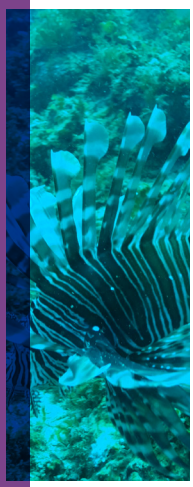


Regional Strategy for the Control of Lionfish in the Mesoamerican Reef (MAR)

Published by: MAR Fund

This publication should be cited as: 2014 C Rodriguez, M González, C González, A Rivas, F Gourdin, R Gómez, R Torres, J Ordóñez, V Dávila, (Regional Strategy for the Control of Lionfish in the Mesoamerican Reef. 53 pp.)

Cover photos: MAR Fund, DIPESCA Guatemala

Compilation of texts: MAR FUND María José González, Claudio González, Ana Beatriz Rivas, Carlos Rodríguez Olivet, CAR-SPAW Franck Gourdin, ICRI Ricardo Gómez, RCDR Rubén Torres, FCG Jorge Ordóñez, CONAP Vanessa Dávila.

Printed in: Mapas de Guatemala

Design and Layout: José Miguel Leiva, National Council of Protected Areas - CONAP - Guatemala, Outreach and Education Department.

Comments and inquiries: Claudio González *cgonzalez@marfund.org*
Carlos Rodríguez Olivet *crodriguez@marfund.org*

Special thanks to Jennifer Chapman/ Blue Ventures

The consultation process as well as the process and development of the Regional Strategy has been possible thnaks to the financial support from the German Development Cooperation through KfW from the United Nations Environment Program and Specially Protected Areas and Wildlife Regional Activity Center.

CONTENT

Sponsors of the Regional Workshop for the Strategy

United Nations Environmental Program
Specially Protected Areas and Wildlife
Regional Activity Center
www.car-spaw-rac.org

National Commission of Natural Protected Areas, Mexico
www.conanp.gob.mx

Reef Check Dominican Republic
www.reefcheckdr.org

Mesoamerican Reef Fund
www.marfund.org

International Coral Reef Iniciative
www.icriforum.org

Authors

Authors

We thank the following colleagues whose discussions and suggestions improved this document.

MEXICO

Alfredo Arellano	CONANP	*arellano@conanp.gob.mx*
José Juan Pérez	CONANP	*jperez@conanp.gob.mx*
María del Carmen García	CONANP	*mcgarcia@conanp.gob.mx*
Raúl Villaseñor	CONAPESCA	*rvillasenort@yahoo.com.mx*
Ricardo Gómez	CONANP	*rglozano@conanp.gob.mx*
Tomás Camarena	CONANP	*tcamarena@conanp.gob.mx*

GUATEMALA

Ana Giró	HRI	*anagiro@gmail.com*
Benedicto Lucas	CONAP	*benelucas@gmail.com*
Carlos Marín	DIPESCA	*cfmarin1058@gmail.com*
Elisa Areano	Mundo Azul	*eareano@msn.com*
Emerson Paz	CONAP	*epazduran@gmail.com*
Jorge Ordóñez	FCG	*jordonez@fcg.org.gt*
José Cajas	CONAP	*jcajas@conap.gob.gt*
José Luis Echeverría	CONAP	*otecbio@conap.gob.gt*
José Martínez	CONAP	*josemartinezmencos@yahoo.com*
Manoel Cifuentes	DIPESCA	*manoeljose@gmail.com*
María Mercedes López	IARNA/URL	*mmlopez-selva@url.edu.gt*
Mario Díaz	MARN	*mdiazcbm@marn.gob.gt*
Sebastián Marcucci	MAGA	*smarcucci@maga.gob.gt*
Sergio Andrino	DIPESCA	*sergio.andrino@msn.com*
Sergio Hernández	CONAP	*sergioesmas@gmail.com*
Sergio Ruano	MARN	*sruano@marn.gob.gt*
Silja Ramírez	FUNDAECO	*s.ramirez@fundaeco.org.gt*
Tannia Sandoval	CONAP	*tannia_tpsg@hotmail.com*
Vanessa Dávila	CONAP	*vanekat13@gmail.com*
Víctor Gudiel	CECON	*vgudielcorona@gmail.com*

BELICE

Celia Mahung	TIDE	*cmahung@tidebelize.org*
Isaias Majil	FISHERIES DEPT	*isaiasmajil@yahoo.com*
Jennifer Chapman	Blue Ventures	*jen@blueventures.org*
Natalie Rosado	PACT	*nrosado@pactbelize.org*
Samir Rosado	CZMAI	*coastalresearch.czmai@gmail.com*
Tanya Barona	TIDE	*tbarona@tidebelize.org*

HONDURAS

Giacomo Palavicini	Roatán Marine Park	*giaco.palavicini@roatanmarinepark.net*
Ian Drysdale	HRI	*iandrysdale@gmail.com*
Rosalina Martínez	ICF	*rosalinamartinez17@yahoo.com*

REGIONAL ACTORS

Ana Beatriz Rivas	MAR Fund	*arivas@marfund.org*
Carlos Rodríguez Olivet	MAR Fund	*crodriguez@marfund.org*
Claudio González	MAR Fund	*cgonzalez@marfund.org*
Franck Gourdin	CAR-SPAW UNEP	*franck.gourding.carspaw@guadeloupe-parcnational.fr*
Gina De Ferrari	WWF	*gina.deferrari@wwfus.org*
María José González	MAR Fund	*mjgonzalez@marfund.org*
Patricia Cabrera	MAR Fund	*pcabrera@marfund.org*
Rubén Torres	REEF CHECK DR	*ruben@reefcheck.org*
Ricardo Gómez	RLC - ICRI	*icri@env.go.jp*

Regional Actors

ICRI will participate in this iniciative as the international institution that promote dialogue among actors and sectors related to the conservation of the coral reef worldwide.

The Regional Strategy for the Control of Lionfish in the Mesoamerican Reef has been based on the following documents:

- Gómez Lozano, R., L. Anderson, J.L. Akins, D.S.A. Buddo, G. García-Moliner, F. Gourdin, M. Laurent, C. Lilyestrom, J.A. Morris, Jr., N. Ramnanan, and R. Torres. 2013. Estrategia regional para el control del Pez León invasor en el Gran Caribe. Iniciativa Internacional sobre los Arrecifes Coralinos. 32 pp.

- Morris, J.A., Jr. (Ed.). 2013. El pez león invasor: guía para su control y manejo. Gulf and Caribbean Fisheries Institute Special Publication Series, No.2, Marathon, Florida, USA. 126 pp.


© DIPESCA

Acronyms

CBD	Convention on Biological Diversity
CCAD	Central American Commission on Environment and Development
CECON	Center for Conservation Studies (USAC)
CONAP	National Council of Protected Areas (Guatemala)
CONANP	National Commission of Natural Protected Areas (México)
CONAPESCA	National Commission of Fisheries and Aquaculture (México)
CORAL	Coral Reef Alliance
CZMAI	Coastal Zone Management Auhtority and Institute
DIPESCA	Fisheries and Aquaculture Regulations Authority (Guatemala)
FUNDAECO	Foundation for The Eco-Development and Conservation
HRI	Healthy Reefs Initiative
IARNA/URL	Institute of Agriculture, Natural Resources and Environment of the Rafael Landivar University
IAS	Invasive Allien Species
ICF	National Institute of Forest Conservation and Development, Protected Areas and Wildlife (Honduras)
ICRI	International Coral Reef Iniciative
KfW	German Development Bank
MAR	Mesoamerican Reef
MARN	Ministry of Environment and Natural Resources (Guatemala)
MAR FUND	Mesoamerican Reef Fund
MPA	Marine Protected Area
NOAA	National Oceanic and Atmosferic Administration
OSPESCA	Organization of the Fisheries and Aquaculture
PACT	Protected Areas Conservation Trust
RCDR	Reef Check Dominican Republic
REEF	Reef Environmental Education Foundation
RMP	Roatan Marine Park
SPAW-RAC	Specially Protected Areas and Wildlife Regional Activity Center
TIDE	Toledo Institute for Development and Environment
UNEP	United Nations Environmental Program

Glossary

Climate Change: The UN Framework Convention on Climate Change (UNFCCC), Article 1 defines ‘ climate change ‘ like’ changing attributed directly or indirectly to human activity that alters the composition weather of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods ‘ . The UNFCCC distinguishes between “climate change” attributable to human activities altering the atmospheric composition, and “climate variability “attributable to natural causes.

