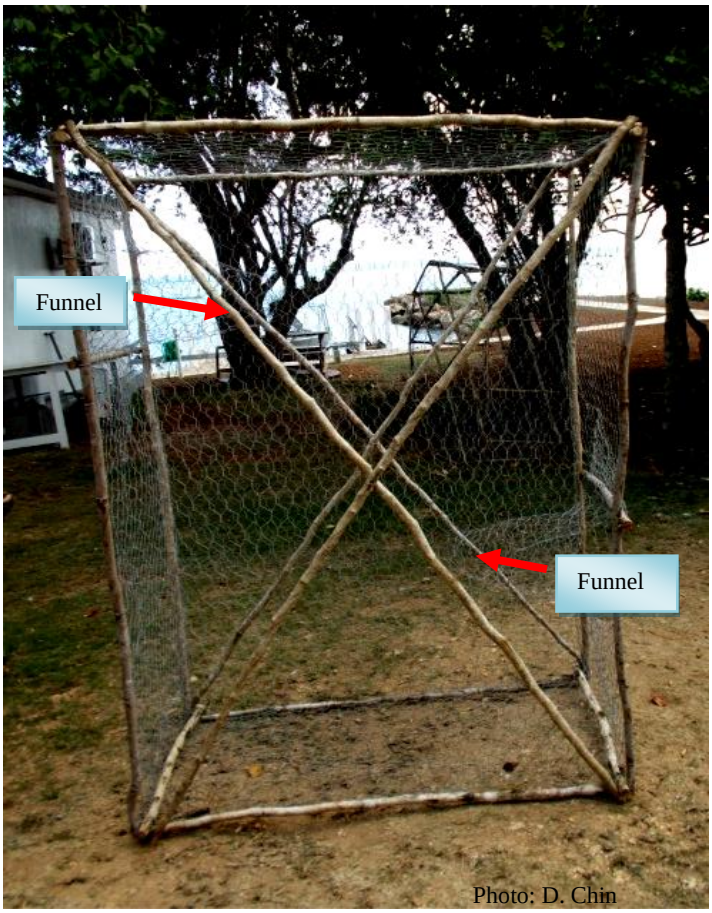


Figure 20. Rectangular Fish Pot

4.1.1 Method

Two sites Discovery Bay in St. Ann and Oracabessa in St. Mary were chosen as the study sites. Fishermen in these areas used the Antillean Z-Trap throughout the study period of July 2011 to March 2012. For each trap deployment, the following information was recorded:

- GPS coordinates
- Depth of seawater

- Bait type (ingredients of bait if composite)
- Date and time of day
- For each trap, a plastic tag (figure 21 with a reference number was tied onto the trap

Figure 21. Fishermen about to deploy tagged fish trap

The following information was recorded at each trap retrieval:

- Tag reference number
- Date and time of day
- Number of lionfish caught and size
- Species and number of individuals of other fish caught.

The data were collated and further analysed.

4.1.2 Results

Over a 9 month period, 625 lionfish were caught in fish pots in Oracabessa and 50 lionfish in Discovery Bay. These lionfish were unintended catch for the fishermen. Table 4 compares the findings of the two sites.

Table 4. Comparison of Discovery Bay and Oracabessa fishing practises

	Discovery Bay	Oracabessa
# of Lionfish Caught	50	625
# of By-catch	529	631
# of Retrievals	160	178
Avg. Soak Time (days)	7	3
Most Lionfish caught (Bait used)	8 (Breadfruit)	40 (Breadfruit & Pickled Mackerel)
Avg. Depth	64'	285'

The average depth at Oracabessa (86.9m/ 285') is notably deeper than Discovery Bay (19.5m/ 64'). Soak time for the pots is half that of Discovery Bay. In Discovery Bay, the ratio of by-catch (any other fish than lionfish) to lionfish is significant (11:1) in comparison to Oracabessa with a 1:1 ratio (figure 22).

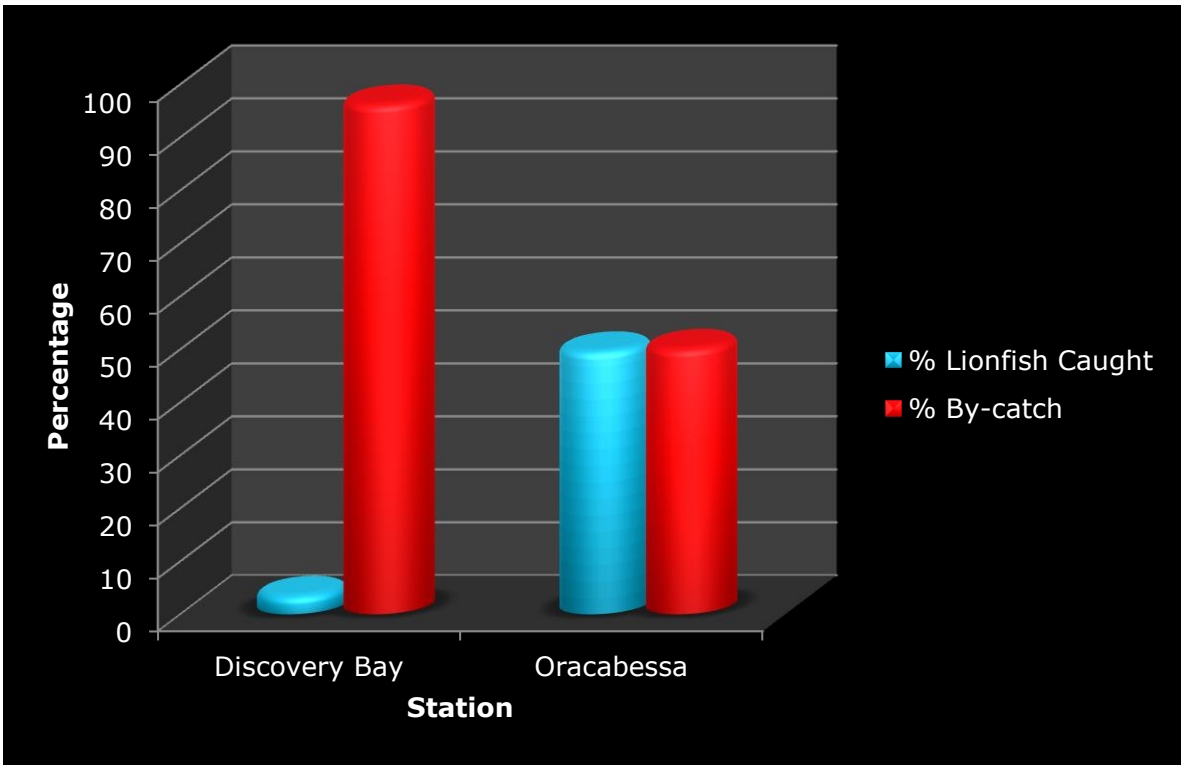


Figure 22. Comparison of lionfish and by-catch caught in Discovery Bay and Oracabessa

Overall, both sites showed an increase in lionfish catch correlated to depth (figure 23).

