



St. Maarten Nature Foundation Lionfish Response Plan



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DUTCH CARIBBEAN NATURE ALLIANCE

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Executive Summary

This document, the St. Maarten Nature Foundation Lionfish Response Plan, serves as a reference for the controlling and management of the invasive Indo-Pacific lionfish (*Pterois miles* and *P. volitans complex*). Lionfish are expected in St. Maarten waters in the near future and can have serious detrimental affects to the island's marine environment, particularly to the populations of both ecologically and economically important fish species. Coral reef ecosystems can also experience degradation due to predatory stress caused by lionfish on coral reef grazers such as parrotfish (*Scaridae*).

The invasive lionfish also poses a threat to public health; the species has fourteen venomous spines over the length of its body which can inflict a painful sting. Particularly vulnerable to lionfish envenomations are those stakeholders of the Marine Park who have the potential of coming in close contact with the species such as fishers and divers. Recreational beach goers also face the potential of being envenomated. Envenomations can be particularly dangerous to infants, the elderly, individuals with a compromised immune system and those sensitive to the venom.

Due to the nature of the invasion of aquatic species in general and lionfish more specifically, it must be realized that a complete eradication of the species is impossible, therefore this plan will seek to actively manage lionfish in St. Maarten territorial waters. The goals and objectives of this management plan are to adequately control the impact the species will have on the ecosystem level and with regards to the risk it poses to the community and to the local economy. Management goals and objectives are coordinated and communicated with different agencies to ensure local and regional cooperation, education of and outreach to stakeholders, research and management option development on the nature of the infestation, and a species control mechanism which will seek to limit the effects of species arrival.

Management actions should be clear in both the management of the species on a local level and contributing species information on a regional and international level. Management actions in this plan are divided into two stages; pre species arrival and post species arrival actions. Actions within the two stages can belong to phase one management actions, which are the first actions to be implemented, or phase two actions, which follow phase 1 actions and are continuous. Some management actions belong to both phase one and phase two management actions. The proposed management actions for the controlling of lionfish in St. Maarten waters include education and outreach on the nature and threats of the invasion, coordination with other agencies and organizations on management options, infestation research and development such as stomach content analysis and genetic sampling, planning and assessment in the form of lionfish action protocols and lionfish sweeps, and specimen control mechanisms such as species collection and eventual culling.

Appreciation is expressed to all those who assisted with technical support regarding this Response Plan, particularly the insight gained from the St. Eustatius Lionfish Action Plan (Bervoets 2009), on which this document is based, during the Lionfish Workshop hosted by the Bonaire National Marine Park in cooperation with the Reef Environmental Education Foundation and funded by the Dutch Caribbean Nature Alliance, and various workshops given by Chris Flook of the Bermuda Museum and Zoo.

1. Introduction

The invasive lionfish will most likely arrive in St. Maarten local waters within the foreseeable future. This arrival can bring with it significant ecological and economic affects due to it changing the ecological makeup of coral reef ecosystems thus affecting local fishery. Therefore a response plan has been developed in order to assist management organizations and stakeholders in the steps that should be taken in order to respond to and manage the invasion. This plan will serve as a reference document for controlling the infestation both on a local level and in order to contribute data and information on the invasion within the region.

2. Introduction to Lionfish

The Indo Pacific Lionfish *Pterois volitans/miles* complex (figure 2.1) is a predatory, venomous fish which has been introduced as an invasive species in the Atlantic Basin. The exotic looking fish is known for its reddish brown and white banding patters that run vertically along its body and the 13 venomous spines that run along the length of the fish (Synagjeweski and Forman-Orth 2004). This invasive carnivore can significantly reduce biodiversity of a local habitat and can drive important fish species to extinction, negatively affecting coral reef ecosystems (Albins and Hixon 2008). The fish also poses a risk to the health of coastal populations affected by the invasion as the species possesses venomous dorsal, anal, and pelvic spines that can inflict a painful sting that may result in serious health complications (www.WebMD.com/lionfish).



Figure 1: Indo-Pacific Lionfish *Pterois volitans* off of the coast of Bermuda
(Photo Tadzio Bervoets)

The native range of the species extends from southern Japan, south to Lord Howe Island off of the east coast of Australia throughout Indonesia, Micronesia and French Polynesia. Additional native ranges extend west of Sumatra throughout the Indian

Ocean and North to the Red Sea (Figure 2) (Whitfield et al 2002). The species has little or no natural predators although prey fish found in its native range have developed defense mechanisms to limit predation. Additionally, some cornetfishes (*Fistularidae*) and grouper (*Serranidae*) have been known to prey on the species in its native habitat (Synagjeweski and Forman-Orth 2004).