Meristic characters: : Countable traitsused to describe species of Fish. For example: number of vertebrae, fin rays, etc.

Ciguatera: Is the toxin responsible for the food-borne illness, Ciguatera Fish Poisoning. It is produced by microscopic organisms living in tropical and subtropical waters that associate with macroalgae.

Warning Coloration: Bright coloration to advertise the possession of chemical or physical defenses against predation. It is most common form of aposematism, which can include a range of conspicuous signals, e.g. sound, smell.

Invasive alien species: Species that have been introduced or have spread beyond their natural ranges and that threaten the native biodiversity of infested ecosystems. Alien invasive species (Ing .) ; Espèce exotique envahissante (Fr.).

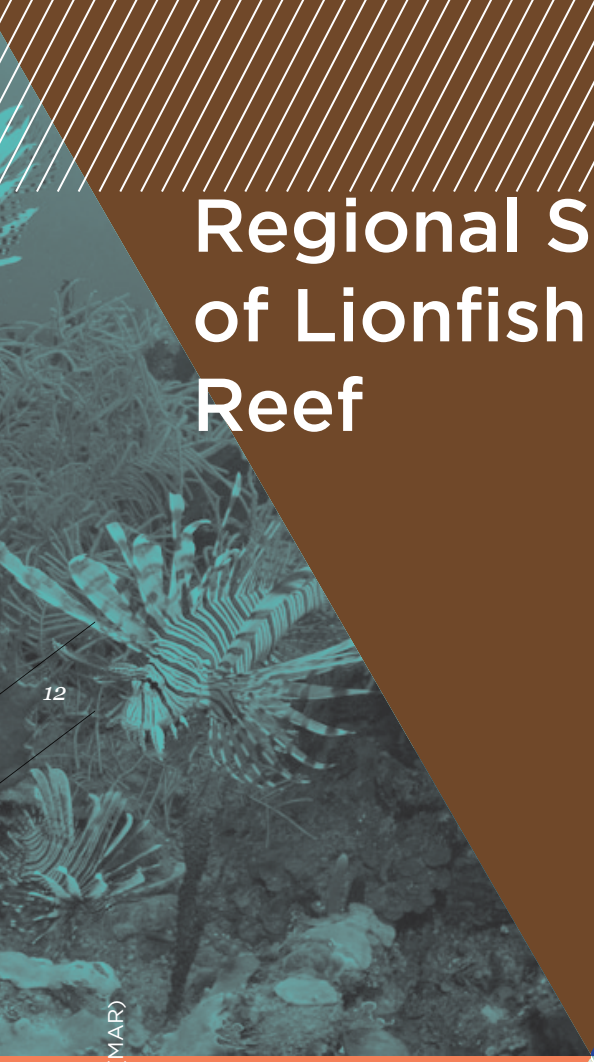
Hawaiian sling: A device used in spearfishing. For purposes of this strategy, this term refers to the device that is used to hunt lionfish. The energy of this device is stored in a rubber tube axis instead of a wood or fiberglass.

Lessepsian (Migration): Invasion of species from the Red Sea (Eritrean and Indo-Pacific) entering the Mediterranean through the Suez Canal. By Ferdinand de Lesseps, the main promoter of the construction of the Canal. Lessepsian (Ing.); Lessepsienne (Fr.).

Scorpionfish: Fish family Scorpionidae, commonly known as stonefish, scorpionfish and lionfish, possessing venomous dorsal, anal and pelvic spines. Included in the Scorpaeniformes order, with predominantly marine species and distributed throughout tropicals and temperate waters. Popular aquarium fish. First appeared in the fossil record in the Paleocene, during Terciarioinferior.

Reef resilience: The resilience of coral reefs is the biological ability of coral reefs to recover from natural disturbances such as storms and bleaching episodes. Resilience refers to the ability of biological and social systems to overcome the stresses and strains to maintain Key features through resistance or adaptation to change.

Regional Strategy for the Control of Lionfish in the Mesoamerican Reef



© DIPESCA

© DIPESCA

EXECUTIVE SUMMARY

In January 2010, in recognition of the seriousness of the invasion of lionfish and its impact on coral reefs and local communities, the 24th General Conference of the International Coral Reef Initiative (ICRI) decided to create an *Ad-hoc* committee to develop a strategic plan to control lionfish in the Wider Caribbean. The strategy was designed in consensus between several regional and national stakeholders to take advantage of existing programmes and efforts in order to minimise the effects of lionfish in the Wider Caribbean region and to provide a framework for action to facilitate a concerted regional response to the threat of lionfish.

Since the lionfish invasion affects not only one but several countries in the Wider Caribbean, including countries of the Mesoamerican Reef System, and in order to add to previous efforts, representatives of the countries that shared the region of the Mesoamerican Reef––MAR––(Mexico, Belize, Guatemala, and Honduras) met in Guatemala City on May 22 and 23, 2014 to familiarize with the strategy adopted by the countries of the Wider Caribbean in response to this threat, in order to initiate the development of a strategy to control lionfish in the MAR.

This workshop was conducted with the financial support of the German Cooperation through KfW, the United Nations Environment Program, (UNEP) SPAW-RAC, MAR Fund, and with technical support of CONANP of Mexico and RCDR.

As a result of the workshop, participants decided to establish the MAR Regional Committee to control lionfish under the same objectives as the strategy for the Wider Caribbean, and keeping coherence between both strategies. The organizations represented in the workshop were established as active members of the Regional Committee. Each country appointed a focal point to monitor the design and implementation of the Regional Strategy, which has been designed as a platform that will enable countries to develop and implement their National Action Plans.

Actions outlined in the proposed MAR strategy are mainly oriented to the pursuit of interagency and inter-sectorial coordination, education and awareness-raising among different actors and sectors, control related to capacity building in the capture of lionfish and techniques to handle it, as well as incentives and marketing and publicity to promote human consumption of the species.

The MAR strategy includes a series of actions oriented to interagency coordination at regional, national and local level, which are aimed at uniting programmes for the control and management of the species. Proposed actions are oriented to: research, management, control, rules and regulations and national policies to support emergency actions needed to address the threat strategically and from the political, economic, social, cultural and environmental fields. This has the purpose of reducing impacts from the presence of lionfish and increasing the resilience of reefs in the Mesoamerican region.

Implementation of the strategy will require the participation of governments at national and local level; business, community, environmental and cultural sectors and all sectors involved in education and dissemination as well as in national and international cooperation in each country, in order to achieve a united impact in the short, medium and long term. Coordination with CCAD and OSPESCA will provide institutional support to the Strategy at the level of ministries represented in these regional bodies, as there are actions within the regional action plan that need government support and promotion.

1. REGIONAL STRATEGY

This strategy provides a directed framework for action shared amongst the four countries encompassing the Mesoamerican Barrier Reef. These agreed-upon regional actions will enable the development of national-level Action Plans, for the ultimate realization of broader regional objectives.

