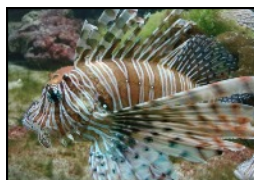


# **Regional Strategy for the Control of Invasive Lionfish in the Wider Caribbean**



**International Coral Reef Initiative**

## Regional Strategy for the Control of Invasive Lionfish in the Wider Caribbean



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Published 2013 by the International Coral Reef Initiative  
ISBN: 978 0 9923027 0 2



**National Library of Australia Cataloguing-in-Publication entry:**

**Author:** R. Gómez Lozano [and others]

**Title:** Regional Strategy for the Control of Invasive Lionfish in the Wider Caribbean

**ISBN:** 97806992302702 (pbk.)

**Subjects:** *Pterois volitans* – Control – Caribbean Area.

*Pterois volitans* – Migration – Caribbean Area.

**Other Authors/Contributors:**

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.  
International Coral Reef Initiative – issuing body.

**Dewey Number:** 597.68

**This publication should be cited as:**

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. *Regional Strategy for the Control of Invasive Lionfish in the Wider Caribbean*. International Coral Reef Initiative, 31 pp.

**Front cover photo:** Rich Carey

**Design:** LeRoy Creswell – Gulf and Caribbean Fisheries Institute

Printed in Mexico for CONANP.

This strategy was prepared with financial support from the United Nations Environment Programme.

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# CONTENTS

Authors .....	i
Collaborators .....	iii
<b>SUMMARY .....</b>	<b>v</b>
<b>1. ABOUT THIS STRATEGY</b>	
1.1 The Regional Lionfish Committee (RLC) .....	1
1.2 Rationale .....	1
1.3 Scope .....	3
<b>2. THE LIONFISH IN CONTEXT</b>	
2.1 The Lionfish in its Native Range: Description of its Biology and Ecology .....	4
2.2 The Lionfish as an Invasive Marine Species in the Caribbean Region .....	5
2.3 The Extent of the Lionfish Problem in the Caribbean .....	6
Ecological Threat .....	7
Socio-economic Threat .....	7
<b>3. A REGIONAL FRAMEWORK FOR ACTION</b>	
3.1 Vision .....	8
3.2 Mission .....	8
3.3 Objectives, Strategies and Actions .....	8
<b>4. EVALUATION AND REVIEW .....</b>	<b>20</b>
<b>5. SUGGESTED READING AND REFERENCES .....</b>	<b>20</b>
<b>Appendix 1. Regional Lionfish Committee members .....</b>	<b>22</b>
<b>Appendix 2. Acronyms .....</b>	<b>23</b>

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# Regional Strategy for the Control of Invasive Lionfish in the Wider Caribbean

## Summary

Lionfishes are venomous species of scorpionfishes which are native to Indo-Pacific coral reef ecosystems and adjacent habitats. Because of their colorful and dramatic appearance, they are prized by aquarists around the world. Through accidental and/or purposeful release into warm Atlantic waters, they have become established as a highly problematic alien species that poses a serious threat to coral reefs in Bermuda, Florida, the Gulf of Mexico, the Caribbean islands, Central America, and northern South America. Invasive lionfish populations can reach high densities and cause extreme disruption to native fish communities; they have been shown to reduce biodiversity, are responsible for the decline of ecologically important species, and hinder stock-rebuilding efforts for economically important species.

In January 2010, in recognition of the severity of the lionfish invasion and its impact on coral reefs and local communities, the 24th General Meeting of the International Coral Reef Initiative (ICRI) agreed to set up an *Ad Hoc* Committee to develop a strategic plan for the control of lionfish in the Wider Caribbean. The Strategy described in this document is one of the actions implemented by the *Ad Hoc* Committee, known as the Regional Lionfish Committee (RLC). It seeks to build on the existing programs and efforts aimed at minimizing the impacts of the lionfish in the region, and to provide a framework for action to provide a regionally coordinated response to the lionfish threat. The Strategy is based on the following objectives:

- i) Facilitate **collaboration** among governments, reef-reliant industries, civil society, and academia by providing mechanisms for coordination of efforts across political and geographical boundaries,
- ii) Encourage a coordinated **research and monitoring** agenda,
- iii) Encourage governments to review and amend relevant **legislation** and, if necessary, develop new **regulations and policies** to control lionfish,
- iv) **Control** invasive lionfish populations using regionally coordinated, effective methods, and
- v) Provide **education, information and outreach** mechanisms to generate public support and foster stewardship in invasive lionfish programs.