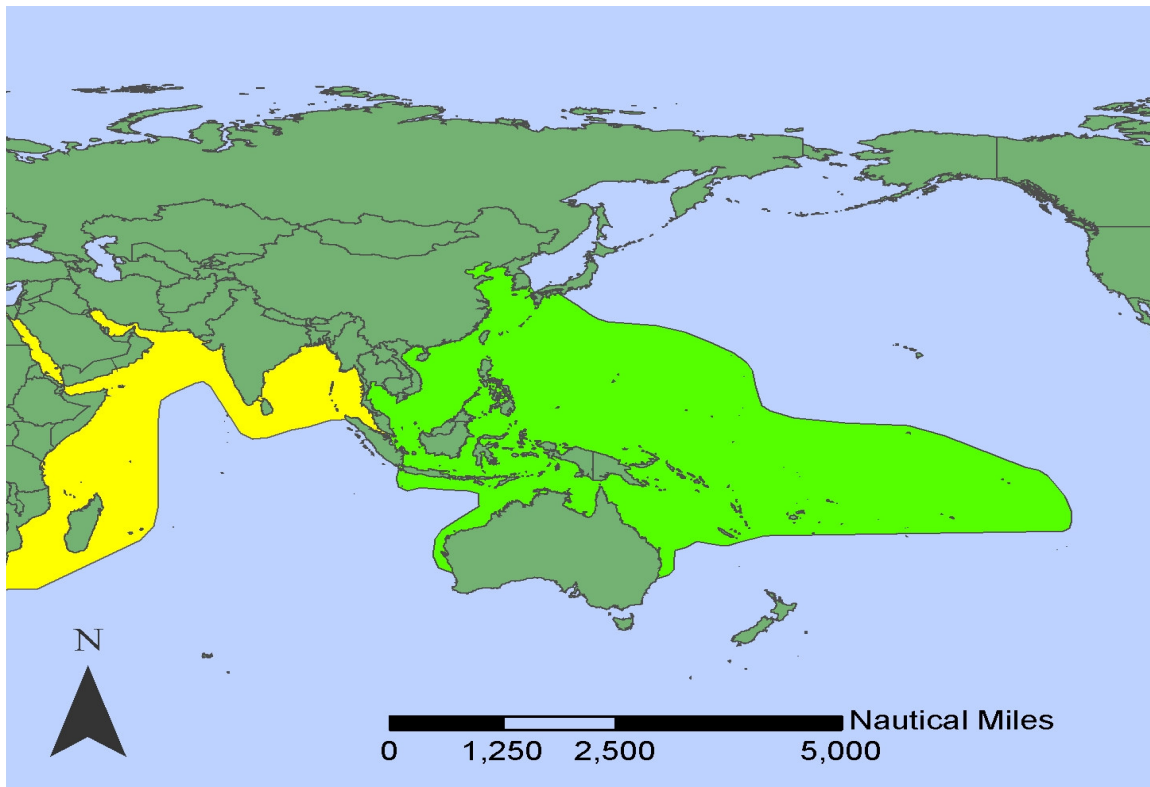


Figure 2: Native distribution of Indo-Pacific Lionfish: *P. miles*, *P. volitans* (source: JK Loefer)

Lionfish are particularly prolific breeders. Once a female is fertilized she can eject up to 15,000 eggs during a single mating event. A healthy adult female can have up to 3 mating events a month (Synagjeweski and Forman-Orth 2004). Juveniles develop rapidly and start to actively hunt at approximately 7 centimeters in length and have been observed consuming prey fish up to two thirds their body lengths (Wood 2001). The species can reach a maximum size of 45 centimeters and has a potential lifespan of approximately 4-10 years (Robins 2002).

Lionfish feed on a wide variety of smaller fish and crustaceans (Sano et al 1984) and use their outstretched pectoral fins to slowly pursue and corner their prey (Allen and Eschmeyer 1973). Lionfish consume 10% of its body weight each year (Synagjeweski and Forman-Orth 2004).

3. Background and Problems and Concerns

Biological invasions consist of the arrival, survival, successful reproduction and dispersal of a species in an ecosystem where that species did not exist previously (Carlton 1989). Invasive species can cause significant and irreparable damage to the environment in which they are introduced, eradicating native species and causing ecosystem collapse (Synagjeweski and Forman-Orth 2004). The Atlantic lionfish infestation is following similar patterns of previous infestations, particularly causing detrimental affects to coral reef habitats in the Atlantic Basin.

The first lionfish was recorded off of the coast of West Palm Beach in 1992 and was possibly released through the aquarium trade (USGS 2002). Genetic haplotype analysis has suggested that the present infestation resulted from a single animal possibly released during hurricane Andrew in 1992 (Hamner et al 2007). Since then the species has continuously migrated north reaching as far north as Long Island, New York and as far east as Bermuda (USGS 2002). Lionfish have also been reported in the Bahamas and south along the Caribbean coasts of Mexico, Costa Rica, Honduras, Venezuela, and Columbia (USGS 2002). With regards to the North Eastern Caribbean, there have been confirmed reports from St. Croix and unconfirmed reports from St. Kitts (USGS 2002, Auth. Personal Communication).



Figure 3 Current status of lionfish progression (source: USGS.com/lionfish)

Existing theories have suggested that lionfish larva is drifting along prevailing ocean currents and is possibly being introduced to areas via ballast water from commercial shipping and cruise ships. Needless to say the species will soon be introduced into the local area if it is not already present.

3.1 Risk to Local Coral Reef Habitat and Economy

The lionfish represents a major threat to coral reef ecosystems by decreasing survival of a wide range of native reef animals via both predation and competition (Albins and Hixon 2008). Fish species found on Caribbean coral reefs are not adapted to the way the lionfish hunts, resulting in numerous reef fish communities collapsing due to the presence of the species. Native predatory fish cannot compete with lionfish due to already established prey fish hunting strategy adaptation, causing predators to seek alternative prey or die of starvation. Lionfish have been observed gorging themselves on passing fish that are unaware of the presence of a top level predator (Hamner et al 2007). Additionally, because of the toxic spines of the species and because of an amino acid that it secretes (Hamner et al 2007) there are no predators which would have the potential to actively prey on lionfish in the Atlantic (Albins and Hixon 2008). This, in addition to their prolific rate of reproduction, can result in veritable lionfish biomass explosions. During research dives in the Bahamas one coral head was found to have 25 adult lionfish and the fish were culled, during follow up dives 24 hours later on the same coral head a dozen lionfish were spotted again (Auth. Pers. Obs.). The species has been observed consuming fish up to 2/3 its overall length (Albins and Hixon 2008), and one specimen was observed eating 20 wrasses (*Labridae*) in a time frame of 20 minutes (Albins and Hixon 2008).

The introduction of lionfish is also a concern because it preys on the juveniles of many commercial species, including snapper (*Lutjanidae*), grouper (*Serranidae*) and parrotfish (*Scaridae*) (Whitfield et al 2002). Many fisheries, particularly in the Bahamas, are nearing collapse due to the predominance of lionfish (Albins and Hixon 2008). Additionally, due to species preying on juvenile reef grazers, an increase in algae on coral reef substrate may result, causing additional stress on coral possibly resulting in coral mortality and negative economic effects due to a possible loss of dive tourism. Similarly, uneducated divers may attempt to approach lionfish unaware of the venomous spines, and could risk being stung, resulting in severe pain and swelling at the location of contact (NOAA, 2004).