1.1 Foundations and principles

FOUNDATIONS

The red lionfish is the first invasive species of coral reef fish to establish within the wider Caribbean region, where it threatens coral reef ecosystems as a whole, as well as associated goods and ecosystem services upon which a large proportion of the coastal communities depend. Though complete eradication is no longer considered possible, effective control measures can be applied in specific areas. Essential conditions for the success of this task include thorough understanding of the problem in all sectors, as well as the coordination and collaboration between affected communities, research institutions, governmental bodies, private sector and technical experts.

The intent of this strategy, shared with the Regional Strategy for the Control of Invasive Lionfish in the Wider Caribbean Region, is to facilitate this collaboration in order to provide a framework for action to:

1. Promote collaboration between relevant actors and sectors associated with the threat and its control and management, monitoring progress through assignment of time-bound responsibilities;
2. Foster and facilitate frequent sharing of experiences, field methods and tools for research and monitoring;
3. Reduce costs and avoid duplication of efforts through the development of regional programmes with shared resources;
4. Guide the efforts of researchers, non-governmental organisations and donors through detailed programmes, initiatives and projects, in order for their investments to have maximum impact for the control of the species;

5. Ensure activities are coherent and complementary across all levels and between all sectors;
6. Devise the political activities and regulations necessary to support the strategic activities for lionfish control and management; and
7. Promote binding activities related to policy, regulations and national legislation to combat the threat of lionfish.

The Strategy considers existing recommendations for regional and international organisations, associated with Aichi Targets, the Convention for Biological Diversity, the International Coral Reef Initiative and institutional mandates at the regional level stemming from the CCAD and OSPESCA. Both regional institutions not only respond to institutional mandates, but also to policy and regional strategies and initiatives related to the conservation and management of natural resources and biodiversity.

Some of the instruments that must be respected as part of this Strategy are as follows:

ALIDES: The Alliance for Sustainable Development of Central America was adopted by the heads of government of Central American countries in October 1994 to achieve development, by means of a progressive process of change in human quality of life, which denotes economic development that considers social equality, the transformation of production methods and consumption patterns, supported by a balanced ecology, a vital foundation to the region.

ERB: The Regional Strategy for the Conservation and Sustainable Use of Biodiversity in Mesoamerica seeks to promote and facilitate the cooperation and coordination of activities in the region in order to attain the understanding, valuation, conservation and sustainable use of biodiversity in the Mesoamerican region, in harmony with national policies, strategies and action plans as well as the international agenda of biodiversity.

ERAS: The Agro-environmental and Health Regional Strategy promotes an intersectorial mechanism for agro-environmental governance, with emphasis on the sustainable management of land, biodiversity, climate change, agro-environmental enterprise and healthy lifestyles, in an approach that contributes to sustainable human development.

ERCC: The Regional Climate Change Strategy is a result of an intensive and dynamic process, with consultation and contribution from both national and regional levels, representing a flexible instrument and guide for the SICA countries. The ERCC hopes to become the coordinated and evolutionary instrument that will allow the CCAD to advance in agreement with its mission for development of a cooperative and integrated environmental system that contributes to resisting threats and taking advantage of opportunities presented by climate change and variability in the region. Furthermore, it provides an advisory instrument for regional activities to complement and add value to national actions.

PACADIR: The Regional Plan for Hydric Resources represents a combination of strategies and actions that guide and coordinate development of hydric reachness possessed by Central America aligned to the concepts of sustainable development, particularly within shared and transboundary watersheds.

Global legislative tools for the sustainability of fisheries resources:

The Law of the Sea (El Derecho del Mar): The United Nations Convention of the Law of the Sea desires "a spirit of mutual understanding and cooperation, all issues relating to the law of the sea and aware of the historic significance of this Convention as an important contribution to the maintenance of peace, justice and progress for all peoples of the world."

Agreement on Fisheries and Aquaculture (Acuerdo sobre Pesca de Altura): This Agreement has been promoted in the United Nations Convention on the Law of the Sea relating to the Conservation and Management of Highly Migratory Fish Stocks. It aims to ensure the long-term conservation and sustainable use of such resources through effective implementation of the relevant provisions of the Convention of the Law of the Sea. To achieve this, it covers issues such as the compatibility of conservation measures and management, international cooperation mechanisms, regional and sub-regional organisation and arrangements, among others.

Code of Conduct for Responsible Fisheries (Código de Conducta para la Pesca Responsable): The member countries of the United Nations Food and Agriculture Organization (FAO), including all Central American countries, have accepted this Code, which contains rules and principles for responsible practices, with a view to ensure the conservation, management and development of living aquatic resources, with necessary respect for the ecosystem and biodiversity. It aims to establish principles, in accordance with the relevant rules of international law, so that fishing activities are conducted responsibly, taking into account all relevant biological, technological, economic, social, environmental and commercial aspects. Although the Code is voluntary, all Central American countries have adopted it, including some countries that recognise its principles in their new laws.

Regional Framework Treaty on Fisheries and Aquaculture (Tratado Marco Regional de Pesca y Acuicultura): The Framework Agreement aims to adopt a Declaration of Principles on a Regional System Planning and Development of Fisheries and Aquaculture, through the establishment of policies, strategies, regulations and joint programs. In the application of this Treaty the Central American States take into account the principles set out in the Protocol of the General Treaty on Central American Economic Integration and the Protocols of Guatemala and Tegucigalpa. Among the objectives of the Treaty is the establishment and harmonisation of strategies, policies and joint rules to gradually establish the aforementioned Regional System.

Policy Integration of Fisheries and Aquaculture in Central America (Política de Integración de Pesca y Acuicultura en el Istmo Centroamericano): This policy seeks to establish a common regional system to increase the participation of Central

American countries and thereby contribute to sound and sustainable use of fisheries resources and aquaculture products. It simililarly promotes regional and national organization of sectors directly related to the management and sustainable use of fisheries and aquaculture, strengthen regional and national institutions with the participation of different actors in the fisheries and aquaculture sectors, integrate regional actions to strengthen regional cooperation and promote colloboration, ensuring sustainable fisheries and aquaculture in biological, economic, social and environmental terms, and encouraging joint research and building knowledge for improved development of fishing activities and aquaculture health and traceability.

PRINCIPLES

Given the current population status of lionfish across the length of the Mesoamerican Reef, the invasion is not yet considered to have realised its maximum level of threat. Therefore, this strategy establishes the following principles to drive the development and adoption of activities required to reach the necessary level of control:

- Mutual collaboration
- Shared responsibility
- Optimization of resources
- Regional vision

1.2 Scope of application

The scope for application of this strategy will be within the countries of the Mesoamerican Reef, including Mexico, Belize, Guatemala and Honduras.

1.3 Organizational structure

As part of the agreements reached during the workshop held in Guatemala on May 22 and 23, 2014, a Regional Lionfish Control Committee for the Mesoamerican Reef was created, as a governance response to the growing impact of the invasion of this species (*Pterois volitans*) in the Mesoamerican Reef. This committee will continually seek to coordinate with all other associated networks and committees for the control of this species, particularly with regard to the Regional Strategy developed for the Wider Caribbean Region.

The committee constitutes governmental and civil society institutions of Mexico (CONANP, CONAPESCA), Belize (Belize Fisheries Department, Blue Ventures, TIDE, PACT, CZMAI), Guatemala (CONAP, MARN, DIPESCA, FUNDAECO, CECON, IARNA-URL, FUNDACION MUNDO AZUL), and Honduras (ICF, Roatan Marine Park), as well as regional actors such as the Healthy Reefs Initiative, SPAW-RAC, Reef Check Dominican Republic and the MAR Fund. However, other actors and sectors wishing to participate are welcome to do so in the future.

One of the first outputs of this Regional Committee is the development of a Regional Strategy that aims to guide strategic actions for the control and management of lionfish, in which each country establishes a National Committee that implements follow-up activities adjusted to national and local circumstances, by means of each country's respective National Action Plan.