Each of the objectives is supported by strategies and actions with specific stakeholders identified as possible implementers. It is expected that this Strategy will be used by governments and other stakeholders to create plans to implement many of the actions identified in this strategy. The action plans would include time-lines and indicators to measure effectiveness in achieving the objectives of this Strategy. Local government, coastal communities, non-governmental organizations (NGOs), and marine industries will play an important role in implementing on-ground actions to reduce lionfish impacts and enhance the resilience of reefs in the Wider Caribbean region.

## 1. ABOUT THIS STRATEGY

### 1.1 *The Regional Lionfish Committee (RLC)*

The Regional Lionfish Committee, also known as *Ad Hoc* Committee for the Caribbean Regional Response to Lionfish Invasion, was established in November 2010 by the International Coral Reef Initiative<sup>1</sup> (ICRI) in response to the growing threat caused by the invasion of the lionfish (*Pterois volitans* and *P. miles*) in the Wider Caribbean.

The Regional Lionfish Committee (RLC) is the result of the combined efforts of United Nations Environmental Program – Caribbean Environment Program (UNEP-CEP) and its Regional Activity Center for the Protocol on Specially Protected Areas and Wildlife of the Cartagena Convention (SPAW-RAC), and partners including the government of Mexico and its Commission on Protected Areas (CONANP), the government of the United States and its National Oceanic and Atmospheric Administration (NOAA), Reef Check Dominican Republic, Centre for Agricultural Bioscience International (CABI), Reef Environmental Education Foundation (REEF), and representative Caribbean experts to address the lionfish issue in the Caribbean.

In response to its mandate, the RLC coordinated the development of a regional Strategy that is intended to help guide action by stakeholders concerned with, and impacted by, the lionfish invasion. The draft Strategy was developed by members of the RLC and key lionfish experts who met in Puerto Rico on 3–6 September 2012 to initiate Strategy development. Following reviews, the draft was presented at the Fifteenth Intergovernmental Meeting of the Parties to the Cartagena Convention on 2012. Likewise, during the Insular Caribbean Aquatic Invasive Species Risk Assessment Tool: Regional Training Course, held in April 2013 in Jamaica, the Strategy was presented at the session on exchange of experiences in managing the Lionfish Invasion in the Insular Caribbean.

### 1.2 *Rationale*

The lionfish is the first reef fish invasive species to become established in the Wider Caribbean Region threatening coral reef ecosystems and associated ecological and economic benefits. Although eradication is now unlikely, control at selected sites can be successfully implemented. However, a good understanding of the lionfish issue across sectors, and coordination and collaboration among affected communities, research institutions, government bodies, and technicians are a

*<sup>1</sup>The RLC was created under the French/Samoa Secretariat. Currently ICRI is co-chaired by Australia/Belize*

prerequisite for success. This Strategy is intended to facilitate such collaboration by providing a framework to:

- i) Facilitate on-the-ground implementation of actions through regular exchanges of experiences, protocols, and tools;
- ii) Help reduce costs and avoid duplicative efforts by designing regional programs with pooled resources;
- iii) Enunciate roles and potential actions among different actors and sectors;
- iv) Guide researchers and donors by identifying projects that require action as top priority; and
- v) Ensure actions are consistent and complementary at all levels and across all sectors.

As such, it constitutes a reference document for implementation of identified priority actions in the Caribbean.

The Strategy takes into account recommendations generated by international and regional bodies including:

- i) The International Coral Reef Initiative (ICRI): 2009 Recommendation on Invasive Alien Species;
- ii) The Aichi Target 9 - by 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment;
- iii) The efforts of the Global Environment Facility (GEF/UNEP/CABI) Project “Mitigating the Threat of Invasive Alien Species in the Insular Caribbean (MTIASIC)” to build capacity in the insular Caribbean to manage the Invasive Alien Species impact;
- iv) The decision taken at the Sixth Conference of Parties to the SPAW Protocol in Montego Bay, Jamaica, October 2010, to participate in the development of a Caribbean regional response to the lionfish invasion and the progress report presented by the SPAW Secretariat in this regard; and
- v) The decision taken at the Fifteenth Intergovernmental Meeting on the Action Plan for the Caribbean Environment Program and Twelfth Meeting of

the Contracting Parties to the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region in Punta Cana, Dominican Republic, October 2012, to take immediate regional actions to control the lionfish invasion in collaboration with relevant international and regional partners and initiatives.

By ensuring that this Strategy is consistent with these guidelines, the RLC wishes to ensure that a more coordinated approach be taken to minimize impacts of the lionfish in the Caribbean.

This Strategy is designed to complement the lionfish best practices manual (Morris, 2012), is non-binding, and is not intended to give rise to any rights or obligations under national or international law.