3.2 Community Health Risk

As mentioned, the lionfish has venomous spines imbedded in its pectoral, caudal, and dorsal fins (Figure 4). There are 13 dorsal spines that run the length of the fish's spine as well as 6 spines in its pectoral and 14 spines in its caudal fin (Synagjeweski and Forman-Orth 2004). Each spine is covered by a thin sheath of skin which, when depressed, compress a small pair of venom glands at the base of the spine (Figure 5). The venom then travels from the glands through small depression in the spines towards the wound (www.WebMD.com/lionfish). The venom toxicity is due to antigenic, heat liable proteins that can cause extreme pain and in rare cases death (www.WebMD.com/lionfish). Cases of death are usually reported in victims who have a previous underlying health condition which may have compromised their immune system or who are particularly sensitive to the toxin. Death has also occurred due to drowning, particularly to divers who were stung during a dive. Aside from the extreme pain caused by the venom, a patient also risks serious secondary infections which may require aggressive antibiotic treatment.



Figure 4 Venomous dorsal spines Lionfish (Source: G. Meister)

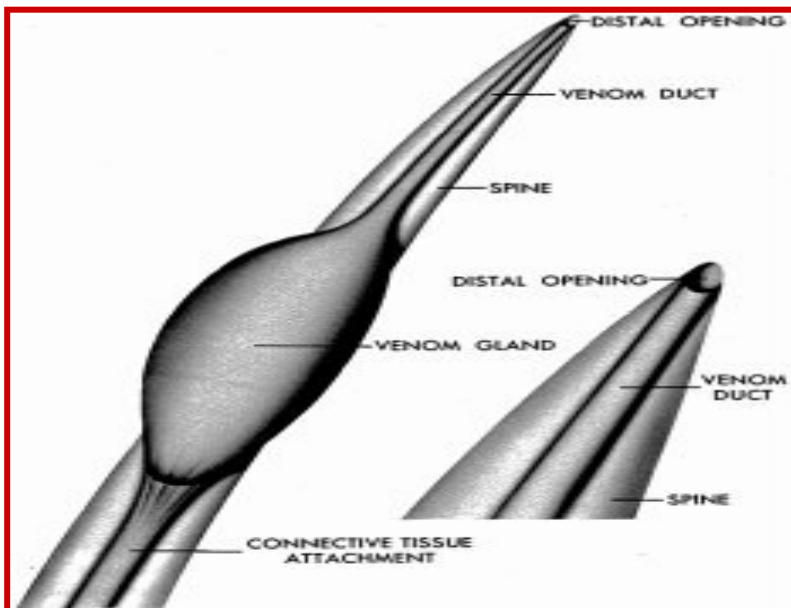


Figure 5: Diagram showing venomous spines (Source: G. Meister)

The health risk the fish poses to the users of the Marine Park centers primarily on divers and fishermen. Fishermen are at a higher risk due to their close physical contact with their catch, particularly when removing specimens from fish traps or lines. Divers are also at risk due to the possibility of being stung at depth, which may result in secondary complications arising from pain and panic (decompression sickness, arterial gas embolisms etc.).

The most effective first aid treatment is immersion in near-scalding hot water. Because the venom is a heat labile protein immersion of an inflicted area in near scalding hot water dissolves the proteins and reduces the venom resulting in less pain for the victim. Secondary treatment should be sought as soon as possible to reduce the risk of infections.

4. Management Goals and Objectives

Due to the nature of the invasion of aquatic species in general and lionfish more specifically, it must be realized that a complete eradication of the species is impossible. Therefore a plan should be in place which will seek to actively manage lionfish in St. Maarten territorial waters. The main goal of this response plan is to adequately control the impact the species will have on the ecosystem level and with regards to the risk it poses to the community and to the local economy. Additional management goals and objectives include:

4.1 Coordination and communication with different agencies

Coordination with various agencies and local stakeholders is essential, particularly with the Federal and Island Government, health services, law enforcement, community centers, and the Tourism Office. Cooperation with various Marine Parks, conservation based foundations, and fisheries agencies within the region, such as the Reserve Naturelle, St. Kitts Nevis Fisheries Office, the Anguilla Department of the Environment, St. Eustatius National Parks, The Saba Conservation Foundation, and the Dutch Caribbean Nature Alliance is also essential to the response plan. Similarly, in order to contribute research of the local population to a wider Atlantic wide database on the lionfish infestation, communication and coordination will be established with REEF and NOAA in order to better understand the status of the infestation and to adjust management alternatives.

4.2 Education and outreach

In order to prepare all the stakeholders of the St. Maarten Marine Park for the lionfish invasion, extensive community outreach and education will be initiated. Stakeholders of the park should be made aware of the risk the animal poses and should know what actions should be taken with regards to reporting and handling the species. Also, a plan has to be in place to inform the general public, bringing about awareness and reducing levels of panic which might occur when a sighting is made. Also, communication should be established within the healthcare sector in order to fully prepare for possible envenomations. Training of ST. MAARTEN NATURE FOUNDATION staff is an essential component of the management plan. Staff will be trained how to properly capture and handle a live lionfish specimen.

4.3 Research and Development

Research and development is also a major goal of the response plan. In order to control the invasion on a local and regional level, research has to be done to determine effective control measures. Research is related to doing pre and post infestation surveys of juvenile prey fish and collecting specimens in order to analyze stomach contents and taking genetic samples.

4.4 Planning and assessment

Planning and assessment is another essential component to the response plan. Pre infestation planning with all stakeholders is central, particularly with users of the park with the highest risk of contact, e.g. divers and fishermen. Post infestation planning is also essential to assess the extent of the infestation and to put in place a culling program if the population reaches critical mass.

4.4 Control mechanism

As mentioned, controlling the infestation will be the most difficult aspect of the action plan to execute, because of the mobile nature of lionfish infestations and the limited resources available to the St. Maarten National Marine Park. Initial specimens reported will be collected for research, however if the species were to reach critical mass a controlled culling program may have to be implemented.