2. THE LIONFISH: CONCEPTUAL FRAMEWORK

Coral reefs and associated ecosystems such as mangroves and seagrass beds are threatened by natural and anthropogenic factors, including adverse weather, coastal development, overfishing, improper fishing practices and pollution. These factors are further compounded by climate change, which leads to elevated sea surface temperature, ocean acidification, sea level rise, and increase frequency and intensity of tropical storms and hurricanes.

Invasive alien species (IAS) constitute another important threat. The dispersal of IAS can result in the loss of economically important species and threaten the survival of endemic species. These threats to biological diversity also affect the functioning and integrity of ecosystems, their cultural and economic uses, and livelihoods derived from natural resource use and biodiversity, particularly to local communities.

However, a range of international agreements on the prevention and management of IAS exist, including the Convention on Biological Diversity (CBD), in which Article 8 (h) calls for the avoided entry, control or eradication of exotic species that threaten ecosystems, habitats or species.

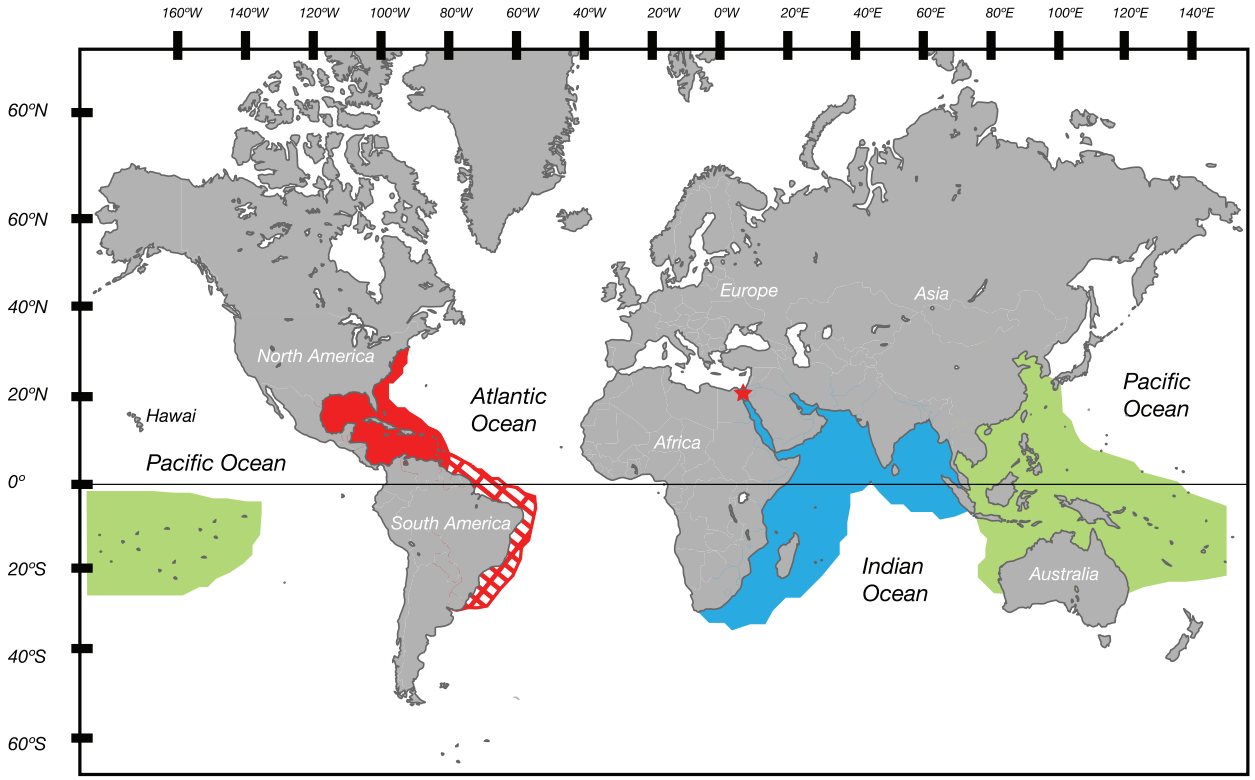
In the Caribbean, two species of lionfish, *Pterois volitans* and *Pterois miles*, are invasive and have this century become one of the greatest threats to the coral reefs of the temperate and tropical Atlantic.

---

1. *Estrategia Regional para el Control del Invasor Pez León en el Gran Caribe. Gómez Lozano, R.,L. Anderson, J.L. Akins, D.S.A. Buddo, G. Garcia-Moliner, F. Gourdin, M. Laurent, C. Lilyestrom, J.A. Morris, Jr., N. Ramnanan, and R. Torres 2013. 31 pp.*

2.1 Brief description of its distribution, biology and ecology

Lionfish, belonging to Family Scorpaeinidae (scorpionfish), originate from the Indo-Pacific Oceans. The wide native range of *P. volitans* extends from Western Australia and Malaysia to French Polynesia and the Pitcairn Islands, and from southern Japan and South Korea to Lord Howe and the Kermadec Islands, as well as throughout Micronesia. P. miles' native range covers the Indian Ocean, from western Sumatra, Indonesia to Kenya, and from as far north as the Red Sea and Gulf of Aden to South Africa (Figure 1). In this vast marine area, lionfish have been recorded in shallow and deep water, mangroves, seagrass beds, coral and artificial reefs.



Fuente: USGS-NOAA-REEF

Figure 1. Map that indicates the original distribution of Pterois volitans (highlighted in green) and P. miles (highlighted in blue), adjusted from Schultz (1986) and Randall (2005). The star that appears in the Mediterranean Sea indicates the Lessepsian migration of the Suez Canal (Golani and Sonin 1992). The red colored zones indicate the distribution of the invasion of P. volitans and P. miles in America (from Schofield et al. 2012). The possible future distribution of lionfish along the South American coast is shown in red hatching (from Morris and Whitfield 2009).

Although *P. volitans* has been recorded throughout the wider Caribbean region, *P. miles* has only been observed along the southeast coast of the United States and in the Bahamas. Although the two species are morphologically indistinct in the Atlantic (Hammer et al., 2007), they are distinguished by meristic characters in their native range: P. volitans has more fin rays on its dorsal and anal fins than P. miles. Lionfish are most active during crepuscular periods (dawn and dusk), when the majority of time is spent foraging for food. Lionfish density in the Atlantic Ocean is greater than in their native range (Kulbicki et al. 2012).

Conspicuous, bright, aposematic colouration serves as a warning to potential predators of their venomous spines located in the dorsal, pelvic and anal fins. There are no venomous spines in the pectoral or caudal fins. Lionfish venom is made up of a complex of proteins, with envenomation leading to affected neuromuscular transmission and clinically presenting as intense, localised pain and swelling. (Cohen and Olek, 1989).

In its original context it is considered that these fish are fit for human consumption, but its economic importance as ornamental fish is far superior. In its original habitat, the lionfish is not listed as threatened or endangered.

2.2 Invasive marine species in the Mesoamerican Reef region and its problematic

The first official record of lionfish in the Caribbean was off the coast of Florida, USA, in 1985. As of the year 2013, lionfish have successfully invaded all coastal areas of the wider Caribbean region, include the Gulf of Mexico and the south-eastern coast of the USA (Figure 2), where only cold water (below 14 C^0) limits further range expansion.

Figure 2. Image of the current distribution of invasive lionfish in the Caribbean (updated to Feb, 2013) .

According to reports from the Healthy Reefs Initiative (HRI), the lionfish invasion has become a significant threat to coral reefs in the Mesoamerican region, both in ecological and economic terms. The first reports of lionfish in the MAR were in 2008. By 2012, lionfish was reported in nearly a quarter of the sites monitored by the HRI team (30 of 133 sites). Honduras was the country that received the highest densities and frequency of occurrence (17 of 59 monitored sites), whereas in Mexico and Belize sightings were scarce, likely due to intensive fishing effort on the part of local authorities and other organisations.