### **1.3 Scope**

The area targeted by this Strategy is the Wider Caribbean Region, as defined through the Cartagena Convention, and including:

- i) The Gulf of Mexico: Cuba, Mexico, and the United States (Texas, Louisiana, Mississippi, Alabama, and Florida),
- ii) The western Caribbean: Belize, Costa Rica, Guatemala, Honduras, Mexico, and Nicaragua,
- iii) The north-eastern and central Caribbean: Bahamas, Cayman Islands, Cuba, Dominican Republic, Haiti, Jamaica, Puerto Rico, and Turks and Caicos Islands,
- iv) The eastern Caribbean: Anguilla, Antigua and Barbuda, Barbados, British Virgin Islands, Dominica, Grenada, Guadeloupe, Martinique, Montserrat, St. Maarten, St. Lucia, St. Kitts and Nevis, St. Vincent and the Grenadines, and the U.S. Virgin Islands,
- v) The southern Caribbean: Colombia, Netherlands Antilles, Trinidad and Tobago, and Venezuela, and
- vi) The equatorial Atlantic North West of South America – French Guyana, Guyana, and Surinam.

The Strategy can however be applied to areas further North or South, should they become affected by the lionfish invasion.

## 2. THE LIONFISH IN CONTEXT

Coral reefs and associated ecosystems such as mangroves and seagrass are under threat by natural and anthropogenic factors, such as adverse weather, coastal development, overfishing, inappropriate fishing practices, and pollution. Many of these stressors are increasingly exacerbated by climate change, through elevated sea surface temperature, ocean acidification, sea level rise, and increased frequency, extent, duration, and magnitude of storms and hurricanes.

Invasive alien species (IAS) are another major threat. The spread of IAS can eventually result in losses of economically important species and threatens the survival of endemic species. These threats to biodiversity also affect the ecosystem functions and the cultural and economic resources of local communities.

There are currently over 20 international agreements related to the prevention and management of IAS, including the Convention on Biological Diversity (CBD) which in Article 8 (h) calls for parties to prevent the introduction of, control, or eradicate those alien species that threaten ecosystems, habitats, or species. However, research indicates that the rate and magnitude of marine IAS introductions is increasing. This relates in part to the many challenges associated with prevention, management, and eradication of IAS, including a lack of understanding of the severity of the threat posed, insufficient information on status and trends, insufficient technical capacity to address the issue, and limited political and public awareness.

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

### ***2.1 The Lionfish in its native range: description of its biology and ecology***

Two introduced species of lionfish, *Pterois volitans* and *Pterois miles* (the first being the most widespread in the Atlantic), are today having significant negative impacts on reef ecosystems and on economic activities. The term "lionfish", encompassing both *P. volitans* and *P. miles* will be used in the next paragraphs, except when it is important to differentiate between the two species.

Lionfish are native to the Indo-Pacific region and the Red Sea. They are usually found in the warm marine waters of the tropics, and have been observed in water depths and on hard bottom, mangrove, seagrass, coral, and artificial reef communities (such as shipwrecks and concrete modules).

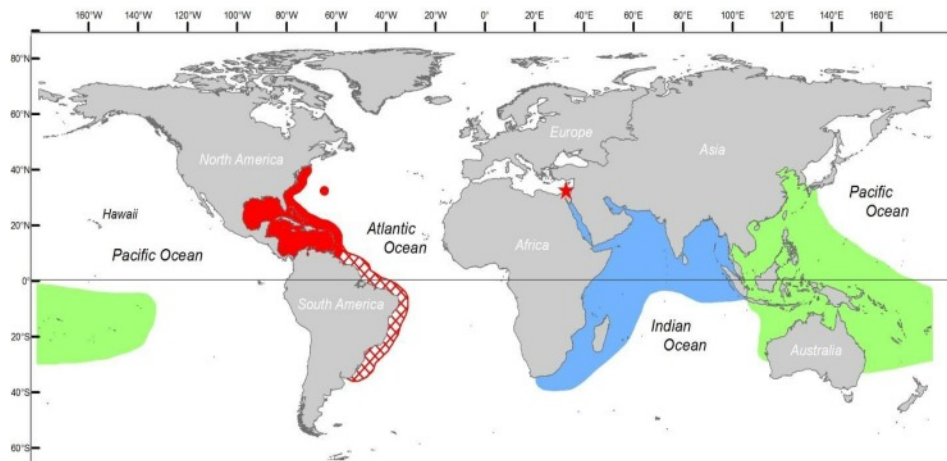
The native range of *P. volitans* covers a very large area from Western Australia and Malaysia on the Eastern side, to French Polynesia and the United Kingdom's Pitcairn Islands on the western side, and up to southern Japan and southern Korea in the north and Lord Howe Island (off the east coast of Australia) and the Kermadec Islands (off New Zealand) to the south. In between, the species is found throughout Micronesia. *P. miles* naturally occur across the Indian Ocean, in the Red Sea and the Gulf of Aden (Figure 1).