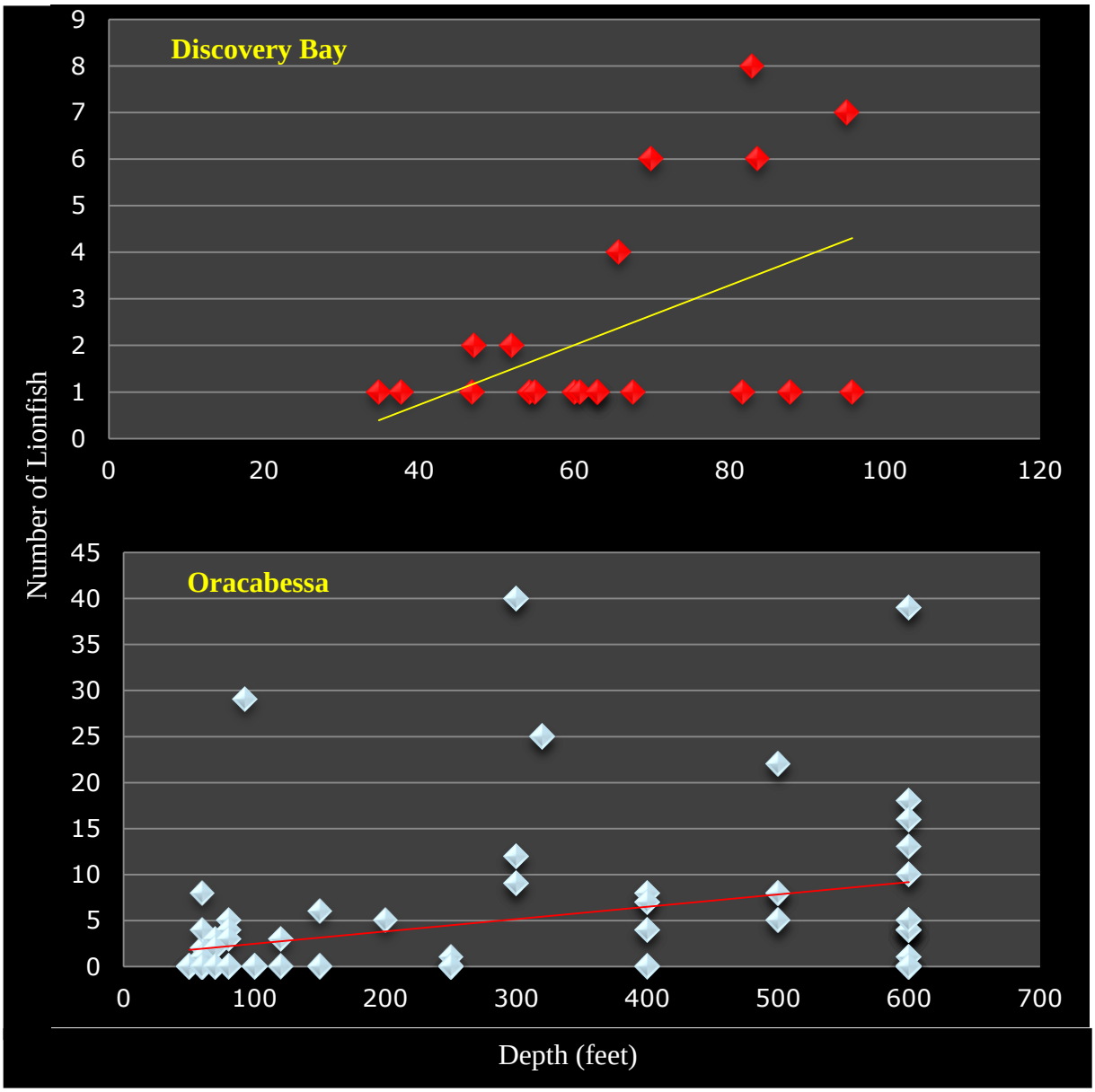
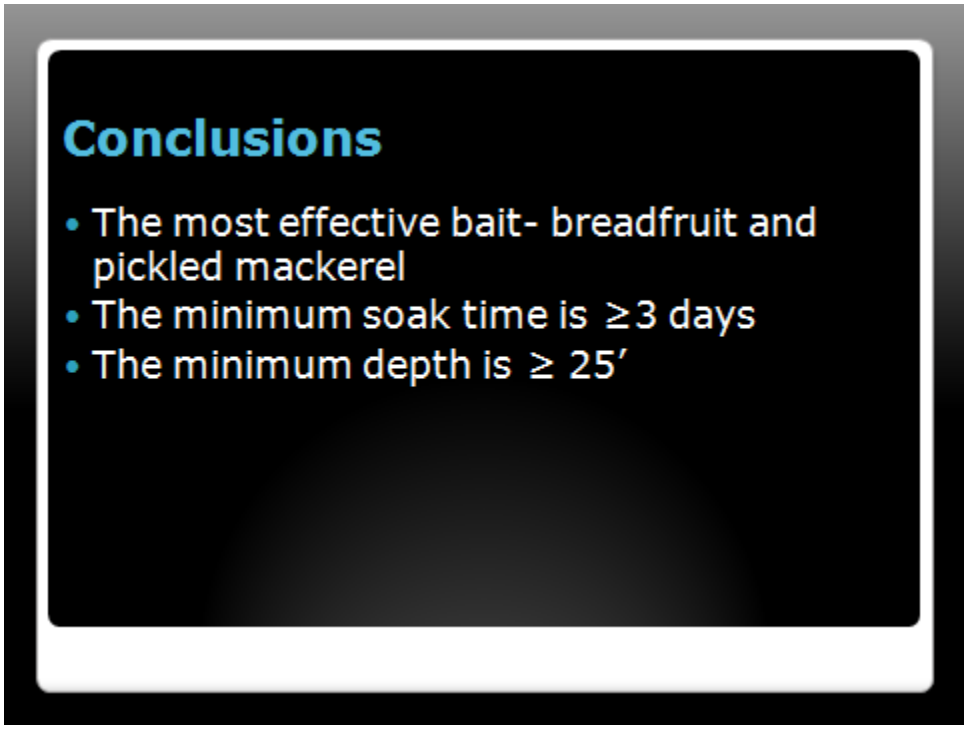


Figure 23. Comparison of lionfish caught with depth at Discovery Bay and Oracabessa

4.1.3 Discussion

This study highlighted the fact that lionfish are captured in Antillean Z-traps. This fish pot is the recommended pot shape around Jamaica. Lionfish was caught as by-catch in these pots

which are normally baited for other fish species such as snappers, grunts, parrotfish and groupers. The pots deployed in Oracabessa had a higher yield which could be attributed to the depth at which they were deployed. Of note, the soak time in Oracabessa was on average 3 days, half the soak time in Discovery Bay.



5.0 Training Programmes

The Lionfish Pilot Project has engaged a wide audience from various backgrounds and age groups. To date, the project has interacted with over 10,000 persons on face to face basis. These individuals received information on:

- Where is the lionfish from and how it got here?
- Impacts of the lionfish invasion
- Safe handling and spine removal
- Identification of venomous spines
- First aid treatment for Lionfish stings.

The project has developed a 3-day "Train-the- Trainer" programme (appendix III). This programme was designed for persons who interact with or is involved with the marine, environment or fisheries such as:

- Marine Biologists
- Fisheries Management Officers
- Recreational SCUBA divers
- Environmentalists
- Medical practioners
- Water sports staff including SCUBA
- Hotels & Resorts
- Chefs.

This programme allows for greater capacity-building and increases the rate of training and awareness among a wide range of stakeholders in the country. At the end of this training course, participants should be able to:

1. Understand the regional impacts of marine invasive alien species
2. Develop programmes and initiatives to manage marine invasive alien species in context of the Caribbean Invasive Alien Species Strategy and Action Plan
3. Perform hands-on control methods for the invasive lionfish
4. Carry-out public education and outreach activities on marine invasive alien species using the lionfish as an example
5. Implement monitoring programmes for marine invasive alien species using the lionfish as an example.

In an effort to engage the wider public, members of the MTIASIC project showcased the research at numerous expositions, school events (primary to tertiary level), culinary festivals (figure 24), agricultural shows and even on the popular Food Network series-"Bizzare Foods".