Across its new range, lionfish has been found to be generalist carnivores that consume over sixty species of fish and many species of invertebrates (crustaceans, mollusks), some of which have great commercial, recreational, cultural or ecological value to the region. The "naïve" behaviour of prey species in the Caribbean compared to its original range largely explains the high efficiency of predation of juvenile and adult fish observed in this region. Analyses of stomach contents in lionfish have revealed a wide variety of prey items of different sizes, with some up to two-thirds the lionfish's body length.

Currently, the existence of potential predators for lionfish is uncertained. There are some documented cases of large-bodied grouper (such as *Epinephelus striatus*), sharks, snapper and moray eels preying upon lionfish, though these incidents are considered rare and are generally the result of feeding for tourists. Given that

2. *Report on ecological health for the Mesoamerican Reef 2010.*

lionfish venom is fatal to many fish (Allen & Eschmeyer 1973), the feeding of lionfish to native predators to encourage bio-control is not advised.

According to the Regional Lionfish Strategy for the Wider Caribbean Region, the proliferation of lionfish over the last ten years constitutes a real and growing threat to the ecology of tropical and subtropical marine areas in the wider Caribbean region, and therefore also for the Mesoamerican Reef. Now that the entire region has been invaded, it is expected that the density will continue to grow. To date, the densities appear to be sufficiently high to have a considerable impact on biological diversity and reef fish communities.

Given the proliferation of lionfish populations in the MAR region, the impacts on native populations and biodiversity of coral reefs, sea grass beds and mangroves may be dramatic, causing abrupt changes in ecosystem structure and competing for resources with economically important species such as snapper (*Lutjanidae*) and grouper (*Epinephelus*).

The socioeconomic impact of the lionfish invasion in the MAR region has not yet been quantified, though the tourism and fishing industries are most likely to be affected. Tourism may be affected through loss of biodiversity and consequential decreased attraction of snorkelling and SCUBA diving areas, and compounded by the risk of envenomation through direct contact with a lionfish. The fishing industry stands be affected through the depletion of populations of commercially significant marine resources, such as lobster. As a result, lionfish primarily threatens livelihoods and quality of life within coastal communities.

2.3 Nationwide management actions

Each country in the MAR has initiated governmental actions in collaboration with other actors and sectors at the national level, and have locally implemented efforts to control and managed this invasive species. Some of these actions, strengthening the Regional Strategy, are as follows:

Mexico:

In Mexico the first sighting of lionfish occurred in January 2009 on the island of Cozumel, Cozumel Reefs National Park (Parque Nacional Arrecifes de Cozumel – PNAC), Quintana Roo, which led to the first workshop to prepare the Early Warning Action Plan in June 2009 and to get acquainted with the problem, standardise messages, learn about capturing and monitoring techniques, train the general public (especially fishermen) and develop an action plan. Efforts have been made with key stakeholders including managers, researchers, government sector, fishermen, service providers, social organizations, environmentalists, researchers, tourists, divers, restaurant managers, residents, young people, students and the general public.

Identified challenges include legal, technical and financial challenges. One of the major challenges is related to increasing active stakeholder participation to implement the strategy, standardise monitoring criteria and promote increased information. Moreover, capturing lionfish involves high costs and it causes damage if improperly handled. Work is currently underway to proclaim this species as a plague in order to have access to additional resources for research, control and management of lionfish.

Belize:

The first sighting of lionfish in Belize was in Turneffe Atoll in December 2008. As little was known about the species, a sub-committee was formed through the National Coral Reef Monitoring Network in 2009. Through this working group, a response plan was initiated in 2009, and finalised in 2012. From there, as in the rest of the MAR countries, outreach efforts, information dissemination events, fisheries exchanges, lionfish hunting tournaments and scientific studies were conducted and informational materials developed.

Guatemala:

The first reports of presence of lionfish in Guatemala came in 2010-2011 from Punta Manabique Wildlife Refuge (Refugio de Vida Silvestre Punta de Manabique), in the reefs of Cabo Tres Puntas and Motaguilla. Currently there is an effort coordinated by DIPESCA and CONAP to promote a joint action plan to control lionfish. Partnerships have been developed with Mundo Azul Foundation and Iniciativa Arrecifes Saludables Guatemala, to plan hunting tournaments with diving schools and local fishermen. Similarly, research actions are encouraged by obtaining biological base data for population monitoring, an updated inventory of reef patches and other benthic ecosystems, population abundance and structure estimates, distribution in Guatemala, dispersion models of the species and its ecology (preys, stomach contents, impacts), oceanographic conditions and vulnerability of the area, in order to build the database on the species in Guatemala.

In 2013, DIPESCA conducted research on stomach contents of at least 83 fish, which allowed determining their natural diet preference in this area (reef patches of Motaguilla): spot-tail mantis shrimp (*Squilla mantis*), flamefish (*Apogon maculatus*), shrimp (*Palaemonidae spp.*)

Honduras:

The earliest reports on the presence of lionfish are from 2009 in Punta Gorda Roatan and later in Utila, Guanaja and Cayos Cochinos (Schofield, 2010). The species has spread to the Bay of Tela, Omoa, Puerto Cortes and the Bay of Trujillo. Due to the appearance of lionfish in these areas and particularly in Roatan, an information campaign on lionfish has been launched in Roatan Marine Park to inform people about what to do in case of sighting the species. A first meeting was held in Tegucigalpa with actors of Bay Islands and with management, legal

and technical personnel of DIGEPESCA to discuss the draft of a decree to control lionfish populations. After its approval, RMP began providing licenses and brief training to experienced divers on how to capture lionfish with “hawaiian slings”. Also, in the framework of the Sustainable Seafood and Responsible Restaurants Programme (Programa de Mariscos Sostenibles y Restaurantes Responsibles) promoted by RMP and CORAL, lionfish has been listed as a good seafood option.

© DIPESCA

© DIPESCA

© DIPESCA

3. REGIONAL FRAMEWORK FOR ACTION

One of the fundamental principles of this strategy is to provide regional guidelines that can be subsequently adapted to national frameworks for lionfish control and management. Moreover, it is intended to facilitate collaboration and provide cohesion with the Regional Lionfish Control Strategy for the Wider Caribbean Region.

3.1. Vision

Reduce the impacts and effects of lionfish on ecosystem services provided by the Mesoamerican Barrier Reef System through management and control of the species and the coordination of multiple actors at regional, national and local levels.

3.2. Mission

Establish a platform of regional, national and local coordination and cooperation in order to manage and control invasive lionfish, with the objective to implement and consolidate national and local action plans that contribute towards minimising the negative impacts of lionfish on marine and coastal ecosystems in the Mesoamerican Reef region.

3.3. Objectives, strategies and actions

This strategy was developed under a coordinating framework for the control and mitigation of the impacts of lionfish in the Mesoamerican Reef region. It was built on the basis of existing relevant activities and programmes, and to involve key stakeholders from all sectors in promoting a coordinated and unified response to the lionfish problem regionally and with country-level strategic actions.

The framework for this strategy is based on five objectives to be achieved through specific measures and actions. These objectives are exactly those addressed in the Regional Lionfish Strategy for Lionfish Control in the Wider Caribbean Region for consistency at the strategic level, although their strategic actions differ between regions and countries.

The strategy will be implemented in collaboration with governments and other stakeholders to implement several of the proposed actions. Affected communities, local NGOs and resource administrators play an important role in the implementation of activities to be undertaken to reduce the threats of lionfish.