Lionfish are typically slow-moving and cryptic and exhibit aposematic coloration with venomous spines for defense. Although lionfish are considered a food-fish in their native range, they are far more important economically in the aquarium trade. Lionfish are not currently listed as threatened or endangered in their native range.

## 2.2 The Lionfish as an Invasive Marine Species in the Caribbean Region

The first records of lionfish in the region are from Florida waters with the first collection occurring in 1985. It is commonly believed that multiple introductions occurred between 1985 and 2000 when multiple individuals were documented off the coast of North Carolina. As of 2013, lionfish have invaded the entirety of coastal waters throughout the wider Caribbean, Gulf of Mexico and Southeast U.S. (see Figure 2), where only colder waters (lower than  $\sim 10^{\circ}\text{C}$ ) appear to act as a barrier.

In the newly invaded range, lionfish have been found to be generalist carnivores that consume more than 60 species of fish and many invertebrate species



**Figure 1.** Map of the native range of *Pterois volitans* (green) and *Pterois miles* (blue) adapted from Schultz (1986) and Randall (2005). The star in the Mediterranean Sea denotes Lessepsian migration of *P. miles* via the Suez Canal (Golani and Sonin 1992). Non-native range of *P. volitans* and *P. miles* in the Americas is shown in red (from Schofield et al., 2012). Predicted future distribution of lionfish along coastal South America is shown in red hatching (from Morris and Whitfield, 2009).

(e.g. crustaceans, mollusks), some of which are commercially, recreationally, culturally, or ecologically important to the region. Lionfish prey on individuals in excess of half their own body size. The “naïve” behavior of prey Caribbean species compared with prey in the lionfish’s native range largely explains the high efficiency of predation of juvenile and adult fish observed in the Caribbean. Stomach content analysis of lionfishes revealed a wide diversity in prey species and size classes.

The potential for lionfish predators in the Caribbean is uncertain. A few cases of lionfish predation by large groupers (such as the Nassau grouper) and some shark species have been reported; but they remain exceptional cases. In addition, parasite loads of lionfish in the Caribbean are low compared to those in the native range. These favorable conditions (and many more, see Morris and Whitfield, 2009) lead to high growth and reproduction rates and therefore a rapid and successful colonization process.

### 2.3 The Extent of the Lionfish Problem in the Caribbean

In the Wider Caribbean region, lionfish has become a high-risk threat both ecologically and economically.



**Figure 2.** Current distribution of invasive Lionfish in the Caribbean (Updated February 2013) Florida was the first location where lionfish were documented in the Wider Caribbean Region.

**Ecological threat** – The proliferation of lionfish in the Caribbean over the last ten years is a real and growing threat to the ecology of tropical and sub-tropical marine areas in the Wider Caribbean Region. Now that the entire region has been invaded, densities of lionfish in newly invaded locations are expected to continue increasing. To date, densities seem to remain high for long enough time to create significant impacts to the biodiversity of reef fish communities.

These impacts occur primarily through an alarming reduction of local native reef fish populations. This, in-turn, can cause a reduction in the growth and survival of native predators. It is currently thought that the lionfish invasion has adversely disrupted the balance of Caribbean reef ecosystems, with effects trickle-down to associated ecosystems such as seagrasses and mangroves, although this has not yet been scientifically shown.

**Socio-economic threat** – The lionfish invasion represents a major ecological threat to reef systems in the Caribbean, but it also as a result, represents a major socio-economic threat to the region. Not only does it represent a safety risk to recreational divers and fishermen because of its venomous spines (which may adversely impact economically important commercial activities such as tourism), it also is thought to have contributed to the decline of commercially important species of fish, including species fished for local consumption which are an important source of protein for coastal communities. Tourism might be affected by the reduction in the biodiversity and hence, the natural attraction of some dive sites. As a consequence, the quality of life of coastal communities is seriously threatened by the presence of lionfish.

Considering the extent of the lionfish colonization to date, the eradication of the species is deemed unlikely with current available technologies. The best way to address this problem may be to promote the control of lionfish populations by local users. Control is possible, and has been successful in some specific areas with strong management oversight, such as marine parks in México, Florida Keys, Cayman Islands, several areas in Puerto Rico, and Bonaire.