This project has also garnered support to boost our public education drive from private sector entities such as the Scotia Foundation, Rainforest Seafoods Ltd. and the Sandals Foundation. There partnerships were also successful with the assistance of entities such as PEPA, MBMPT, GEF SGP and Oracabessa Foundation.

Figure 24. Lionfish exhibit

A number of educational and promotional materials have been developed to promote the control of lionfish including brochures, flyers (appendix IV), totes, sun visors and a story entitled "Bully on the Reef" written by Raz Barnea, Lauren Barnes and Patrick Marti (figure 25).

Figure 25. Cover of story: "Bully on the Reef".

To continue the efforts this pilot project, the DBML has incorporated a lionfish talk as a part of their tour and their eco-camp programme.

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Appendix I

Lionfish Survey Kit:

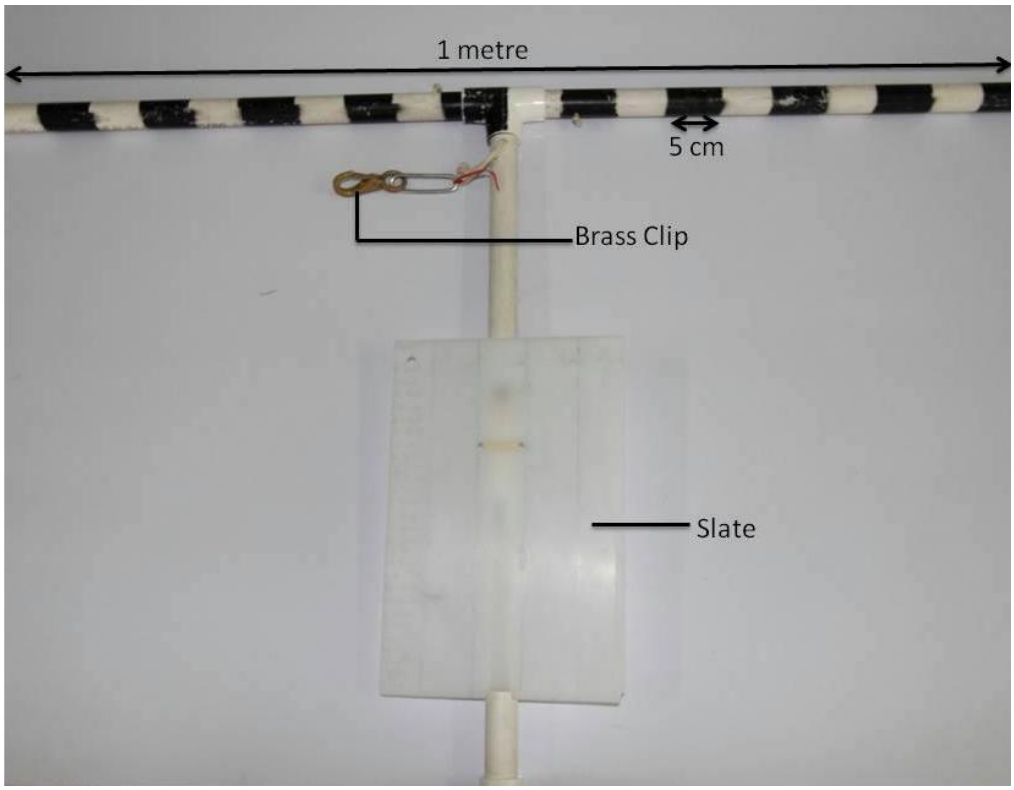

Figure 26. Photograph of T-bar. **Lionfish total lengths are estimated using the 1 metre width with stripes at 5 cm intervals.**

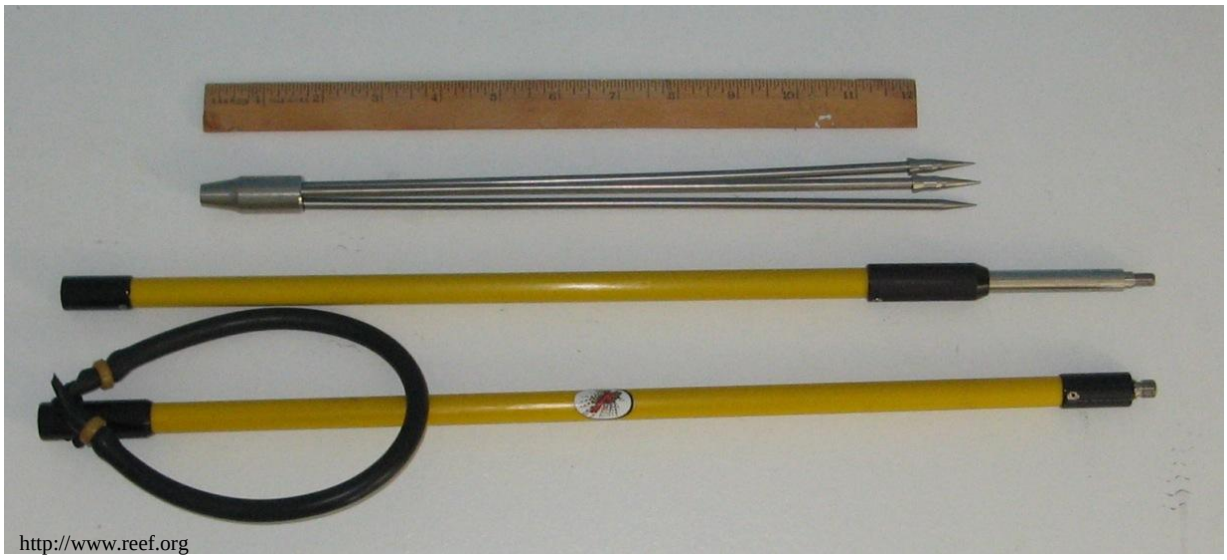

Figure 27. Collapsable pole spear for lionfish culling.

Figure 28. Lionfish collection bag.

Figure 29. 30-metre measuring tape

Appendix II

Lionfish Spine Removal Technique:

STEP 1

Wearing protective gloves hold lionfish firmly by the head or mouth.

STEP 2

Remove dorsal spines and rays using a shear. Cut from the tail towards the head.

STEP 3

Remove the anal spines and rays by cutting in the tail to head direction.

STEP 4

Remove the pelvic fins carefully noting the location of the venomous spines.

STEP 5

The pectoral fins may be removed if desired. Place spines and rays in one direction and wrap in thick layers of paper. Safely dispose in the garbage by placing in hard container such as bottles or jars.

Appendix III

UWI

UNIVERSITY OF THE
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MITIGATING THE THREAT OF INVASIVE ALIEN SPECIES IN THE INSULAR CARIBBEAN

GLOBAL ENVIRONMENT FACILITY (GEF)
UNITED NATIONS ENVIRONMENT PROGRAMME (UNEP)
CENTRE FOR AGRICULTURE BIOSCIENCE INTERNATIONAL (CABI)

THE MANAGEMENT AND CONTROL OF THE INVASIVE LIONFISH

3-DAY TRAINING COURSE FOR TRAINERS

LEAD INSTRUCTOR

DR. DAYNE BUDDO

MARINE INVASIVE SPECIES RESEARCHER

NATIONAL LIONFISH PROJECT LEAD

UNIVERSITY OF THE WEST INDIES

CENTRE FOR MARINE SCIENCES

JAMAICA

Purpose

The Lionfish Invasion has been described as one of the fastest finfish invasion in history. The Caribbean is under severe threat from this species, and it is increasingly important that countries which have been invaded, and those, still yet to be invaded build technical capacity to respond to the invasion.