5. Management Actions

Management actions regarding the lionfish infestation are divided into pre species arrival and post species arrival. Both pre species arrival and post species arrival stages are divided into two phases which correspond to the ideal time frame for the implementation of a particular action (Table 1 and Table 2). Phase 1 actions in the pre species arrival stage will be the first actions to be taken upon approval of this response plan. Phase 2 actions will continue until the first sighting of the species. Upon confirmation of the first lionfish specimen in local waters implementation of the post species arrival stage will be initiated. Phase 1 of the post species arrival stage will be initiated immediately upon confirmation of the species in local waters and phase 2 actions will be implemented indefinitely. Some actions are both phase 1 and phase 2 actions.

Pre species arrival actions are primarily focused on education and outreach programs in order to increase awareness and vigilance amongst the population. Baseline prey fish surveying will also be conducted during pre-species arrival in order to allow for comparative data with regards to possible fish population effects due to lionfish predation.

Post species arrival management actions will be centered on controlling the infestation. Due to the nature of marine based exotic species infestations the controlling of lionfish will be the greatest challenge. Initially, all specimens reported will be captured using methods that will allow for genetic and stomach content analysis. However, as the numbers of specimens grow management actions may have to shift towards a more involved culling program. The progress of the infestation should be carefully monitored and recorded for eventual sighting increases and more aggressive action should be initiated when this occurs such as bounties being placed on the species. Post species

arrival management will also include the continuing of education and outreach programs, stakeholder training, and the continuation of fish surveys.

5.1 Pre Species Arrival Management Actions

5.1.2 Education and Outreach

Education and outreach are essential to this response plan in order to create awareness on the nature of the infestation, in order to make stakeholders prepared for species arrival, in order to implement control mechanisms, and so that all management activities are clearly outlined amongst all stakeholders.

Pre species arrival education programs will be focused primarily on those stakeholders that will come in closest contact with the species. Subsequent outreach and education programs will then be focused on the general public. Stakeholders most closely involved in initial contact will be fishers, divers and snorkelers, and ST. MAARTEN NATURE FOUNDATION Staff.

5.1.3 Education and Outreach for Fishers (Phase 1 and Phase 2 Action)

It is most likely that the first lionfish specimen will be reported by a fisher. It is therefore essential that fishers are made aware of the nature of the infestation, species identification, specimen handling, and catch reporting and delivery to ST. MAARTEN NATURE FOUNDATION offices. Flyers and posters (Appendix F) will be distributed to fishers in order to give baseline information before an informative and training session is established. ST. MAARTEN NATURE FOUNDATION has workshops planned centered on fisher education and outreach and a significant portion of these workshops will be devoted to lionfish education. It is also essential that fishers, once a lionfish is caught, deliver the specimen to ST. MAARTEN NATURE FOUNDATION Offices for specimen analysis. Another central component of fisher education is first aid treatment in case of an envenomation. Because fishers will inevitably get stung by a lionfish, it is essential that they are aware of first aid treatment. This information will be given to fishers during workshops and information sessions as well as in posters and flyers.

5.1.4 Education and Outreach for Divers (Phase 1 and Phase 2 Action)

Divers are another essential stakeholder with regards to the lionfish invasion. After fishers, divers are the next most likely reporter of a lionfish sighting in local waters. Divers will likely have less close contact with a specimen than a fisher would, however the nature of dive tourism, with its high turnover of non-resident divers, will influence specimen reporting. It is essential that when a diver reports a specimen he or she makes information available such as location of sighting, depth, number of specimens, and activity when sighting was recorded. This information will be made available in posters and flyers (Appendix F) as well as during information sessions.

5.1.5 Education and Outreach ST. MAARTEN NATURE FOUNDATION Staff (Phase 1 and Phase 2 Action)

ST. MAARTEN NATURE FOUNDATION staff will be on the frontlines of the battle to control the lionfish invasion. Staff training will be conducted extensively in order to familiarize staff with specimen capturing method, specimen data collection, and reportage of specimen sightings to involved agencies (NOAA and REEF). To facilitate the process of responding to a lionfish sighting a Lionfish Action Protocol has been developed (Appendix A) so that all staff is clear in the actions which should be taken. The Lionfish Action Protocol includes the Lionfish Reporting Form, The Lionfish Specimen Collection Protocol, Lionfish Sweep protocols, Prey fish Survey Data Sheets, and the Lionfish Processing Sheet. Several dry runs will be made in order to familiarize staff with the steps outlined in the protocol.

5.1.6 Public Outreach (Phase 1 and Phase 2 Action)

Public Outreach will be centered on information dissemination through the distribution of flyers and posters, through Public Service Announcements given on the radio, radio interviews with ST. MAARTEN NATURE FOUNDATION staff on the infestation issue, and information sessions with the general public.

5.1.7 Coordination with other Agencies and Organizations (Phase 1 Action)

Due to the fact that the lionfish infestation is a cross border issue that crosses over territorial waters, close cooperation with other organizations and Organizations both nationally and internationally is essential. On an island level cooperation with the Island Government, particularly with the Commissioner of Environment, is the starting point for dissemination of the action plan. Outreach with other government Organizations such as the Harbor Office, DROB/ VROM, the Healthcare Sector, and the Government Information Service will be done via the dissemination of this response plan and subsequent follow-up consultations. Cooperation and coordination with the Reserve Naturelle will be essential as both sides of the island share a common coastline

On a Dutch Caribbean level close cooperation with Marine Parks of Saba and St. Eustatius will be essential in controlling the infestation. Proper communication and management of the infestation through the comparison and recommendations made by the three Dutch Windward Islands on their respective Response Plans and subsequent synthesis of respective plans would serve as a general response mechanism to adequately control and manage not only the lionfish infestation but also other introduced exotic marine organisms should they occur. It should also be noted that close cooperation will be necessary with the fisheries authority in St. Kitts and Nevis and St Bartholomew due to the close geographic location between those respective islands and St. Maarten. If a sighting is confirmed on either island this should be reported immediately to the authorities involved; if a specimen is confirmed on St. Maarten it will in all likelihood be present in Anguilla or St Bartholomew and vice versa. Similarly cooperation with the ABC islands and the Dutch Caribbean Nature Alliance should result in a uniform response plan for the infestation in the Dutch Caribbean.