In these sites, it has been found that control is an effective way to attenuate the negative effects of the lionfish invasion. Available resources and size and depth of management areas help determine control levels. Nevertheless, the colonization pattern of the species, i.e., its capacity to move between sites, renders coordination and collaboration at regional, national, and local levels a key factor for success. This is what a Regional Strategy for the Control and of Invasive Lionfish in the Wider Caribbean Region can help achieve.



### 3. A REGIONAL FRAMEWORK FOR ACTION

#### 3.1 Vision

The effects of lionfish on ecosystem services and economic value of reef communities in the Wider Caribbean Region are reduced by coordinated control actions implemented at the regional level.

#### 3.2 Mission

Provide a framework for regional cooperation, collaboration and coordination for lionfish management and control in the Caribbean, so that best practices are used to develop local action plans to minimize negative impacts of lionfish on marine and coastal ecosystems of the Caribbean region.

#### 3.3 Objectives, Strategies and Actions

This Strategy has been developed as a framework for lionfish control and mitigation in the Wider Caribbean region. It seeks to build on existing activities and programs on lionfish control and mitigation, and to engage stakeholders across sector to foster a coordinated, united response to the lionfish problem through improved knowledge and understanding. The framework of this Strategy is based on five objectives carried through strategies and actions.

A regional coordination mechanism could be facilitated to establish partnerships with interested governments and other stakeholders to implement many of the Strategy's actions. Affected communities, local NGOs, and resource managers will play important roles in implementing on-ground activities to reduce the lionfish threat.

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

- i) Facilitate **collaboration** among governments, reef-reliant industries, civil society, and academia by providing mechanisms for coordination of efforts across political and geographical boundaries,
- ii) Encourage a coordinated **research and monitoring** agenda,
- iii) Encourage governments to review and amend relevant **legislation** and, if necessary, develop new **regulations and policies** to control lionfish,
- iv) **Control** invasive lionfish populations where possible using regionally coordinated, effective methods, and
- v) Provide **education, information, and outreach** mechanisms to generate public support and foster stewardship in invasive lionfish programs.

These objectives drive key actions that will be taken towards the Strategy's mission and vision. Targets for measuring success will determine modifications to the Strategy as required (see Section 4).

**Objective 1: Facilitate collaboration** – The lionfish invasion in the Caribbean is a trans-boundary issue which, by nature, requires a coordinated response by all parties affected and/or involved. Human and financial resources are limited in the Wider Caribbean region, so coordinating the use of resources would be necessary to ensure that the lionfish issue is dealt with in the most cost-effective and efficient manner. Local action plans should be designed to feed into a regional framework to allow others to benefit from lessons learned and best practices. The high colonization profile of the lionfish and important connectivity among lionfish populations in the region make consistency in actions all the more important to achieve a shared objective: controlling the spread of lionfish to minimize and mitigate its impacts on important ecosystems. An important first step for achieving this objective is to agree on a mechanism for collaboration and coordination of efforts, whether it is by amending the RLC's mandate or by establishing another mechanism for this purpose.

**Objective 2: Encourage coordinated research and monitoring** – Lionfish are a new species in the Wider Caribbean, and their high invasive profile requires that control mechanisms are tailored to the species' characteristics in order to be efficient. Research is essential to acquire a better understanding of the biology, ecology and potential impacts of the species and the response of the Caribbean ecosystems to the invasion. This can help design appropriate tools and targets for control, based on best available science. Monitoring the trends of the lionfish populations and the impacts of control programs is also required to assess, and adjust actions as an adaptive management process.

**Objective 3: Encourage legislation, regulations, and policies for lionfish control** – The invasion of lionfish throughout the Caribbean region has highlighted a number of gaps and inconsistencies among policies, legislations and regulations governing the management of marine resources in Caribbean countries, and few countries have laws and regulations specifically dedicated to the lionfish issue (or more broadly marine invasive alien species) already in place at the domestic level.

It is important to identify domestic policies and legislation that may be hampering or supportive lionfish control efforts, and where appropriate, seek to amend such instruments to achieve greater legislative coherence nationally, and between countries and territories. The need to fill any gaps in the existing legal frameworks through the adoption of new policies and regulations should be also explored, at local, national, and regional levels.

Issues that are best addressed through legal instruments include importation and exportation of lionfish for live trade in the pet industry, removal (culling of) lionfish from “no-take” areas, use of fishing gear and traps to remove lionfish, and commercialized use of the lionfish for human consumption. Amendments to relevant national laws and regulations could provide a supportive legislative framework for lionfish control and thereby increase the likelihood of success of any control measures.

Amending legislative instruments typically requires time, and it is therefore particularly important for Caribbean countries to start this process as soon as possible in order to enable the implementation of control actions in a timely manner. Regional organizations may be able to provide support to achieve this.