Under the Global Environment Facility's Regional Project "*Mitigating the Threat of Invasive Alien Species in the Insular Caribbean (MTIASIC)"*, Jamaica has embarked on a National Lionfish Project. This project is coordinated regionally by the Centre for Bioscience International (CABI), and nationally executed by the National Environment and Planning Agency (NEPA). The University of the West Indies (Mona) is the Project Lead for the Lionfish Project through the Marine Invasive Species Lab at the Discovery Bay Marine Laboratory and Field Station.

A key component of this project is the formulation and development of a Training Course on the Management and Control of Lionfish. This has been delivered as a "Train the Trainer" model, which allows for greater capacity-building and increases the rate of training and awareness among a wide range of stakeholders in the country. The programme also ensures that the information delivered to these stakeholders by trainers is accurate to avoid confusion and inconsistency.

Course Outline

MODULE 1: INTRODUCTION TO MARINE INVASIVE SPECIES AND MANAGEMENT

Duration: 2 hours
Delivery: 2hr Lecture (PowerPoint and Video)

- The Biological and Ecological Characteristics of Aquatic Invasive Species
    - Case Studies from around the World and the wider Caribbean Region
        - The green mussel, *Perna viridis* in Jamaica
        - *Vibrio cholerae* in Peru
        - Comb Jellyfish in the Mediterranean
        - among others
- Impacts of Marine Invasive Species
    - Ecological
    - Economic
    - Public Health
- Pathways for Invasion of Species into the Marine Environment
    - Ballast Water and Sediments
    - Hull-fouling
    - Aquarium (pet-fish) trade
    - Aquaculture/Mariculture
    - Improper Disposal of live material
    - Among others
- The Management of Ballast Water
    - IMO Ballast Water Convention
    - Research in Ballast Water Management
- The Invasion of the Lionfish *Pterois volitans* in the Wider Caribbean Region
    - Source of the Invasion
    - Distribution of the Species – Rate of Colonization in the Region, Future expansion, etc.
    - Preferred Habitats
    - Impacts – Realized and Potential

MODULE 2: BIOLOGICAL CHARACTERISTICS OF THE LIONFISH

Duration: 4 hours
Delivery: 1 hr Lecture (PowerPoint and Video) and 3hrs Practical (Practical 2A-1hr: First Aid; Practical 2B- 2hr: Handling Specimen and Gathering

Scientific Data)

- External Morphological Features of the Lionfish
  - Naming the parts of the Lionfish
  - Venomous and non-venomous spines
- Internal Anatomy of the Lionfish
  - Digestive System
    - Vacuum-like oesophagus
    - Large Folded Stomach
  - Gonad/Sex Determination
  - Otoliths (ear-stones)
- Safe Handling of the Dead Lionfish Specimen
  - Safety Equipment Required
    - Recommended Ways to Handle a Lionfish Specimen
  - Venom of the Lionfish
    - Characteristics of the Venom
    - Effects of the Venom
    - First-aid Treatment in the Event of a Sting
    - Guidelines to Physicians for Further Medical Treatment
- Gathering Scientific Data from the Specimen
  - Length and Weight
  - Dorsal and Anal Fin ray counts
  - Gape of Mouth Measurements
  - Analyses of Gut Contents/Prey Consumed
  - Extraction of otoliths
  - Extraction of gill tissue

MODULE 3: IN-WATER COLLECTION OF LIONFISH

Duration: 4 hours

Delivery: 1 hr Lecture (Narrated Video) and 2hr In-water Practical and 1hr Video review

- Equipment Necessary for Collection and Variations
- Reduction of Reef Damage from Removal Effort
- Safety of Divers
- Searching Techniques
- Removal Techniques
- Handling Techniques
- Collection of Data from Removal Dive
- Actual in-water Training Dive

MODULE 4: MONITORING LIONFISH POPULATIONS

Duration: 4 hours
Delivery: 1 hr Lecture (Powerpoint and Video) and 2hr In-water Practical and 1hr data processing

- The Importance of Monitoring Surveys
- Designing the Monitoring Team
- Survey Techniques
- Actual in-water Training Dive
- Done by Dr. Dayne Buddo and Dr. Ruben Torres (REEF DR)

MODULE 5: PUBLIC EDUCATION AND OUTREACH

Duration: 3 hours
Delivery: 1 hr Lecture, 1hr in-class Practical and 1hr Community Outreach Activity

- Case studies of Public Education and Outreach in the Region
- Sending Clear Messages
- Packaging your Messages for Different Audiences
- Use of Various Media (radio, television, posters, etc)
- Designing your Material
- Practice of Techniques in the Community

Draft Agenda

Day 1:

Day 1	Training Activity	Duration and Special Notes	Resources Required from Workshop Host
9am	• Welcome and Introductions • Description of 'Lionfish Resource Package' • Overview of training programme	30 mins	- Meeting Room - LCD Projector and screen - Laptop - Speakers - Printed Material
9:30am	MODULE 1: INTRODUCTION TO MARINE INVASIVE SPECIES AND MANAGEMENT	2hrs	- Meeting Room - LCD Projector and screen - Screen/White Wall - Laptop - Speakers - Printed Material
11:30	LIONFISH STATUS IN-COUNTRY	45mins	- Meeting Room - LCD Projector and screen - Laptop - Speakers - Printed Material
12:15	LUNCH		
2pm	MODULE 2: BIOLOGICAL CHARACTERISTICS OF	2hrs	- Meeting Room - LCD Projector and Screen - Laptop - Speakers - Printed Material

Day 1	Training Activity	Duration and Special Notes	Resources Required from Workshop Host
	THE LIONFISH Part 1: Lecture and Practical 2A (First Aid)		- Hot Water - Vacuum Flask - Trays (for placing hand in) - First Aid Kit with hot packs
4pm	BREAK		
4:30pm	**MODULE 3: IN-WATER COLLECTION OF LIONFISH** Part 1: Briefing for Hunt	1hr	- Meeting Room - LCD Projector and Screen - Laptop - Speakers

Day 2:

Day 2	Training Activity	Duration and Special Notes	Resources Required from Workshop Host
6 am	MODULE 3: IN-WATER COLLECTION OF LIONFISH Part 2: Practical In-Water Lionfish Collection	- 2hrs - Site depth required (40-60ft)	- Tanks - Weights - Buckets (2) - Dive Gloves for all participants - Lionfish

Day 2	Training Activity	Duration and Special Notes	Resources Required from Workshop Host
		- 1-tank dive	Collection bags - Pole Spears - Underwater Video camera with Videographer - First Aid Kit with hot packs - Hot water
9am	**MODULE 3: IN-WATER COLLECTION OF LIONFISH** Part 3: Review of video footage and notes collected from Training Collection Dives	1hr	- Meeting Room (tables arranged in U-shape) - LCD Projector - Screen/White Wall - Laptop - Speakers - Printed Material
10am	**MODULE 2: BIOLOGICAL CHARACTERISTICS OF THE LIONFISH** Part 2: Practical 2B (***Handling Specimen and Gathering Scientific Data***)	2hrs	- Meeting Room (tables arranged in U-shape) - Newspaper - Paper Towels - Hot Water - First Aid Kit - Hand soap - Fish Boards - Cutting Shears - Knives - Gloves - Digital Scale - Vernier Caliper - Dissecting Kits - Small collecting vials - Small glass jars - 70% ethanol