The five objectives that form the backbone of this strategy are:

1. Facilitate collaboration between governments, industries dependent upon coral reefs, civil society and academia, providing mechanisms for the coordination of efforts across political and geographical boundaries.

2. Promote coordinated research and monitoring directed at management.

3. Encourage governments to examine and modify corresponding legislation and, if necessary, develop new rules and regulations for lionfish control.

4. Control invasive lionfish populations wherever possible, using effective methods and regional coordination.

5. Implement education and outreach programmes for the control and management of lionfish in the Mesoamerican Reef region.

These objectives hold the key to fulfilment of the vision and mission of this strategy.

Objective 1: Facilitate collaboration among governments, industries that depend on reefs, civil society and academia, providing mechanisms to coordinate efforts across political and geographical boundaries.

The lionfish invasion in the Mesoamerican region is, by its nature, a transboundary problem and therefore requires a coordinated response from all concerned and/or involved parties. Given that human and financial resources are limited in the MAR, it is important to coordinate their use to ensure that the lionfish issue is addressed in the most cost effective and efficient manner possible. National action plans should be designed with the goal of feeding a regional framework to allow others to benefit from the lessons learnt and best practices. This goal is, in essence, one of the pillars of this regional strategy, as it promotes a platform for multi-stakeholder coordination that will allow for focused actions and optimal resource use.

Strategies	Actions	Stakeholders								Specific actors	Schedule
		Gov.	Acad.	OR/ IO	MR/ AD	ONG	SP	CL	DN		
Create a mechanism to promote the coordination of lionfish control and management in the MAR region through existing regional and international organisations	Create a MAR Regional Lionfish Committee to coordinate strategy implementation	x	x	x	x	x	x	x	x	All	2014
	Determine the functions and role of the lionfish committee members	x	x	x	x	x	x	x	x	Regional Commitee	2014
	Develop the Strategy for Control and Management of Lionfish in the MAR Region	x	x	x	x	x	x	x	x	To be defined	2014

Strategies	Actions	Stakeholders								Specific Actors	Schedule
	Approve the Strategy for Control and Management of Lionfish in the MAR Region	x	x	x	x	x	x	x	x	To be defined	2014
	Create an annual forum to share advances in lionfish control and management	x	x	x		x			x	To be defined	2014
Encourage implementation of actions to unify the MAR region on lionfish control and management	Promote integrated coastal zone management as a factor that reduces vulnerability to invassion	x	x	x	x	x			x	Regional Commttee	Oct 2014

Strategies	Actions	Stakeholders								Specific Actors	Schedule
	Monitor, evaluate and adapt the Strategy for Control and Management of Lionfish in the MAR Region	x	x	x	x	x	x	x	x	To be defined	Permanent (annual)
	Encourage sharing of experiences and exchanges between countries for actions related to lionfish control and management	x	x	x	x	x	x	x	x	To be defined	Permanent (annual)
	Create an annual forum for sharing advances in the management and control of lionfish	x	x	x		x			x	Regional Committee	Oct 2014
	Ensure that lionfish exploitation and market development is socially responsible	x	x	x	x	x	x	x	x		2015, 2016

Strategies	Actions	Stakeholders								Specific Actors	Schedule
	Promote, at a national level, the linkage of governmental institutions that regulate fisheries, environment and protected areas, to address the social , economic and environmental impact of lionfish.	x			x	x			x	National Authorities on fisheries and protected areas	Permanent
Manage financial resources for implementation of the strategy	Define budgets and identify possible sources of local and international funding to implement the strategy	x	x	x	x	x	x	x	x	Regional Committee	Since 2015

Strategies	Actions	Stakeholders								Specific Actors	Schedule
	Manage financial resources for implementation of the strategy	x	x	x	x	x	x	x	x	Regional Committee	Since 2015
Create a mechanism to promote the coordination of lionfish control and management in each country through existing national organizations	Create and/ or strengthen national committees that coordinate implementation of the strategy	x	x		x	x	x	x	x	Regional Committe with support of the Gran Caribe Committee	2015
	Promote the development of national plans of action to control lionfish that are consistent with the strategy	x	x		x	x	x	x	x	National Committees	2015

Strategies	Actions	Stakeholders								Specific Actors	Schedule
	Determine the functions and roles of the national committees members, and identify two representatives per country for the Lionfish Regional Committee	x	x		x	x	x	x	x	National Committees	2015
	Monitor the implementation of the strategy at the national level	x	x		x	x	x	x	x	National Committees	Since 2015

Groups: Gob. = Government, Acad.= Academia, OR = Regional Organisations, MR/AD=Resource Managers/PA Managers, ONGs = Non Governmental Organisations, SP= Private Sector, CL = Local Communities, DN = Donors

Objective 2: Encourage a coordinated research effort and management-oriented monitoring

Given the lionfish is a new species to the MAR region, in order for control and management mechanisms for this high-profile invasion to be effective, they must be adapted to specific characteristics of the species. Research is essential to better understand the biology, ecology and potential impact of the species and the response of ecosystems in the MAR region to the invasion. This can help to develop tools and amend objectives for control based upon improved scientific knowledge. It is also necessary to monitor trends in lionfish populations, as well as the impact of control programs, in order to evaluate and adaptively manage interventions.

Strategies	Actions	Stakeholders								Schedule
		GOV	ACAD	OR/ IO	MR/ AD	ONG	SP	CL	DN	
Promote the adoption of existing standard survey methods for lionfish and incorporate these into relevant monitoring programmes (fisheries, coral reefs, etcetera)	Agree, based upon the guide for control and management (http://lionfish.gcfi.org/manua/) and through regional workshops, the best methods for lionfish research, monitoring and evaluation.	x	x	x	x	x			x	Once a year starting in 2015
	Promote standard methods that allow for the precise monitoring of the status of the lionfish invasion.	x	x	x	x	x			x	To be defined

Strategies	Actions	Stakeholders								Schedule
	Review and approve the incorporation of lionfish as an indicator within existing monitoring methods in the MAR region	x	x			x				Once a year starting in 2015
	Assimilate existing baseline data and information on lionfish monitoring.	x	x	x		x				Oct 2014
	Promote the standardization of methods for control, montiroing and evaluation of lionfish.	x	x	x	x	x	x	x	x	2015
	Create and standardize methods for monitoring and research in the deep sea.	x	x	x		x			x	Oct 2014
	Encourage research to determine the socioeconomic aspects of the lionfish, including: economic impact assessment, market research and price fluctuation, impact on community food security, utilization in local restaurants, business plans, etcetera.	x	x			x				Permanent

Strategies	Actions	Stakeholders								Schedule
Promote and support research seeking technical solutions for lionfish control.	Assimilate lionfish landings data	x		x	x	x	x			Permanent
	Develop mechanisms for monitoring with local artisanal fishers, using agreed upon and appropriate methods in each country	x		x	x	x	x			Studies in Mexico should be implemented in other MAR countries by 2015
	Promote studies on the impacts of lionfish on coastal marine ecosystems, to promote reef resilience and reduce vulnerability.	x	x	x	x	x	x	x	x	Permanent
	Develop a study on the use of lionfish in the regional aquarium trade.	x	x	x	x	x	x		x	2015
	Strengthen existing research into genetics and connectivity (ECOSUR, CINVESTAV)	x	x	x	x	x		x	x	Studies in Mexico and Guatemala should be implemented in other MAR countries by 2015

Strategies	Actions	Stakeholders								Schedule
	Develop new technologies for control where necessary, such as the development of lionfish specific traps for use in deep water environments.	x	x	x	x	x		x	x	2015
	Promote research into the use of lionfish for medicinal purposes.	x	x	x			x			2015
Promote studies that guarantee the safety of lionfish consumption.	Develop studies that promote the consumption of lionfish (food science, e.g. nutritional content)	x	x	x					x	2015
	Support studies that investigate ciguatera and other illnesses that may result from the consumption of lionfish.	x	x	x	x	x			x	2015

Groups: Gob. = Government, Acad.= Academia, OR = Regional Organisations, MR/AD=Resource Managers/PA Managers, ONGs = Non Governmental Organisations, SP= Private Sector, CL = Local Communities, DN = Donors

Objective 3: Influence governments to review and amend the relevant legislation and, if necessary, develop new rules and regulations for the control of lionfish

The invasion of lionfish in the MAR region has revealed a series of gaps and inconsistencies in policies, laws and regulations governing the management of marine resources in the MAR countries. Some countries have laws and regulations specifically for lionfish, or more broadly to alien invasive marine species, that already exist at the national level. It is important to identify policies and national-level legislation that may facilitate or obstruct facilitate lionfish control efforts, and where appropriate, seek to modify these in order to achieve greater legal coherence at the national level as well as among countries and territories. It is also necessary to evaluate the need to fill gaps in existing legal frameworks at the local, national and regional levels and for the adoption of new policies and regulations.