**Objective 4: Control** – Based on current technologies, management mechanisms, and available science, eradication of lionfish in the wider Caribbean is not likely. However, local control of lionfish populations to levels that will minimize impacts is proving to be viable. Strategies and tools for lionfish control differ depending on local variables and the spatial scale at which control is enacted. Implementing control targets and allocating resources according to removal priorities provides resource managers with measurable goals for directed removal plans. Sharing knowledge of removal tools and techniques can ensure the use of best practices around the region. Collaborative efforts among stakeholders and partnerships with reef-reliant industries such as fisheries and tourism can promote buy-in and enhance removal resources.

**Objective 5: Education, Information, and Outreach** – Successful education and outreach (E&O) programs can help shape public perception, enhance constituent involvement, and direct government support and funding. Because effective lionfish control programs encompass all of these components, they will benefit greatly from well thought-out and designed E&O activities. In general, the earlier appropriate E&O activities are implemented, the more broadly they are supported. When possible, share resources will be sought and used with other invasive alien species E&O activities (existing Caribbean IAS network). It’s imperative to empower communities and utilize participatory approach to ensure control and management.

Objective I		Facilitate collaboration among governments, reef-reliant industries, civil society, and academia by providing mechanisms for coordination of efforts across political and geographical boundaries												
Strategy	Actions	Actors*								Timeline				
		Govt.	Univ.	RB/IO	RM	NGO	PS	LC	DN					
<p><b>Create a mechanism to promote coordination of control and management of lionfish in the Wider Caribbean through existing regional bodies and international organizations.</b></p>	Amend the current mandate of the Regional Lionfish Committee or establish another mechanism to coordinate the implementation of this strategy			✓									2013	
	Provide and a convening mechanism to facilitate political consensus and represent the region			✓									2013-14	
	Identify national focal points tasked with monitoring and reporting on control actions	✓												2013-14
	Identify functions and roles of committee members	✓	✓	✓	✓									2013-14
	Provide technical support to governments		✓											2014-15
	Mobilize resources			✓	✓	✓	✓							2014-15
	Coordinate actions within the country through the establishment of working groups	✓												2014-15
	Include lionfish on the agenda of Invasive Alien Species protocols	✓												2014-15
	Identify potential funding sources to implement control programs	✓	✓	✓	✓	✓	✓	✓	✓					2014-15
	<p>*Govt. = governments; Univ. = Academia; RB/IO = Regional bodies/International organisations; RM = Resource managers; NGO = Non-Governmental Organizations; PS = Private Sector; LC = local communities; DN = donors</p>													



Objective 2 continued		Encouraging a coordinated research and monitoring agenda											
Strategy	Actions	Actors*								Timeline			
		Govt.	Univ.	RB/IO	RM	NGO	PS	LC	DN				
<b>Promote a coordinated research agenda at regional level</b>	Facilitate discussions among researchers and resource managers to share information and encourage complementary and coordinated studies	✓	✓	✓	✓	✓							2013-14
	Help prioritize research agenda	✓	✓										2013-14
<b>Encourage and support research to develop technological solutions for lionfish control</b>	Record and assess existing technologies and identify most successful ones	✓	✓	✓									ongoing
	Where relevant, develop new control technologies	✓	✓	✓	✓	✓							ongoing
<b>Create mechanisms for the dissemination of scientific information about lionfish</b>	Encourage use of web portal (currently hosted by GCFI with US support) that consolidates information available on the spread of the lionfish and provides a forum for information sharing	✓	✓	✓								✓	2013
	Support regular conferences where new scientific progress are presented and shared within and beyond the scientific community	✓	✓	✓									ongoing
<b>Promote studies to ensure that human consumption of lionfish is safe</b>	Assess and develop safe lionfish harvesting strategies for seafood markets	✓	✓	✓		✓						✓	2014
	Support studies on ciguatera and other potential food-borne illness that may be associated with lionfish	✓	✓										2013-14

\*Govt. = governments; Univ. = Academia; RB/IO = Regional bodies/International organisations; RM = Resource managers; NGO = Non-Governmental Organizations; PS = Private Sector; LC = local communities; DN = donors