Day 2	Training Activity	Duration and Special Notes	Resources Required from Workshop Host
12 noon	LUNCH		
1pm	**MODULE 5: PUBLIC EDUCATION AND OUTREACH** PART 1: LECTURE AND IN-CLASS PRACTICAL	2hrs	- Meeting Room (tables arranged in U-shape) - LCD Projector - Screen/White Wall - Laptop - Speakers - Printed Material - Poster Paper - Markers - Crayons
3pm	BREAK		
3:30pm	**MODULE 4: MONITORING LIONFISH POPULATIONS** PART 1: LECTURE	1hr	- Meeting Room (tables arranged in U-shape) - LCD Projector - Screen/White Wall - Laptop - Speakers - Printed Material
4:30pm	**MODULE 4: MONITORING LIONFISH POPULATIONS** PART 2: PREPARATION FOR SURVEY PRACTICAL DIVE	30mins	- Meeting Room (tables arranged in U-shape) - LCD Projector - Screen/White Wall - Laptop

Day 2	Training Activity	Duration and Special Notes	Resources Required from Workshop Host
			- Speakers Printed Material

Day 3:

Day 3	Training Activity	Duration and Special Notes	Resources Required from Workshop Host
6 am	**MODULE 4: MONITORING LIONFISH POPULATIONS** PART 3: SURVEY PRACTICAL DIVE	- 2hrs - Site depth required (40-50ft) 1-tank dive	- Tanks - Weights - Buckets (2) - Pole spears - Collection bags - Dive Gloves for all participants - Underwater Video camera with Videographer - 30m transect survey tapes (1 tape per buddy pair) - AGRRA T-Bar or length reference pole for fish length estimation - Dive slates with pencils - First Aid Kit with hot packs
9am	**MODULE 4: MONITORING LIONFISH POPULATIONS** PART 4: RECORDING SURVEY DATA	1hr	- Meeting Room - LCD Projector - Screen/White Wall - Laptop - Speakers - Printed Material
10am-11am	TRAVEL AND SET-UP AT OUTREACH LOCATION		

Day 3	Training Activity	Duration and Special Notes	Resources Required from Workshop Host
11am	**MODULE 5: PUBLIC EDUCATION AND OUTREACH** PART 2: PRACTICAL – COMMUNITY OUTREACH ACTIVITY (LED BY TRAINEES)	1hr - Community outreach will be led by the Trainees, while Instructor will be an Observer)	- Choose a community group (fishing beach, school, etc), ***no more than 30mins away*** - Transportation to site
12 noon	LUNCH		
1pm	**EXAMINATION OF TRAINEES**	1hr - Multiple Choice Questions - Assessment of Module 5 Practicals (in class and in community)	- Meeting Room - LCD Projector and Screen - Laptop - Speakers Printed Material
2pm	CLOSURE AND PRESENTATION OF CERTIFICATES TO TRAINERS (30MINS)		

Target Groups:

This Training Programme is designed especially for persons who will be participating in active lionfish research, public education/outreach, lionfish surveys and removals and persons who will be called upon to administer first aid and advanced medical treatment of a venomous

lionfish sting. It is intended that ALL graduates of this course will be able to conduct training in the country to a wide range of stakeholders. Target Groups include:

- Marine Scientists
- Fisheries Officers
- Environmental Officers
- Marine Protected Areas' Managers
- Dive Operators
- First Aid Responders and Medical Doctors (in particular emergency room physicians)
- Public Education/Outreach Officers

Lead Instructor:

Dr. Dayne Buddo
Marine Biologist
Lecturer and Academic Coordinator
National Lionfish Project Lead
Chair – Regional Marine Invasive Species Working Group
Mitigating the Threat of Invasive Alien Species in the Insular Caribbean (MTIASIC) Project
Co-Author: Best Strategies and Practices for Invasive Lionfish – A Guide for Managers
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University of the West Indies - Jamaica
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Email: dayne.buddo@uwimona.edu.jm and daynebuddo@gmail.com

Lionfish Catch Per Unit Effort (CPUE) Data Sheet

Dive #:	1	Dive Site name:	M1	Lengths of lionfish (cm)			
Time:	6:00am	Date:	07/ 08 /2011	10.5	12.8	9.4	10.5
Dive time (min):	30	Total divers:	4	16.2	7.2	15.4	18.1
Depth (ft):	60	# of shooters:	2	11.3	17.1		
# of lionfish seen:	22	# of lionfish caught:	10				
Comments:	Lionfish seen in large numbers grouping together						

Dive #:		Dive Site name:		Lengths of lionfish (cm)			
Time:		Date:					
Dive time (min):		Total divers:					
Depth (ft):		# of shooters:					
# of lionfish seen:		# of lionfish caught:					
Comments:							

Dive #:		Dive Site name:		Lengths of lionfish (cm)			
Time:		Date:					
Dive time (min):		Total divers:					
Depth (ft):		# of shooters:					

# of lionfish seen:		# of lionfish caught:					
Comments:							

Dive #:		Dive Site name:		Lengths of lionfish (cm)			
Time:		Date:					
Dive time (min):		Total divers:					
Depth (ft):		# of shooters:					
# of lionfish seen:		# of lionfish caught:					
Comments:							

Dive #:		Dive Site name:		Lengths of lionfish (cm)			
Time:		Date:					
Dive time (min):		Total divers:					
Depth (ft):		# of shooters:					
# of lionfish seen:		# of lionfish caught:					
Comments:							

Lionfish Data Sheet

Fish #	Date	Site	Time	Data Processor	Depth (m)	No. of Hard Dorsal Fin Rays	No. of Soft Anal Rays	Total Length (mm)	Gape Height (mm)	Gape Width (mm)	Weight (g)	Sex (M/F/IM)	Habitat Type	Gut Contents	Notes
JM001	08/12/2010	Dairy Bull	09:00:00 AM	JohnDoe	20	12	8	237	23	21	154	Female	Coral Reef	Shrimp	
JM002	12/12/2010	Lime Cay	07:00:00 AM	JohnDoe	35	13	8	238	21	22	258	Male	Sand	Wrasse	
JM003	20/12/2010	M1	11:00:00 AM	JohnDoe	35	12	8	178	30	33	62	Immature	Seagrass	Doctor fish	

LIONFISH TRAINING EXAMINATION

This examination consists of thirty (30) multiple choice questions.

Time: 40 minutes

1. What is the scientific name for the lionfish?
    a. *Pteros voltis*
    b. *Acanthurus guttatus*
    c. *Pterois millans*
    d. *Pterois volitans*
    e. c and d

2. What does the acronym IAS mean?
    a. Impacting Animal System
    b. Invasive Alien Species
    c. Incurring Advanced Study
    d. Invading Animal Species
    e. International Alien Species

3. Where are the venomous spines located on the Lionfish?
    a. Dorsal Spines, Pectoral Spines and Pelvic Spines
    b. Caudal Spines, Dorsal Spines and Anal Spines
    c. Anal Spines, Pelvic Spines and Dorsal Spines

d. Facial Spines and Caudal Spines
e. Pelvic Spines, Facial Spines and Dorsal Spines

4. You are conducting a lionfish collection dive at sixty feet (60'); your dive buddy indicates to you that he/she has been stung by the lionfish. What is the recommended safety procedure to bring your injured dive buddy to the surface?

a. Tell your injured dive buddy to ascend observing the safety stop at twenty feet (20') for 3 minutes before surfacing. While you secure the lionfish and equipment and meet him/ her on the surface.

b. Tell your dive buddy to end the dive. Ensure your dive buddy is calm and breathing properly. Indicate that your injured dive buddy to ascend observing the safety stop at twenty feet (20') for 3 minutes before surfacing. While you finish up the dive, secure the lionfish and equipment.

c. Abort the dive. Ensure your dive buddy is calm and breathing properly. Always keeping an eye on your injured dive buddy, remove the danger by securing the lionfish and equipment. Ensure your buddy remains calm. Ensure that your buddy ascend normally. Indicate that you are going to ascend observing the safety stop at twenty feet (20') for 3 minutes before surfacing.

d. Abort the dive. Ensure your dive buddy is calm and breathing properly. Always keeping an eye on your injured dive buddy, remove the danger by securing the lionfish and equipment. Ensure your buddy remains calm. Ensure that your buddy ascends normally. Indicate that you are going to ascend straight to the surface.

e. Tell your injured dive buddy to finish up the dive. Ascend as quickly as possible to the surface.