The problems are best solved through legal approaches are import and export of live lionfish for the aquarium trade, forming an exception to existing regulations to allow for removal lionfish from "fishing exclusion zones", the use of fishing gear and traps to catch lionfish, and commercial use for human consumption. Amendments to some of these instruments could provide an enabling legal framework to control lionfish and thus increase the chances of success of control measures. Generally, adjusting laws and regulations takes time, which reinforces the importance for MAR countries to begin this process as soon as possible, in order to implement control measures in a timely manner. Regional organisations could provide support in this regard.

Strategies	Actions	Stakeholders									Schedule
		GOV	ACAD	OR/ IO	MR/ AD	ONG	SP	CL	DN	EF	
Promote institutional arrangements to coordinate actions that address the social, economic and environmental impacts of lionfish.	Carry out a diagnostic of legislation in the MAR countries linked to the issue of invasive marine species	x	x	x		x					2014

Strategies	Actions	Stakeholders									Schedule
	Facilitate the adoption of regulations, standards and national guidelines which address lionfish impacts	x		x		x					2015
	Identify and promote the ratification of protocols and associated conventions (Tulum Declaration, SPAW, Convention on Biological Diversity, Convention on Climate Change, etcetera)	x		x		x					2015
	Promote the development of specific legislation to regulate the use of lionfish as an ornamental species.	x									2015-2016

Strategies	Actions	Stakeholders								Schedule
Legally support best practices for the control and exploitation of lionfish	Develop technical specifications that maximise lionfish capture and minimize by-catch	x			x	x				2015-2016
	Where necessary, modify best practice rules for lionfish control and exploitation based on technical specifications	x								2015-2016
Promote the creation and implementation of economic instruments that incentivize the control and exploitation of lionfish	Promote regional projects through financial institutions for the development and implementation of relevant incentives	x	x			x		x		x	Permanent
	Create microloan schemes and targeted subsidies/grants for efficient lionfish control	x				x		x		x	Permanent
	Create an agreement for the processing of lionfish according to the market needs within each or the four countries	x	x			x		x		x	Permanent

Groups: Gob. = Government, Acad.= Academia, OR = Regional Organisations, MR/AD=Resource Managers/PA Managers, ONGs = Non Governmental Organisations, SP= Private Sector, CL = Local Communities, DN = Donors

Objective 4: Control lionfish population through effective and coordinated regional methods

According to current technologies, management mechanisms and existing scientific knowledge, eradication of lionfish in the Mesoamerican Reef is unlikely. However, it is possible to control lionfish populations at levels that minimize negative impacts. Strategies and tools to control lionfish differ according to local variables and the spatial scale at which monitoring is performed. The application of control measures and allocation of resources according to prioritized extraction provides administrators measurable objectives resources disposal plans. Knowledge exchange on extraction tools and techniques can facilitate the implementation of best practices in the region. Collaborative efforts among stakeholders and partnership with sectors that rely on reefs, such as fishing and tourism, can garner support and expand resources for extraction.

Strategies	Actions	Stakeholders								Schedule
		GOV	ACAD	OR/IO	MR/ AD	ONG	SP	CL	DN	
Identify areas where it is possible to effectively control lionfish	Define selection criteria and determine priority areas for lionfish control, including representation of the three zones requiring different management strategies (marine protected areas, fishing zones and deep sea)	x	x	x	x	x	x	x		2014/2015

Strategies	Actions	Stakeholders								Schedule
	Identify, raise and allocate funds and resources on a permanent basis to promote, develop and implement mechanisms and site-specific (marine protected areas, fishing zones and deep sea) management actions	x	x	x	x	x	x	x	x	Permanent
Execute lionfish control programmes	Identify specific control methods according to the prioritized areas within each of the three zones (marine protected areas, fishing zones and deep sea)	x	x	x	x	x	x			2014-2015
	Promote the adoption of best practices for control among interested parties, as identified in "Invasive Lionfish: A Guide to Control and Management" - Morris, J.A. Jr. -	x	x	x	x	x	x	x	x	Permanent

Strategies	Actions	Stakeholders								Schedule
	Through sharing experiences, help countries to develop mitigation and control plans, selecting the best available tools (consumption, fishing tournaments, etcetera) depending on the status of the invasion and capacity at each site	x	x	x	x	x	x	x	x	Permanent
	Verify the application of standard practices for effective control.	x	x	x	x	x				Permanent
Contribute to and promote ecosystem resilience through natural resource management and ecosystem restoration programs	Create a program that incentivizes the application of best practices for control and that rewards contribution to ecosystem resilience	x		x	x	x	x		x	2015

Strategies	Actions	Stakeholders								Schedule
	Adopt "Invasive Lionfish: A Guide to Control and Management" - Morris J.A., Jr. - in order to establish best practices for lionfish capture, according to specific conditions within each country.	x	x	x	x	x	x	x	x	2015
	Develop and implement conservation and monitoring programmes for lionfish control methods	x		x	x	x		x		Permanent
Promote diverse uses of lionfish across multiple sectors	Identitify a range of potential markets for lionfish exploitation and use.	x	x	x	x	x	x	x		2015
	Identify and promote removal of existing barriers to permit comprehensive lionfish exploitation according to identified potential markets	x	x	x	x	x	x	x		2014/2015
	Create an eco-label to promote consumption	x	x	x	x	x	x	x		2014/2016

Strategies	Actions	Stakeholders								Schedule
	Promote development of market chains for comprehensive exploitation and use of lionfish (ecotourism, aquarium trade, direct and value-added products)	x	x	x	x	x	x	x		Permanent

Groups: Gob. = Government, Acad.= Academia, OR = Regional Organisations, MR/AD=Resource Managers/PA Managers, ONGs = Non Governmental Organisations, SP= Private Sector, CL = Local Communities, DN = Donors

Objective 5: Implement education and communication programme for the control and management of lionfish in the Mesoamerican Reef.