Objective 3		Encourage governments to review and amend relevant legislation and, if necessary, develop new regulations and policies to control lionfish										
Strategy	Actions	Actors*								Timeline		
		Govt.	Univ.	RI/O	RM	NGO	PS	LC	DN			
Promote close collaboration among national, regional and international bodies on invasive species of which the lionfish invasion is an exemplar.	Work in regional and international bodies to identify ways to strengthen the prevention and control of invasive species, e.g., a listing of invasive species based on Article 12 of the SPAW Protocol **	✓		✓								2015-16
Encourage government to review and/or amend existing regulations / legislation that inhibit or restrict lionfish control	Facilitate workshops/meetings to review existing legislation to identify gaps related to lionfish efforts, and in particular with respect to the prohibition of lionfish introduction/import	✓		✓	✓	✓	✓					2013-14
Encourage the incorporation of lionfish control strategies into government programs	Propose coordination among countries to harmonize national regulatory standards. Two situations should be distinguished: import of lionfish from abroad; and possible export of captured lionfish	✓		✓								2014
	Identify appropriate agencies to manage lionfish programs, e.g. environmental management, fisheries, trade and tourism related agencies as relevant.	✓										2014
	Allocate resources for lionfish programs	✓										2014-17

\*\*SPAW Protocol: Article 12 Introduction of Non-Indigenous or Genetically Altered Species – Each Party shall take all appropriate measures to regulate or prohibit intentional or accidental introduction of non-indigenous or genetically altered species to the wild that may cause harmful impacts to the natural flora, fauna or other features of the Wider Caribbean Region.

Objective 3 continued		Encourage governments to review and amend relevant legislation and, if necessary, develop new regulations and policies to control lionfish											
Strategy	Actions	Actors*								Timeline			
		Govt.	Univ.	RB/IO	RM	NGO	PS	LC	DN				
Encourage governments to develop specific laws, policies, and/or regulations where these currently do not exist	Inform decision makers of existing national laws and policies and international work that may be relevant to controlling lionfish in order to determine what could be incorporated into the national laws, regulations, and policies (e.g., aquatic invasive species law)	✓		✓		✓							2014
	Facilitate capacity building with the support of regional organizations where appropriate	✓		✓					✓				2013-15
	Review existing, amended and projected policies and regulations and provide advice on their gaps if any, and on option to strengthen their consistency	✓	✓	✓	✓								2014
Encourage consistency among national legislation, policies and regulations	Facilitate capacity building with the support of regional organizations where appropriate	✓		✓									2013-15
	Provide appropriate domestic resources for monitoring compliance and enforcement	✓										✓	2014-15
Monitor and enforce regulations	On-ground monitoring and enforcement				✓								2015-17
	*Govt. = governments; Univ. = Academia; RB/IO= Regional bodies/International organisations; RM = Resource managers; NGO = Non-Governmental Organizations; PS = Private Sector; LC = local communities; DN = donors												



Objective 4		Control invasive lionfish populations using regionally coordinated, effective methods													
Strategy	Actions	Actors*Timeline								LC	DN				
		Govt.	Univ.	RB/IO	RM	NGO	PS	LC	DN						
Prioritize locations for lionfish control efforts	Support process for site prioritization to help countries identify priority areas for lionfish control efforts	✓		✓											2013-14
	Develop and allocate sustainable funding to increase capture in deep sea and other inaccessible areas, and other control associated activities	✓	✓	✓						✓				✓	
Implement effective and efficient lionfish control programs	Identify and allocate sustainable funding for local control mechanisms	✓	✓	✓					✓				✓		2014
	Promote the adoption of best practices in control among various stakeholder groups, as identified in the document "Invasive Lionfish: A Guide for Control and Management"	✓		✓	✓	✓	✓	✓							2013-15
	Encourage and promote the use of the best equipment and tools available for control and mitigation (with the organization of workshops, trainings, exchange of experiences)	✓		✓		✓									2013-15
	Help countries design control and mitigation plans by selecting the best array of tools (consumption, fishing tournaments, etc.) depending on their particular situation with respect to invasion and local capacities	✓		✓			✓								
	Verify the enforcement of standards of best control practice	✓	✓	✓	✓	✓	✓	✓	✓				✓		2015-20

Control invasive lionfish populations using regionally coordinated, effective methods											
Objective 4 continued	Strategy	Actions	Actors*							Timeline	
			Govt.	Univ	RB/IO	RM	NGO	PS	LC		DN
	Enhance ecosystem resilience through management and restoration programs	Implement protection and restoration programs for mitigating lionfish impacts (eg. design and creation of new MPAs)	✓			✓	✓	✓			2015-17
	Promote human consumption of lionfish, if safe, as a control Strategy	Establish cooperation schemes between fishermen, restaurants and hotels to encourage consumption of lionfish. Design marketing schemes in the community to encourage the consumption of lionfish.			✓		✓	✓			2013-14 2014-15

\*Govt. = governments; Univ. = Academia; RB/IO= Regional bodies/International organisations; RM = Resource managers; NGO = Non-Governmental Organizations; PS = Private Sector; LC = local communities; DN = donors