5. What is the reproductive rate of lionfish in the Caribbean?

    a. Once per week
    b. Four times per month
    c. Every four days
    d. Every four hours
    e. 2 million times annually

6. The lionfish is native to_____.

    a. Indian and Pacific Oceans
    b. United States of America
    c. Atlantic Ocean
    d. Caribbean Sea
    e. Atlantic and Pacific Oceans

7. Lionfish likes to feed at dusk only preying on juvenile and small adult fish including invertebrates.

    a. True
    b. False

8. First aid treatment for lionfish envenomations is:

a. Carefully remove any visible spine/ foreign material from wound. Squeeze the puncture area until blood clots. Scrub with soap & water. Soak wound in vinegar. Administer antihistamines/ analgesics.

b. Flush injury with large amounts of sea water to remove any remaining foreign material. Apply pressure immobilization technique. Place victim in the recovery position if breathing. Transport to the nearest emergency medical facility.

c. Control bleeding. Clean wound with soap and water. Soak in vinegar. Cover with sterile dressing. Antihistamines/ analgesics may be given. Seek medical attention.

d. Carefully remove any visible spines/foreign material from the wound. Immerse in room temperature water for 30-90mins. This step may be repeated as necessary for pain control. Scrub with soap & water. Vigorously irrigate with fresh water. Antihistamines/ analgesics may be given, if available, prior to seeking medical attention. **All** injuries should be referred to a Physician for medical attention.

e. Carefully remove any visible spines/foreign material from the wound. Immerse in water which is as hot as can be tolerated for 30-90mins (113°F/45°C max). This step may be repeated as necessary for pain control. Scrub with soap & water. Vigorously irrigate with fresh water. Antihistamines/ analgesics may be given, if available, prior to seeking medical attention. **All** injuries should be referred to a Physician for medical attention.

9. What are some of the symptoms of Lionfish envenomations?

   a. Extreme pain
   b. Redness
   c. Swelling
   d. Numbness/ tingling
   e. All the above

10. Marine invasive species can be introduced by:

   a. Ballast water
   b. Aquarium (pet-fish) trade
   c. Aquaculture/ Mariculture
   d. a only
   e. a, b and c

11. Lionfish are poisonous fish.

   a. True
   b. False

12. A female lionfish can produce up to _____eggs annually.

   a. 10,000
   b. 200,000
   c. 4
   d. 4,000,000
   e. 2,000,000

13. Lionfish is termed a “sit and wait” predator. They are often found in various habitats such as:

    a. Seagrass
    b. Coral Reef
    c. Ship wrecks
    d. Mangroves
    e. All of the above

14. The recommended way to remove the venomous spines from the lionfish is to:

    a. Wearing safety gloves, remove dorsal spines cutting from the head towards the tail. Remove the pelvic spines followed by the anal spines cutting from the head towards the tail.
    b. Wearing safety gloves, remove dorsal spines cutting from the head towards the tail. Remove the pelvic spines followed by the anal spines cutting from the tail towards the head.
    c. Wearing safety gloves, remove dorsal spines cutting from the tail towards the head. Remove the pelvic spines followed by the anal spines cutting from the tail towards the head.
    d. Remove pectoral fins followed by the dorsal spines, anal and pelvic fins using kitchen shear.
    e. None of the above

15. Lionfish can be removed using various methods such as:

    a. Fish traps
    b. Hook and line
    c. Polespears
    d. All of the above

e. None of the above

16. Lionfish monitoring are conducted using this type of survey method.

a. Roving Diver Technique
b. AGGRA
c. Reef Check
d. Line Transects
e. Quadrats

17. Lionfish can be eaten by humans or marine creatures.

a. True
b. False

18. The venom affects neuromuscular and cytolytic (i.e. cell destruction) processes.

a. True
b. False

19. Lionfish belongs to the scorpionfish family.

a. True
b. False

20. The recommended way to dispose lionfish spines is:

a. Incineration
b. Tossing them in the sea
c. Wrapping them in thick old paper with the spines placed in one direction then

placing it in the garbage

d. Cutting them up and placing it in the garbage
e. Burying them in the sand

21. Marine invasive species, like the lionfish may:

a. Outcompete native species
b. Reduce biodiversity
c. Negatively impact the economy
d. a and b
e. a, b and c

22. Puffer fish, angel fish prey on lionfish larvae.

a. True
b. False

23. Public education plays an important role in controlling and managing marine invasives.

a. True
b. False

24. Lionfish can be cannibalistic.

a. True
b. False

25. It usually takes _____ for the formation of lionfish larvae.

a. 12 hours
b. 18 hours
c. 24 hours
d. 36 hours
e. 48 hours

26. Sharks and large groupers can prey on injured or healthy lionfish since they are able to tolerate its venom.

a. True
b. False

27. Lionfish was first reported in this country in the 1980s.

a. Jamaica
b. United States
c. Barbados
d. Cuba
e. Bahamas

28. Lionfish cannot survive temperatures less than ____°C.

a. 9
b. 10
c. 11
d. 20
e. 30

29. What are some of the recommended equipment used to remove lionfish spines?

a. Gloves
b. Cutting Shear
c. Knife
d. Thick Old Paper
e. All of the above

30. What are some of the parameters collected from lionfish specimens for research?

a. Length
b. Weight
c. Sex
d. Gape Width
e. All of the above

END OF EXAM

Appendix IV

THE NATIONAL LIONFISH PROJECT

The National Lionfish Project is a Pilot Project within a larger Regional Project entitled Mitigating the Threat of Invasive Alien Species in the Insular Caribbean (MTIASIC) funded by the Global Environment Facility (GEF) and the United Nations Environment Programme (UNEP). The Lionfish Pilot Project in Jamaica is led by the University of the West Indies- Discovery Bay Marine Lab (UWI-DBML) and National Environment and Planning Agency (NEPA). It seeks to strengthen partnerships among government and non-governmental agencies in Jamaica, as well as to promote regional cooperation.

It is very unlikely that the lionfish with be totally eradicated from Jamaica or the region, and therefore it is increasingly important to learn how to manage this species effectively. The Pilot takes a research based approach to developing a management strategy for Lionfish in Jamaica. Under the National Lionfish Project, the following are elements of Research being done:

- Population-tracking Island-wide
- Analyses of prey consumed by the lionfish
- Design of special traps for lionfish
- Analyses of the genetics of the population
- Biology and Ecology of the lionfish larvae
- Impacts of the lionfish on artificial reefs
- Impacts on local potfishing
- Formulation of Management Plans

Contact Information:

Marine Invasive Species Laboratory

Discovery Bay Marine Laboratory and Field Station

University of the West Indies

Tel: (876) 973-2241

(876) 973-2946

Email: lionfishprojectjamaica@gmail.com

For additional information on the **MTIASIC Project in Jamaica** and invasive alien species, contact:

GEF/UNEP/CABI MTIASIC Project

The National Environment & Planning Agency,

10 Caledonia Avenue, Kingston 5

Telephone : 754 - 7540 ext. 2319

www.nepa.gov.jm

Other Partners:

Portland Environmental Protection Association

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Dayne Buddo

National Environment and Planning Agency

University of the West Indies

THE INVASIVE LIONFISH IN JAMAICA

"Let's Eat It to Beat It"

GEF UNEP www.cabi.org

WHAT IS A LIONFISH?