On an international level all reports of confirmed sightings will be delivered both to the Reef Environmental Education (REEF) and to the National Oceanographic and Atmospheric Association (NOAA) who both maintain an international database on sightings throughout the Atlantic Basin. All sightings made on St. Maarten and in the Dutch Caribbean for that matter should all be reported to both REEF (<http://www.reef.org/programs/exotic/lionfish>) and NOAA (<http://www.ccfhr.noaa.gov/stressors/invasivespecies/lionfish>) in order to contribute to the Atlantic wide lionfish database.

5.1.8 Infestation Research and Development: Prey Fish Surveying (Phase 2 Action)

The initial implementation of research into the local lionfish infestation and the development of new control strategies will be centered on prey fish monitoring in the pre species arrival phase. Prey fish monitoring is done in the initial phase in order to get a baseline estimate of juvenile species that have been shown to form the central diet of lionfish in the Atlantic basin (Green and Cote, 2009). These species also include the juveniles of some of the most commercially important fish for the local fishery (Green and Cote, 2009). The lionfish monitoring data forms to be used are based on the forms developed by S. Green (2009) and will include data on species descriptions, dive site descriptions, substrate composition and structure. These data will be used to gauge the overall changes the species will have on prey fish and commercially important species. Staff will be trained in surveying methods and techniques.

5.1.9 Planning and Assessment: Lionfish Action Protocols and Lionfish Sweeps (Phase 1 and Phase 2 Action)

Lionfish Action Protocols (Phase 1 Action)

In the pre-species arrival phase, planning and assessment will be limited to the development of Lionfish Action Protocols for the planning phase and Lionfish Sweeps for the assessment phase. The Lionfish Action Protocols will include a Lionfish Reporting Protocol, a Specimen Delivery Protocol, A Specimen Processing Protocol, a Specimen Collection Protocol and Lionfish Reporting Forms to be filled in when a sighting is made. Staff will be trained in how to specifically fill in and apply the various protocols when necessary.

Lionfish Sweeps (Phase 2 Action)

During the various working dives conducted by the St Maarten Nature Foundation in daily operations, brief lionfish sweeps will be made. Lionfish sweeps, which involve monitoring dives looking particularly for specimens under ledges and in crevices, will increase vigilance for sightings of the species and will also stress the arrival of the species with the Marine Park staff.

5.2 Post Species Arrival Management Actions

5.2.1 Control Mechanisms (Phase 1 and Phase 2 Action)

Due to the nature of aquatic infestations, controlling the lionfish invasion will prove to be the most difficult aspect of implementing this response plan. Marine aquatic invasions are by nature highly mobile and difficult to control, therefore prompt response to sighting reports is essential in the controlling of the species.

Initial control of the species will involve reporting about sightings and collecting as many specimens as possible. Collecting of specimens will be conducted using nets in order to increase catch success and reduce the possibility of divers being envenomated. The Specimen Collection Protocol should be carefully followed both to increase catch success and to reduce diver injury.

It is also essential that education and information sessions makes it abundantly clear that if a specimen is caught by fishers it should not be thrown back but should be brought into the office for processing and reporting purposes.

When the rate of species infestation grows, perhaps a more aggressive control mechanism should be initiated and steps should be taken in order to implement a controlled lionfish culling program. In areas where lionfish infestation has reached critical proportions, particularly in the Bahamas, a culling program involving a bounty on caught and delivered species has shown some signs of success (Green and Cote, 2009) and may be necessary for St. Maarten in the future. However, extensive consultations between stakeholders should be held, as well as a review of this response plan, before any steps towards a culling program be initiated.

5.2.2 Coordination with other Agencies and Organizations (Phase 1 Action)

As soon as a specimen is confirmed and species arrival has been established, it is of high importance that all agencies and organizations involved are made aware. Government entities as mentioned in the pre species arrival stage should be made aware as soon as species level confirmation is made of the presence of lionfish. Coordination between these agencies as the infestation develops is essential, particularly with regards to control mechanisms and the exchange of information.

5.2.3 Infestation Research and Development: Specimen Analysis and Continued Prey Fish Surveying

Specimen Analysis (Phase 1 and Phase 2 Action)

In order to gauge the level and impact the lionfish infestation is having on local ecosystems; all specimens should be analyzed through the delivery of DNA samples and stomach content analysis.

Live fish should be euthanized in Eugenol solution and preserved on ice until the specimen can be processed. Processing should occur no later than 24 hours after capture (Green and Cote, 2009). A genetic sample should be taken. Genetic sampling involves taking a sample of the ventricle fin and storing it in a vial containing DMSO solution. Vials will be preserved until a regional framework has been developed for DNA analysis of the collected tissue samples. DNA analysis will give information regarding the origin of species introduction and spread and will assist in the development of additional control mechanisms (Albins and Hixon 2008).

Stomach content analysis is essential in determining which prey fish are actively being preyed on by lionfish. Stomach content will be analyzed based on the prey fish species monitored during prey fish surveying in order to compare and contrast the data from both (Green and Cote, 2009). Stomach contents will be precisely recorded on the Lionfish Processing Form and the data will be shared with all agencies involved.

Continued Prey Fish surveying (Phase 1 and Phase 2 Action)

Prey fish surveying will continue post species arrival in order to determine level of infestation and effects that the infestation is having on the local coral reef ecosystem. Continued surveying will be based on the forms developed by S. Green (2009). During the post species arrival phase, data collected through prey fish surveying and stomach content analysis will be compared in order to get a clearer picture on the ecological impacts lionfish are having on local fishery.

5.2.4 Continued Education and Outreach (Phase 1 and Phase 2 Action)

Once in the post species arrival phase, education should be centered on continued awareness and vigilance and emphasis should be placed on preventive measures with regards to envenomations. It should also be made clear that any species caught should not be thrown back into the sea but should be brought into ST. MAARTEN NATURE FOUNDATION offices for reporting purposes and for processing the specimen. Continued Education and Outreach will also be conducted through the distribution of flyers and posters and through Public Service Announcements. ST. MAARTEN NATURE FOUNDATION staff will serve as the information point for all questions regarding the lionfish infestation and all action to be taken with regards to the infestation.