Objective 5	Provide education, information and outreach mechanisms to generate public support and foster stewardship in invasive lionfish programs										
	Strategy	Actions	Actors*								Timeline
Govt.			Univ.	RB/IO	RM	NGO	PS	LC	DN		
Develop a regional communication Strategy to raise public awareness on the lionfish issue	Identify key messages and target audience Identify effective communication channels and direct target audience for the best use of information and resources Implement monitoring and evaluation methods to determine effectiveness of communication strategies Securing the endorsement of the various sectors to support the communication scheme (eg, funding support, design, distribution)	✓		✓		✓					2013
		✓	✓	✓		✓					2013
		✓	✓	✓		✓					2015-16
		✓	✓	✓	✓	✓	✓	✓		2014-20	
		✓		✓		✓					2014-15
Promote the adoption of lionfish education tools and their integration in school curricula	Encourage governments to include invasive alien species in general, and the lionfish in particular, in the school natural science programs Integrate invasive alien species in general, and the lionfish in particular, into relevant tertiary courses Use the contact list developed by the RLC to disseminate relevant education tools		✓								2014
		✓		✓		✓					2013-15

Provide education, information and outreach mechanisms to generate public support and foster stewardship in invasive lionfish programs											
Objective 5 continued	Strategy	Actions	Actors*							Timeline	
			Govt.	Univ.	RB/O	RM	NGO	PS	LC		DN
Promote the consumption of lionfish, if safe		Compile and encourage standardized analyses of ciguatera throughout affected countries to make sure that lionfish are not ciguateric and thus improper for human consumption	✓		✓		✓		✓		2013-15
		Promote the consumption of lionfish as one of the most efficient means of control through awareness and communication campaigns targeting the general public and restaurants (to encourage them to serve lionfish)	✓	✓	✓						2014-15
Provide appropriate training to end users		Support the training of fishermen and reef reliant industries staff on first aid, safe fishing, and handling of lionfish	✓	✓		✓	✓				2015-17
		Identify and disseminate best control practices	✓	✓	✓	✓	✓	✓	✓	✓	2014-20

\*Govt. = governments; Univ. = Academia; RB/O= Regional bodies/International organisations; RM = Resource managers; NGO = Non-Governmental Organizations; PS = Private Sector; LC = local communities; DN = donors

## 4. EVALUATION AND REVIEW

This Strategy should be evaluated and reviewed on a regular basis to include further actions according to regional developments on this issue. These regular reviews are expected to play a key role in determining future priorities as the lionfish invasion progresses and social and policy priorities evolve.

## 5. SUGGESTED READING AND REFERENCES

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## **Appendix 1. Regional Lionfish Committee members**

### ***Co-chairs***

*June 2013*

#### **Mexico**

Ricardo Gomez Lozano, Comisión Nacional de Áreas Naturales Protegidas (CONANP)

#### **USA**

Christine Dawson, Department of State

#### **UNEP CEP**

Alessandra Vanzella-Khouri, SPAW Program Officer, UNEP/CAR-RCU  
Franck Gourdin, SPAW Regional Activity Center  
Hélène Souan, SPAW Regional Activity Center

#### **France**

Jean-Philippe Marechal, Observatoire du Milieu Marin Martiniquais

### ***Members***

#### **ICRI Secretariat**

Anne Caillaud, Great Barrier Reef Marine Park Authority, Australia  
John Baldwin, Great Barrier Reef Marine Park Authority, Australia  
James Azueta, Fisheries Department, Belize

#### **Reef Check Dominican Republic**

Ruben Torres

#### **NOAA**

James A. Morris, Jr.

#### **CABI**

Naitram (Bob) Ramnanan

#### **University West Indies – Jamaica**

Dayne St. A. Buddo

## Appendix 2. Acronyms

<b>CABI</b>	Centre for Agricultural Bioscience International
<b>CBD</b>	Convention on Biological Diversity
<b>CEP</b>	Caribbean Environment Programme
<b>CONANP</b>	Comisión Nacional de Áreas Naturales
<b>GCFI</b>	Gulf and Caribbean Fisheries Institute
<b>GEF</b>	Global Environment Fund
<b>IAS</b>	Invasive Alien Species
<b>ICRI</b>	International Coral Reef Initiative
<b>MPA</b>	Marine Protected Area
<b>NOAA</b>	National Oceanic and Atmospheric Administration
<b>REEF</b>	Reef Environmental and Educational Foundation
<b>RLC</b>	Regional Lionfish Committee
<b>SPAW-RAC</b>	Specially Protected Areas and Wildlife Regional Activity Center
<b>UNEP</b>	United Nations Environment Program