The Lionfish (*Pterois volitans* and *Pterois miles*) belongs to a group of venomous fishes and is related to the scorpionfish which are found regularly in Jamaica. It is a "sit-and-wait" predator, capable of consuming large quantities of fish and shellfish daily and can negatively impact the fish stocks in a country. Its venomous spines protect itself from becoming prey for other fish, and these spines are also capable of inflicting a very painful sting to humans.

HOW DID IT GET HERE?

The Lionfish is native to the Indian and Pacific Oceans. In the late '80s and early '90s, marine aquaria enthusiasts mainly in the USA imported these fish for their homes and offices. However, for many reasons, these fish were released into the canals and seas, and "set free". Since then, they have made their way along the east coast of the USA, the Bahamas, Hispaniola, Cuba, Jamaica, and many other countries throughout the Caribbean.

WHAT IS THE IMPACT OF THE LIONFISH?

The Lionfish preys on juvenile fish and shellfish. Many countries have reported staggering numbers of lionfish on their reefs and other marine environments. The lionfish reproduces all-year round in the Caribbean (every 4 days). A female lionfish is capable of producing 2 million eggs each year. Lionfish in Jamaica have been found in very shallow seagrass areas to areas 335m (1100ft) deep below the surface. They have been recorded in Jamaica to lengths of 51cm (20 inches).

The lionfish has been described as highly invasive in the Caribbean, due to its negative impacts on the reef ecology, economy and public health.

HOW TO HANDLE & CLEAN A LIONFISH

- Wearing heavy gloves, hold for manoeuvring in the mouth.
- Remove all the spines cutting above or into the flesh along each side
- Cut from the tail to the head with scissors.
- Scale and gut fish.
- You can remove head and fillet the Lionfish.
- Dispose of spines carefully by storing or wrapping in **thick** layers of paper!
- Incinerate in an isolated container (e.g. Metal bin) then crushing the spines.
- Cook in the normal fashion at high temperatures

SIGNS & SYMPTOMS OF A LIONFISH STING

The range of the effects of the sting varies widely and is dependent on the victim and the amount of venom that was injected. The victim may experience:

- **Extreme** pain
- Puncture wounds/ laceration
- Bruising/ purple-black discolouration, redness, swelling, numbness/ tingling, tissue shedding at the wound site
- Nausea, vomiting, abdominal cramps
- Hypotension, shortness of breath, changes in heart rate
- Tremors, weakness, fainting, seizures
- Shock, respiratory/ cardiac arrest

FIRST AID TREATMENT

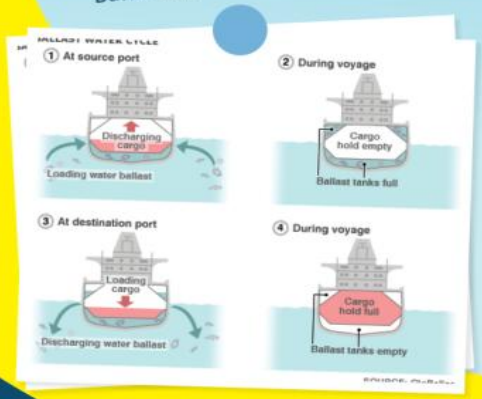
- Carefully remove any visible spines/ foreign material from wound
- Immerse in water which is as hot as the victim can tolerate for 30-90mins (45˚C/113˚Fmax).
- Repeat this step, if necessary, for pain control. If at sea, hot water from the jet on the outboard of engine of boat can be used on your way to land
- Scrub with soap and water
- Vigorously irrigate with fresh water
- Antihistamines/ analgesics may be given, if available, prior to seeking medical attention.
- **ALL injuries should be referred to a physician for medical attention.**

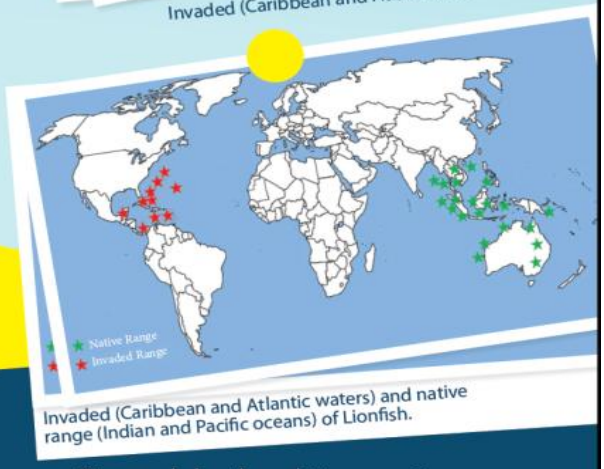
HOW DID IT GET HERE?

The lionfish is a popular aquarium fish , thought to have entered Atlantic waters via the **pet trade.** Prevalence in Atlantic waters thought to be mainly due to **aquarium releases.**

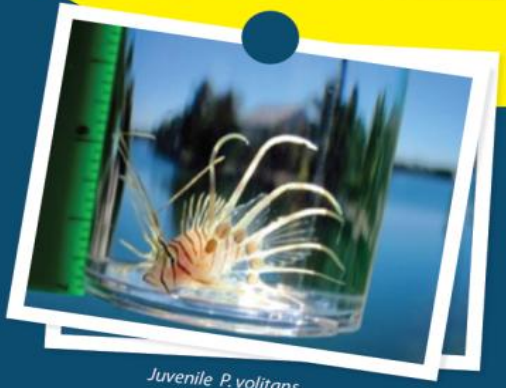
- ***P. volitans*** has invaded the Atlantic coasts of the USA and the Caribbean.
- Highest densities of the fish observed on the southeastern coast of the USA, Bermuda and the Bahamas.

Invaded (Caribbean and Atlantic) waters.





Invaded (Caribbean and Atlantic waters) and native range (Indian and Pacific oceans) of Lionfish.



Juvenile P. volitans

- Dispersal also thought to occur in pelagic larval phases, where **larvae can move in ocean currents.**
- Eggs and larvae may be transported via **ballast water.** (water used to stabilize ships)

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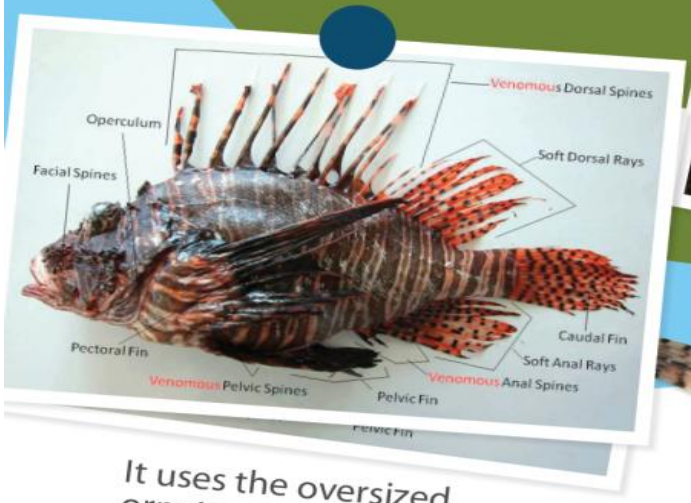
FEEDING ECOLOGY

***Pterois volitans* is an ambush predator that preys on small and juvenile fish, crustaceans and molluscs.**

Lionfish stomachs can expand over 30 times in volume when consuming a large meal.

They consume between 2.6-6% of their body weight per day in its native range.

However, current studies show that they may be consuming more than this in its invaded range.