6. Implementation Table

Table 1: Pre Species Arrival Implementation Table (Phase 2 to be carried out until confirmation of species arrival)

Action	Phase1	Phase 2
Education and Outreach for Fishers	x	x
Education and Outreach for Divers	x	x
Education and Outreach ST. MAARTEN NATURE FOUNDATION Staff	x	x
Public Outreach	x	x
Coordination with other Agencies and Organizations		x
Infestation Research and Development: Prey Fish Surveying		x
Planning and Assessment: Lionfish Action Protocols	x	
Planning and Assessment: Lionfish Sweeps		x

Table 2: Post Species Arrival Implementation Table (once phase action is implemented, action is to be carried out indefinitely)

Action	Phase1	Phase 2
Control Mechanisms	x	x
Coordination with other Agencies and Organizations	x	
Infestation Research and Development: Specimen analysis	x	x
Infestation Research and Development: continued prey fish surveying	x	x
Continued Education and Outreach	x	x

7. Conclusions and Recommendations

The invasive Lionfish will soon be arriving in the territorial waters of St. Maarten, posing a threat not only to the marine ecosystem but also to local fishery and public health. This response plan serves as a reference for management actions to be taken with regards to the infestation. Steps in this plan act to serve as a guideline for those actions with regards to ecological research on species effects, management, controlling, and public education and outreach. The protocols included in the appendices of this plan serve as a standard for collection, reporting, and processing information regarding the lionfish invasion.

Complete eradication of the species is not an option due to the mobile nature of aquatic invasions. Therefore cooperation and communication with organizations and institutions on a regional as well as local level is essential for the sound management of the species.

It is possible that Control Mechanisms will shift from the collection of all reported specimens to a controlled culling program if lionfish populations reach a critical mass. However, before such a program can be initiated this action plan may need to be revised and adapted in order to accommodate the introduction of a culling program. Legalities regarding the introduction of a culling program, which may include culling the use of spear fishing equipment, will have to be reviewed and discussed extensively.

Another management option which may be introduced is the commercial fishery of lionfish. Lionfish meat is quite palatable and some places have already introduced this as a management option. This option should also be reviewed and the response plan adjusted to accommodate it in the case lionfish populations reach a critical mass.

Lionfish are causing negative effects to the ecosystems of the Atlantic basin through the irresponsible action of man. It must be realized that it is due to human influence that the species has become an invasive organism, not due to any inherent maliciousness. Remembering this fact should be the central tenet of managing the impending arrival of lionfish within the St. Maarten's Territorial Waters.

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Appendix A: Lionfish Action Protocol

Lionfish Action Protocol

This protocol outlines the actions to be taken in the event of a reported lionfish sighting, on lionfish collection dives, on preyfish surveys, and during specimen processing. Lionfish are toxic animals that cause a very painful sting. All actions should be completed with extreme caution. IF STUNG BY A LIONFISH RINSE AREA IN NEAR SCALDING HOT WATER FOR THIRTY MINUTES. APPLY DISINFECTANT SUCH AS IODINE, HYDROGEN PEROXIDE SOLUTION, OR RUBBING ALCOHOL AND SEEK EMERGENCY MEDICAL ATTENTION IMMEDIATELY.

Follow the outlines of this protocol precisely.

If a lionfish is reported by phone or in person:

FILL IN LIONFISH SIGHTING FORM:

1. Note name, address, and contact information of the person reporting
2. Note activity of person when sighting was made (fishing, diving, snorkeling, swimming etc.)
3. Note time of sighting
4. Note location where lionfish was reported by site/ location name
5. Note particulars on sighting location and nature of sighting i.e. depth, location on site where lionfish were spotted, number of specimens, and activity of specimens while sighted.

If a lionfish is brought into ST. MAARTEN NATURE FOUNDATION offices or collected:

FILL IN LIONFISH SIGHTING FORM:

1. Note name, address, and contact information of the person delivering specimen
2. Note location where specimen was caught
3. Note time when specimen was caught
4. Note fishing method used when specimen was caught (hook and line, fish traps, spearfishing)
5. Note bait type used to catch specimen
6. Store specimen in a secure cooled area such as ice filled cooler or fridge until specimen can be processed

7. Follow processing protocol while processing

LIONFISH CAN REMAIN ALIVE FOR QUITE SOME TIME OUT OF THE WATER. DO NOT ASSUME THAT A LIONFISH OUT OF THE WATER FOR A SIGNIFICANT PERIOD OF TIME IS SAFE TO HANDLE. ALWAYS USE EXTREME CAUTION WHILE HANDLING LIONFISH. A LIONFISH CAN STILL STING WHEN DEAD.

When on species collection:

Items to bring on collection trips (in addition to usual dive related equipment):

1. **Lionfish Specimen Collection Data Sheets**
2. Collection nets
3. clipboard
4. PVC gloves
5. Cooler filled with ice
6. Thermos with hot water or hot packs (in case of sting)
7. First Aid kit (already onboard but double check)
8. Pliers

While on dive:

One member of dive the team designated as specimen collector (carries nets and wears gloves); one diver to photograph specimen and record information on Lionfish Specimen Collection Data Sheets, other divers to act as safety divers and to ensure a visual is always kept on specimen

Follow collection procedure as learned in practical training

When back on board:

Remove specimen using pliers and wearing PVC gloves

Store specimen in cooler

If specimen needs to be euthanized use Eugenol Solution

When On Preyfish Surveys and Lionfish Sweeps:

Items to Bring:

- 1. Preyfish Survey Data Sheets**
2. Tape for Transect Lines
3. Clip Boards
4. Pencils

Survey Dives should be conducted by a minimum group of 4 divers.

Two divers lay out 50 m transect line and wait at the end of the transect line. Diver counting fish species waits five minutes after transect line is laid and then counts fish species recording information on data sheets, another diver accompanies recording information on substrate composition. Transect line is rolled up by divers who rolled out line initially.