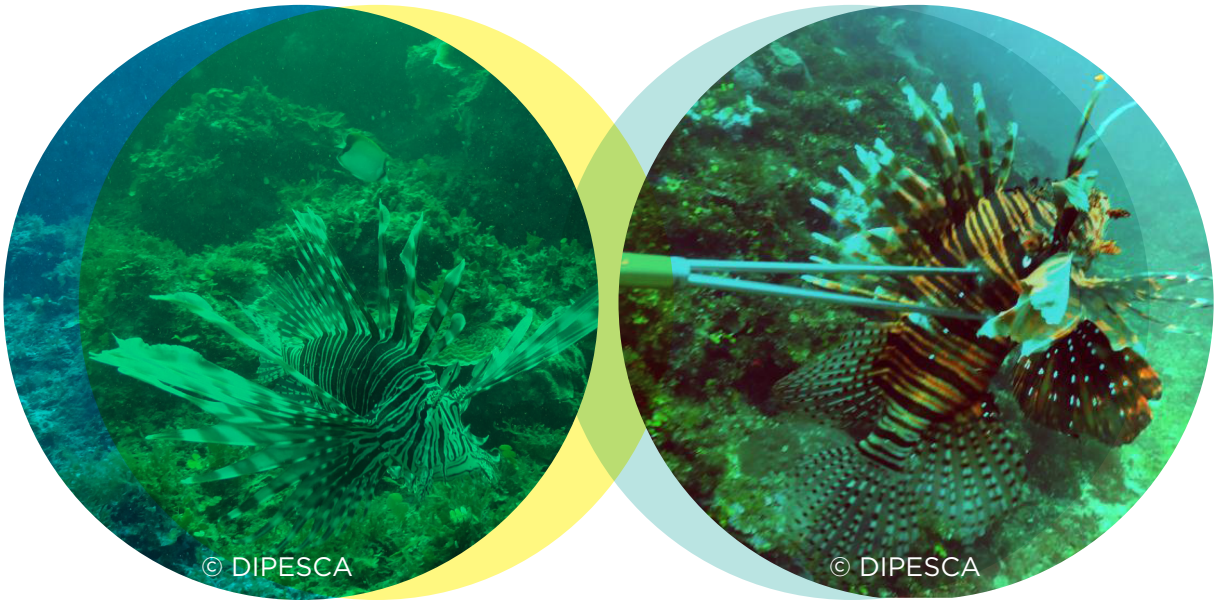
Well-implemented education and outreach programs can help to positively change perception and attitudes, increase public participation, and increase direct and financial support from government. In general, the earlier the activities outlined in this strategy are executed, the more support they will receive. Whenever possible, it is advisable to share resources for use in other invasive alien species programmes. It is essential to strengthen community involvement and use a participatory approach for effective control and management.

Strategies	Actions	Stakeholders								Schedule
		GOV	ACAD	OR/ IO	MR/ AD	ONG	SP	CL	DN	
Design a regional communication programme that supports the other four strategic objectives	Identify key messages for each objective	x	x	x	x	x	x	x	x	2015-2018
	Work with the public in order to utilize the most impactful and appropriate means for information dissemination (social media, radio, television, etcetera)	x	x	x	x	x	x	x	x	Permanent
	Create, implement and evaluate the effectiveness of the communication strategy	x	x		x	x				Permanent
	Integrate the lionfish strategy into the agenda of relevant national and regional fora	x	x	x	x	x	x	x	x	Permanent

Strategies	Actions	Stakeholders								Schedule
Encourage the development of outreach materials on lionfish to support education and training	Identify and approve key messages for inclusion in the development of outreach materials	x	x		x	x				2015
	Train and encourage advocates in the use and for distribution of materials	x	x		x	x				Permanent
	Promote comprehensive exploitation and use of lionfish (tasting events, recipies, the arts, etcetera)	x	x	x	x	x	x	x	x	Permanent
	Compile outreach experiences for evaluation and adaptation to regional and local conditions	x	x	x	x	x	x	x		Permanent
Create mechanisms for the dissemination of scientific information on lionfish	Create and/or add to existing information databases on lionfish monitoring, and use these to develop outreach materials	x	x	x	x	x			x	Oct 2014

Strategies	Actions	Stakeholders								Schedule
Disseminate information on the rules and regulations associated with lionfish control	Create an official platform for dissemination of specified rules and regulations	x		x						2015
	Disseminate outreach materials on rules, regulation and benefits of lionfish control that uses an accessible language style	x	x	x	x	x	x	x	x	Permanent
	Communicate the adoption of best practices for control	x	x	x	x	x	x			2015/permanent
	Socialize and implement best practices for and restrictions for control	x	x	x	x	x	x			2015/permanent

Groups: Gob. = Government, Acad.= Academia, OR = Regional Organisations, MR/AD=Resource Managers/PA Managers, ONGs = Non Governmental Organisations, SP= Private Sector, CL = Local Communities, DN = Donors



4. EVALUATION AND MONITORING

This strategy will be evaluated and revised periodically to include new measures, as new developments in the field transpire. These periodic reviews play a key role in defining future priorities, as the lionfish invasion progresses and policies and social priorities change.

Each country will develop a National Action Plan that will be monitored and evaluated by the National Lionfish Committees that are yet to be formed; these actions will influence the progress of the regional strategy.

The Regional Committee will meet annually to assess the impact of regional and national actions, and each National Committee will meet frequently to monitor the implementation of actions at local and national levels.

Bibliography

- http://coris.noaa.gov/exchanges/lionfish/
- Alcolado, P.M. 2008. El pez león amenaza a los arrecifes de Cuba. Informe elaborado en el marco del proyecto PNUD/GEF Sabana-Camagüey.
- Carlton, J.T. 2000. Global change and biological invasions in the oceans. En Invasive species in a changing world (Mooney H.A., y R.J. Hobbs, eds.). Island Press, Washington D.C., 457pp.
- Courtenay, W.R. 1995. Marine fish introductions in southeastern Florida. American Fisheries Society Introduced Fish Section Newsletter, 14:2-3
- Gómez Lozano, R., L. Anderson, J.L. Akins, D.S.A. Buddo, G. García-Moliner, F. Gourdin, M. Laurent, C. Lilyestrom, J.A. Morris, Jr., N. Ramnanan, and R. Torres. 2013. Estrategia regional para el control del Pez León invasor en el Gran Caribe. Iniciativa Internacional sobre los Arrecifes Coralinos. 32 pp.
- Morris, J.A., Jr. (Ed.) 2013. El pez león invasor: guía para su control y manejo. Gulf and Caribbean Fisheries Institute Special Publication Series, No.2, Marathon, Florida, USA. 126 pp.
- Morris, J.A., Jr., y P.E. Whitfield. 2009. Biology, Ecology, Control and Management of the Invasive Indo-Pacific Lionfish: An Updated Integrated Assessment. NOAA. Technical Memorandum NOS NCCOS, 99, 57 pp.
- Schofield, P.J. 2009. Geographic extent and chronology of the invasion or non-native lionfish (Pterois volitans [Linnaeus 1758] and P. miles [Bennett 1828]) in the Western North Atlantic and Caribbean Sea. Aquatic Invasions, 4(3):473-479.
- Whitfield P.E., J.A. Hare, A.W. David, S.L. Harter, R.C. Muñoz, y C.M. Addison. 2007. Abundance estimates of the Indo-Pacific lionfish Pterois volitans /miles complex in the Western North Atlantic. Biol. Invasions, 9:53–64.
- Terms of Reference of the ICRI Ad-Hoc Committee on Caribbean Regional Response to Lionfish Invasion .2012. pp
- “Lionfish Response Plan, a Systematic Approach to Managing Impacts from the Lionfish, an Invasive Species, in Units of the National Park System”. 2012. http://www.nature.nps.gov/publications/nrpm/nrr.cfm
- Plan para el Manejo y Control del Pez León Pterois volitans en el Caribe Colombiano 2012-2014. pp

Appendix 1. Members of the Regional Lionfish Committee in the Mesoamerican Reef System

MEXICO

- CONANP
- CONAPESCA

GUATEMALA

- CONAP
- DIPESCA
- FUNDACION MUNDO AZUL
- IARNA/URL
- MARN
- FCG
- FUNDAECO
- CECON

BELIZE

- TIDE
- FISHERIES DEPARTMENT
- BLUE VENTURES
- PROTECTED AREAS CONSERVATION TRUST (PACT)
- CZMAI

HONDURAS

- ROATAN MARINE PARK
- ICF

REGIONAL ACTORS

- MAR Fund
- SPAW RAC / UNEP
- WWF
- REEF CHECK
- ICRI
- HRI