It uses the oversized, ornate pectoral fins to herd and ambush small reef fishes and crustaceans

They are capable of consuming large-sized prey relative to their body size.

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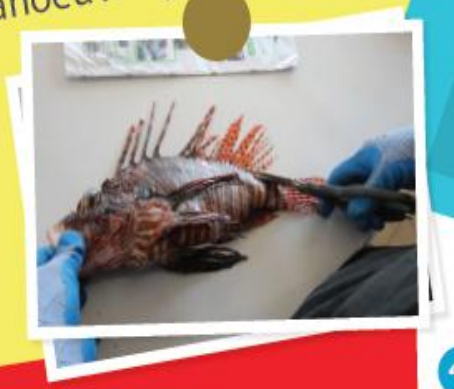
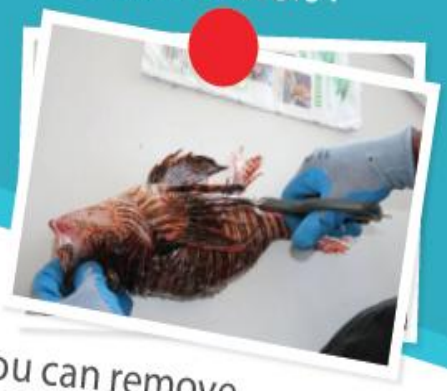
HOW TO HANDLE AND CLEAN LIONFISH

1 Wearing heavy gloves, hold lionfish by the head for manoeuvring.



2 To remove the spines cut at the base of the spines from the tail towards the head with scissors .



3 Scale and gut fish.

4 You can remove head and/ or fillet the lionfish.

5 Carefully wrap spines in THICK layers of paper.

6 Dispose of wrapped spines in old bottles or jars and place in garbage.

SYMPTOMS OF BEING STUNG

General symptoms include:

- Extreme pain
- Puncture wound/ laceration
- Bruising/ purple-black discolouration
- Redness
- Swelling

Other symptoms include:

- Numbness/tingling
- Tissue shedding at wound site
- Vomiting and abdominal cramps
- Nausea
- Reduced blood pressure
- Shortness of breath
- Slowed or increased heart rate
- Sweating
- Weakness
- Fainting
- Seizures
- Shock
- Respiratory and cardiac arrest

FIRST AID TREATMENT OF LIONFISH STINGS

1. Carefully remove any visible spines/ foreign material from wound.
2. Immerse in water which is as hot as the victim can tolerate for 30-90mins (45°C/ 113°F max).
3. Repeat this step if necessary, for pain control. If at sea, a heat pack or hot water from the jet on the outboard engine of boat can be used on your way to land.
4. Scrub with soap and water.
5. Vigorously irrigate with freshwater.
6. Medication for allergies and pain/swelling may be given, if available, prior to seeking medical attention.
7. ALL INJURIES SHOULD BE REFERRED TO A PHYSICIAN FOR MEDICAL ATTENTION.

Recommended Medical Treatment Protocol for Lionfish Stings

The Lionfish is a **venomous** fish and belongs to the same family as Scorpionfishes and Stonefishes. Native to the Pacific and Indian Oceans, it is invasive in the Caribbean and the numbers are on the rise. It contains long venomous spines along its dorsal surface (back/top) as well as small spines along the pelvic and anal sections (along the belly). The lionfish, when approached, will position itself with it large dorsal spines angled towards the diver. It is not likely to attack humans, but a lionfish may dart out if it feels threatened.

Signs and Symptoms

The range of the effects of the sting varies widely and is dependent on the victim and the amount of venom that was injected. The victim may experience:

- Extreme pain (immediate, lasts up to 12 hours)
- Puncture wounds/laceration
- Bruising/purple-black skin discolouration, redness, swelling, numbness/ tingling, tissue shedding at wound site
- Nausea, vomiting, abdominal cramps,
- Irregular heartbeat, shortness of breath, hypotension
- Tremors, weakness, fainting, seizures,
- Shock, respiratory/cardiac arrest

Treatment

Note: If SCUBA diving, ensure that you end the dive immediately and surface according to the dive protocols (notification of buddy, safety stops, etc.). If swimming or snorkelling, end the activity and get back to land safely and quickly.

First Aid

- Carefully remove any visible spines/foreign material from the wound
- Immerse in water which is as hot as can be tolerated for 30-90mins (113°F/45°C max). This step may be repeated as necessary for pain control.
- Scrub with soap & water
- Vigorously irrigate with fresh water
- Antihistamines/ analgesics may be given, if available, prior to seeking medical attention.
- **All** injuries should be referred to a Physician for medical attention.

Notes to Physician

- Antihistamines/ analgesics may be administered if not previously done
- A local anaesthetic or nerve block may be considered for pain management
- Antivenom (if available) should be given
- Complications of the sting should be managed accordingly
- X-Rays may be done to ensure that no spines/ fragments remain in the wound
- Antibiotics may be prescribed to prevent infection of the wound
- Analgesics should be continued at home to maintain pain relief
- Antihistamines may be continued at home

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Endorsed by the Mitigating the Threat of Invasive Alien Species in the Insular Caribbean Project

Appendix V

List of stakeholders trained:

Alloa Fishermen	Pedro Bank Fishers
American Caribbean Experience	Pennsylvania State University
Beaches Boscobel	Port Antonio High
Belmont Hgh School	Port Maria High
Black River	Port Antonio Fishing Beach
Blue Shades Art & Festival	Portland PCV
Brown's Town Community College	Queens High
Brown's Town Fire Station	Rainforest Seafood
Browns Town High	Red Cross
Buff Bay Primary	Rio Bueno Baptist Church
Bull Bay Fishing Co-operative	Ritz Carlton
College of Agriculture, Science and Education	Robins Bay Primary
Catherine Hall Primary	Roehampton High
Charlemont High School	Runaway Bay All-age
Churches Teachers' College	Salem Fishermen
Columbus Prepartory	Sam Sharpe Teachers' College
Denbigh Agricultural Show	Sandals Caribbean
Domonican Republic Fishermen	Sandals Riveria
Duncans All-age	Sandals Whitehouse
Environmental Foundation of Jamaica Awards	Scotiabank's "Let's Go Green with Lionfish" Launch
Fair Prospect High	SHINE Summer Camp
Ferncourt High	Sigma College Nursing & Applied Sciences
Golden Grove All-Age	Silver Sands Fishing Beach
Green Expo	St Ann Primary
Green Pond High	St Cathrine High
Half Moon Hotel	St Hilda's High
Hampstead Primary	St. Ann JAS Expo
HEART Runaway Bay	St. Ann Prep. & High
Higgin's Land Primary & Junior High	St. Catherine High
IAS Working Group	Stonybrook University
ICCD: Hellshire	SuperClubs
Immaculate Conception High	Taste of Jamaica
Intern Seminar (DBML)	Teamworks High
International Maritime Organization	Tornedo Swim Club
Irwin High School	TPDCo
Island Special Constabulary Force	

Lionfish Wednesday Launch	Travel Channel
Ministry of Foreign Affairs and Foreign Trade	University of Technology
Moneague College	UTech: Food & Safety Expo
Montego Bay Christian Academy	UWI- DBML Eco-Camp
Montego Bay Prep	UWI Ecology Class 2012
Mount Zion Primary	UWI Research Day 2012
NEPA Climate Change Expo	UWI Western Campus
NEPA ICCD	UWI-PAS
New Providence Primary	Vista Prep.
Observer Food Awards	Water Mount Primary
Ochi Rios Bay Beach	Westwood High
Oracabessa Marlin Tournament	Wolmers Boys
	York Castle High