When on Lionfish Sweeps:

On day to day diving operations lionfish sweeps can be conducted. During lionfish sweeps pay attention to overhangs, under ledges, and in overhead areas for the presence of lionfish. If a lionfish is sighted note depth, dive site, water temperature and approximate location on the reef.

ALWAYS PRACTICE SAFE DIVING PROCEDURES

When lionfish specimen is being processed:

Items to bring while processing:

- 1. Lionfish Processing Data Sheets**
2. Measuring tape
3. Filet knife
4. Container for stomach content analyses
5. Vials containing DMSO solution for genetic samples
6. Surgical Scissors
7. Latex Gloves
8. Tweezers
9. Dissection board

Use lionfish data sheet to record relevant information

Safely discard carcass after processing (one specimen should be preserved in formaldehyde solution for display purposes)

LIONFISH CAN REMAIN ALIVE FOR QUITE SOME TIME OUT OF THE WATER. DO NOT ASSUME THAT A LIONFISH OUT OF THE WATER FOR A SIGNIFICANT PERIOD OF TIME IS SAFE TO HANDLE. ALWAYS USE EXTREME CAUTION WHILE HANDLING LIONFISH. A LIONFISH CAN STILL STING WHEN DEAD.

Appendix B: Lionfish Sighting Form

Lionfish Sighting Form

Please fill out precisely

Date: (dd/mm/yy) ____/____/____

Time: _____

Data recorded by: _____

Sighting number: _____

Name of reporter

First: _____ Last: _____ M.I: _____

Address:

Location of sighting:

_____ Lat: _____ Long: _____

Date of sighting: (dd/mm/yy) ____/____/____

Activity while sighted

- ☐ Diving
- ☐ Fishing
- ☐ Swimming
- ☐ Other (Specify _____)

If sighted while diving note site: _____

Depth (m): _____

Location at dive site (bearing, landmarks etc.)

_____ Lat: _____ Long: _____

Number of specimen observed: _____

Activity of specimen when observed

If caught while fishing note catch location

_____ Lat: _____ Long: _____

Number of specimen caught: _____

Fishing method:

- ☐ Line and hook trolling
- ☐ Line and hook bottom fishing
- ☐ Fish traps (fish pots)
- ☐ Spearfishing
- ☐ Other (Specify _____)

Status of specimen

- ☐ Live
- ☐ Dead

Has specimen been brought into office? Y/N

Specimen placed in secure, cooled container? Y/N

If specimen is live euthanize in Eugenol solution

LIONFISH CAN REMAIN ALIVE FOR QUITE SOME TIME OUT OF THE WATER. DO NOT ASSUME THAT A LIONFISH OUT OF THE WATER FOR A SIGNIFICANT PERIOD OF TIME IS SAFE TO HANDLE. ALWAYS USE EXTREME CAUTION WHILE HANDLING LIONFISH. A LIONFISH CAN STILL STING WHEN DEAD.

Appendix C: Lionfish Specimen Collection Data Sheet

Lionfish Specimen Collection Data Sheet

NOTE: LIONFISH CAN REMAIN ALIVE FOR QUITE SOME TIME OUT OF THE WATER. DO NOT ASSUME THAT A LIONFISH OUT OF THE WATER FOR A SIGNIFICANT PERIOD OF TIME IS SAFE TO HANDLE. ALWAYS USE EXTREME CAUTION WHILE HANDLING LIONFISH. A LIONFISH CAN STILL STING WHEN DEAD. ALWAYS USE GLOVES AND NETS. USE NEAR SCALDING HOT WATER IF STUNG AND SEEK MEDICAL ATTENTION IMMEDIATELY.

Date: (dd/mm/yy) ____/____/____

Time: _____

Data recorded by:

Sighting number: _____

Location

Lat: _____ Long: _____

Depth (m): _____

Number of specimen: _____

Activity pre-catch:

- ☐ Passive
- ☐ Passive hunting
- ☐ Active hunting
- ☐ Other (Specify _____)

Specimen collected: Y/N

Appendix D: Preyfish Survey Data Sheets

Based on: S. Green 2009

Site:		Time:	Depth:
Date:		Length:	Duration:
Direction:		Temp:	Current & Vis:
Recorder name		Buddy name	
Species	Size (cm) & Count	Species	Size (cm) & Count
Chromis		Hamlet	
blue		barred	
brown		butter	
Wrasse		Damselfish	
bluehead		bicolor	
yellowhead		3 spot	
creole		longfin	
rainbow		dusky	
clown		Gobies	
slippery dick		masked/glass	
spanish hogfish		cleaning	
Parrotfish		sharknose	
princess		pepermint	
striped		goldspot	
redband		colon	
stoplight		bridled	
Bass/Basslets		pallid	
fairy		Blenny	
blackcap		saddled	
tobaccofish		diamond	
harlequin		Other	
Cardinalfish		sharpnose	
		puffer	
belted		dusky	
flame		squirrelfish	

Appendix E: Lionfish Processing Data Sheets

Based on: S. Green 2009

Date Specimen Processing: (dd/mm/yy)		Processed by:	Length of Specimen (cm):
Date Specimen Caught: (dd/mm/yy)			Genetic Sample Taken Y/N
Stomach Content Species		Stomach Content Species	
	Size (cm) & Count		Size (cm) & Count
Chromis		Hamlet	
blue		barred	
brown		butter	
Wrasse		Damselfish	
bluehead		bicolor	
yellowhead		3 spot	
creole		longfin	
rainbow		dusky	
clown		Gobies	
slippery dick		masked/glass	
spanish hogfish		cleaning	
Parrotfish		sharknose	
princess		pepermint	
striped		goldspot	
redband		colon	
stoplight		bridled	
Bass/Basslets		pallid	
fairy		Blenny	
blackcap		saddled	
tobaccofish		diamond	
harlequin		Other	
Cardinalfish		sharpnose puffer	
belted		dusky squirrelfish	
flame			

The Lionfish Are Coming!!



Lionfish do not belong in our waters and can have a very negative impact on our fish populations.

But there is more that you need to know!!

Come to the

Lionfish Presentation & Information Session

Where you will get more information
AND the opportunity to ask questions.

Location/ Time/ Date

Have you seen me?

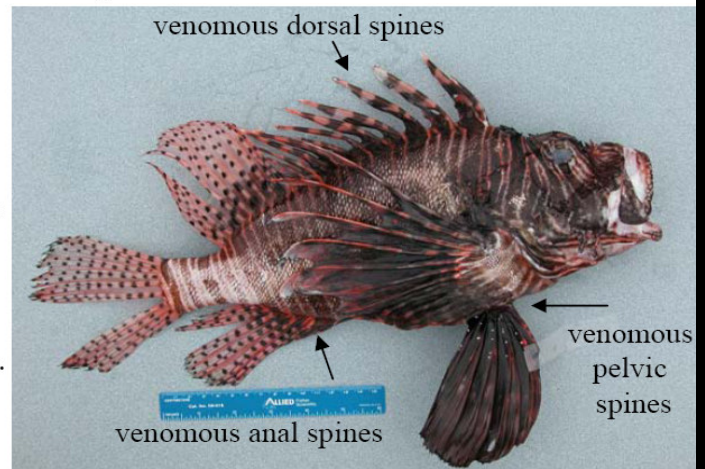


Lionfish underwater

Lionfish are a major threat to local fish species. Because fish do not see lionfish as a predator they have no natural defense against it. Lionfish can kill all the commercial fish in local waters, destroying the local fishing grounds.

IT IS VERY IMPORTANT THAT IF YOU SEE OR CATCH A LIONFISH YOU REPORT IT IMMEDIATELY TO ST. MAARTEN NATURE FOUNDATION: 5444267

The venomous Indo-Pacific 'Lionfish' is regularly observed in habitats within the southeast region (Florida to North Carolina) and the Bahamas. These fish are not native to Atlantic waters and may have a negative impact on native fish populations. **All of their spines are venomous and can cause extreme pain!** If stung, immerse wound in hot water and seek medical attention as soon as possible.



Identification: Lionfish have distinctive red, maroon, and white vertical stripes; fleshy tentacles above eyes and below mouth; fan-like pectoral fins, 13 long separated dorsal spines, 10-11 dorsal soft rays, 3 anal spines and 6-7 anal soft rays. An adult lionfish can grow as large as 18 inches.

Handle with Extreme Caution: If caught DO NOT throw fish back. Store in a secure container and report catch information including location, depth, and description to ST. MAARTEN NATURE FOUNDATION: 5444267

IF STUNG IMMERSE WOUND IN HOT WATER AND SEEK MEDICAL ATTENTION IMMEDIATELY

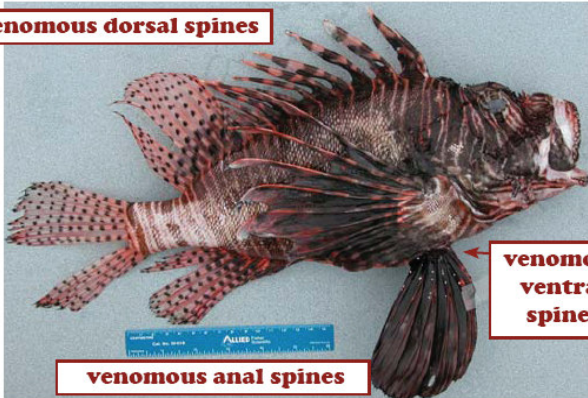
Source: NOAA Invasive Species Program



Last updated 05/22/2007

Divers, Have You Seen Me?

venomous dorsal spines

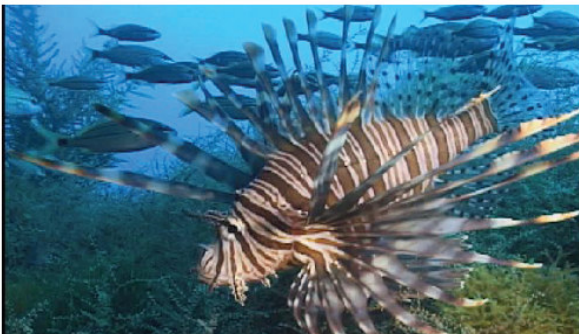


venomous ventral spines

venomous anal spines

Identification:

- Lionfish have distinctive red, maroon, and white vertical stripes;
- Fleshy tentacles above eyes and below mouth;
- Fan-like pectoral fins;
- 13 long separated dorsal spines;
- 10-11 dorsal soft rays;
- 3 anal spines;
- and 6-7 anal soft rays;
- An adult lionfish can grow as large as 18"



The venomous Indo-Pacific 'Lionfish' is regularly observed in habitats within the southeast region (Florida to North Carolina) and the Bahamas. These fish are not native to Atlantic waters and may have a negative impact on native fish populations. **All of their spines are venomous and can cause extreme pain!** If stung, immerse wound in hot water and seek medical attention as soon as possible.

Lionfish are a major threat to local fish species. Because fish do not see lionfish as a predator they have no natural defense against it. Lionfish can kill all the commercial fish in local waters, destroying the local fishing grounds.

IT IS VERY IMPORTANT THAT IF YOU SEE OR CATCH A LIONFISH YOU REPORT IT IMMEDIATELY TO ST. MAARTEN NATURE FOUNDATION: 5444267

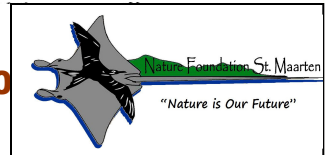
Recommendation: If you catch a lionfish be extremely careful, do not come in contact with the dorsal, anal or ventral

IF CAUGHT DO NOT THROW FISH BACK.

IF STUNG IMMERSE WOUND IN HOT WATER AND SEEK MEDICAL ATTENTION IMMEDIATELY

Handle with Extreme Caution: If sighted report to ST. MAARTEN NATURE FOUNDATION: 5444267 or 5270490

Source: NOAA Invasive Species Program



1:

