



Ecosystem Approach to Fisheries for the Caribbean Spiny Lobster *Panulirus argus*

June 2019

DRAFT. NOT TO BE DISSEMINATED.

ACKNOWLEDGMENTS:

Development of this Information Product and its contents, and/or the activities leading thereto, have benefited from the financial support of the UNDP/GEF Project:

“Catalysing Implementation of the Strategic Action Programme (SAP) for the Sustainable Management of shared Living Marine Resources in the Caribbean and North Brazil Shelf Large Marine Ecosystems”

(CLME+ Project, 2015-2020)

The CLME+ Project is executed by the United Nations Office for Project Services (UNOPS) in close collaboration with a large number of global, regional and national-level partners. All are jointly referred to as the “CLME+ Project co-executing partners”.

www.clmeproject.org

info@clmeproject.org



As a GEF Agency, the United Nations Development Programme (UNDP) implements a global portfolio of GEF co-funded Large Marine Ecosystem projects, among which the CLME+ Project.
www.undp.org



Through the International Waters (IW) focal area, the Global Environment Facility (GEF) helps countries jointly manage their transboundary surface water basins, groundwater basins, and coastal and marine ecosystems.
www.thegef.org



UNOPS mission is to serve people in need by expanding the ability of the United Nations, governments and other partners to manage projects, infrastructure and procurement in a sustainable and efficient manner.
www.unops.org

CLME+ Project Information Products are available on the CLME+ Hub (www.clmepius.org) and can be downloaded free of cost.

Publication:

[Author(s)], [Month] [Year]

[Contact details]

© [All rights reserved]. [Text field for the copyright holder]

[Text field for [e.g. front/back cover] photo credits]

Citation: [please provide citation]

[Author(s)] [and the CLME+ Project co-executing partners] encourage[s] the reproduction, dissemination and use of this Information Product. Except where otherwise indicated, material from this Information Product may be copied, downloaded, reproduced and disseminated for private study, research, educational and [advocacy]/[awareness-raising purposes, or for use in non-commercial products or services, without special permission from the copyright holder(s)], provided that the appropriate acknowledgment of the source is made and that endorsement by the Author(s) and/or the GEF, UNDP and the CLME+ Project co-executing partners of the users' views, products or services is not implied in any way.

[No part of this publication may be reproduced, disseminated or used for any commercial purposes or resold without the prior written permission of the Author(s).]

CLME+ Project Information Product Series [- Technical Reports]

DISCLAIMER:

The designations employed and the presentation of information in any format in this Information Product do not imply the expression of any opinion whatsoever on the part of the GEF, UNDP and/or any of the CLME+ Project co-executing partners [other than the Author(s)] concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

The mention of specific companies or of certain manufacturers' products does not imply that they are endorsed or recommended by the GEF, UNDP and/or any of the CLME+ Project co-executing partners [other than the Author(s)] in preference to others of a similar nature that are not mentioned.

Unless expressly stated otherwise, the content, facts, findings, interpretations, conclusions, views and opinions expressed in this Information Product are those of the Author(s), and publication as a CLME+ Project Information Product does not by itself constitute an endorsement of the GEF, UNDP and/or any of the CLME+ Project co-executing partners other than the Author(s) of such content, facts, findings, interpretations, conclusions, views or opinions.

The GEF, UNDP and/or any of the CLME+ Project co-executing partners [other than the Author(s)] do not warrant that the information contained in this Information Product is complete and correct and shall not be liable whatsoever for any damages incurred as a result of its use.

CLME+ Project co-executing partners:



Contents

Acronyms and Abbreviations	1
Introduction	3
Spiny Lobster fisheries status and trends	5
Stock definition.....	5
Exploitation status.....	5
Fishery landings.....	7
Impact.....	8
Associated social and economic aspects	9
Benefits from the spiny lobster.....	9
Production and value.....	9
Employment.....	12
Human well being and social justice in spiny lobster fisheries.....	12
Impact.....	13
Drivers and pressures	14
Drivers.....	14
Pressures.....	14
Impact of spiny lobster fisheries on marine habitats and biodiversity.....	17
Responses	18
Governance architecture.....	18
Governance processes.....	19
Stress reduction measures.....	21
Recommendations for action.....	23
References	24

Acronyms and Abbreviations

CARICOM	Caribbean Community
CFMC	Caribbean Fishery Management Council
CLME+	The Caribbean Large Marine Ecosystem and the North Brazil Shelf Large Marine Ecosystem
CRFM	Caribbean Regional Fishery Mechanism
GDP	gross domestic product
GEAF	Governance Effectiveness Assessment Framework
IUCN	International Union for Conservation of Nature
IUU	illegal, unreported and unregulated (fishing)
LME	Large Marine Ecosystem
MPA	marine protected areas
MSC	Marine Stewardship Council
OSPESCA	Central American Fisheries and Aquaculture Organization
RFMO	regional fisheries management organization
SAP	Strategic Action Programme
SDG	Sustainable Development Goal
SICA	Central American Integration System
SPA	Specially Protected Areas and Wildlife
WECAFC	Western Central Atlantic Fishery Commission

Key facts and messages



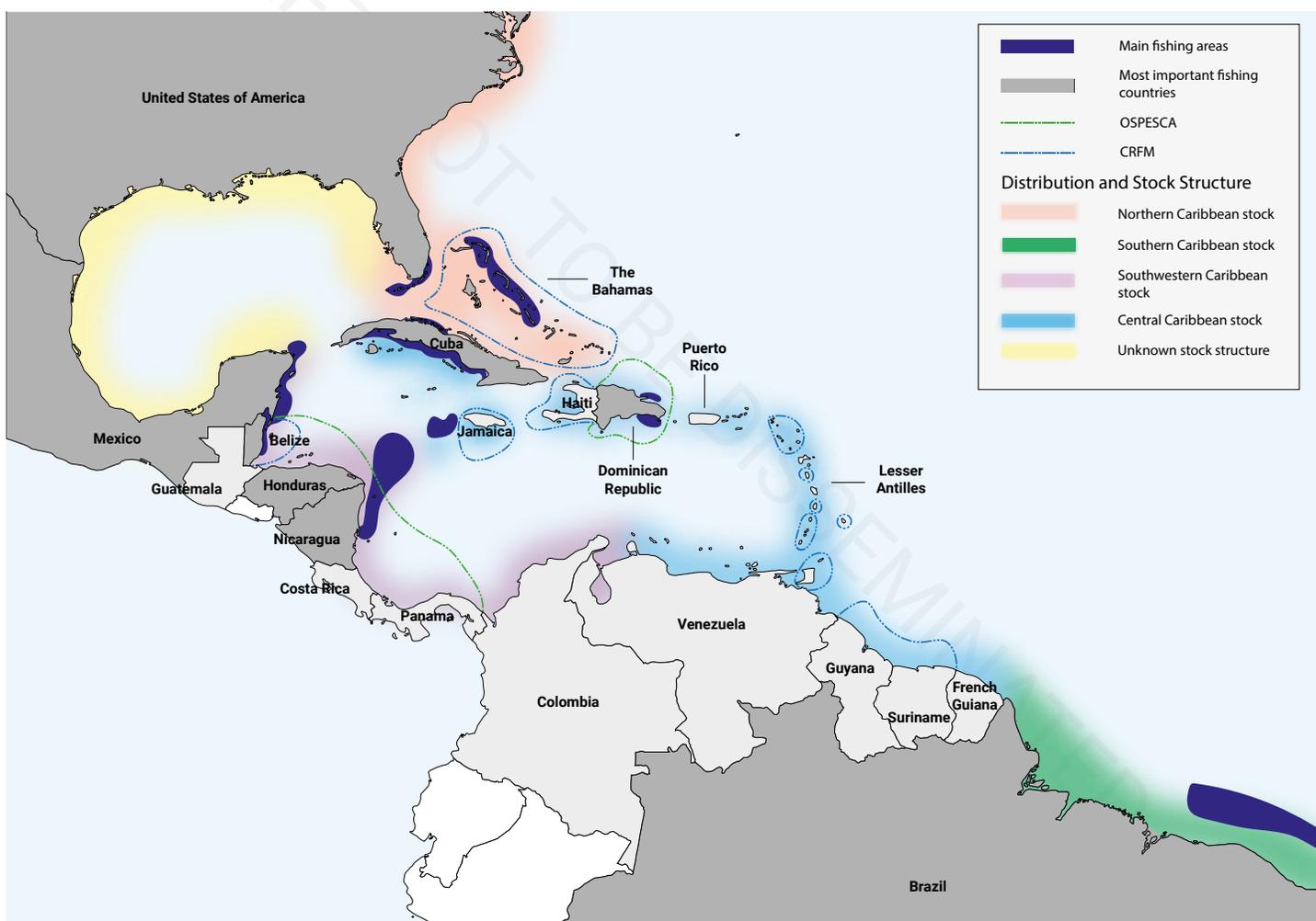
- The Caribbean spiny lobster, *Panulirus argus*, is distributed throughout the Western Central Atlantic Fishery Commission (WECAFC) area.
- Spiny lobster production and survival are highly dependent on the quality of its preferred marine habitats including seagrass beds, mangroves, coral reefs and rocky areas.
- The planktonic larvae are dispersed by ocean currents throughout the Caribbean Sea, and maintaining the lobster population at a particular site may depend on larvae arriving from distant localities, including across political boundaries.
- Four spiny lobster stocks have been proposed, consisting of one stock in Brazil and three stocks whose respective distributions are largely consistent with the WECAFC, Caribbean Regional Fishery Mechanism (CRFM) and Central American Fisheries and Aquaculture Organization (OSPESCA) geographical areas of competence.
- Countries in the WECAFC region derive a range of social and economic benefits from the provisioning and cultural ecosystem goods and services provided by the spiny lobster.
- This species sustains one of the most valuable fisheries in the region, with nearly 40,000 tons valued at up to US\$ 1 billion dollars landed in 2016.
- Spiny lobster fisheries provide employment for 60,000 fishers and about 200,000 more people engaged in related activities. These fisheries are the key economic livelihood of some coastal communities.
- Lucrative prices and high demand for export and by the local tourism sector are the main drivers for exploitation of the spiny lobster. High demand coupled with reduced supply of spiny lobster has increased lobster prices and promoted overcapitalization in the fishery.
- Illegal, unreported and unregulated (IUU) fishing and 'ghost fishing' by lost or abandoned lobster fishing gear contribute to unsustainable fishing of spiny lobster, but the levels are currently unknown.
- Caribbean spiny lobster stocks appear to be "maximally sustainably fished" throughout most of their range, and may not support a further increase in fishing effort.
- In a number of countries the spiny lobster fishery is overfished, while in others it is fully fished or its status is unknown. In Brazil, the stock may be close to collapse.
- Overfishing of spiny lobster undermines the achievement of relevant goals and targets, including Sustainable Development Goal (SDG) Targets 14.4 and 14.7, and Aichi Target 6.
- Because of the socioeconomic importance of the spiny lobster and its shared nature, improving its status should be a priority for international fisheries.
- Due to the wide larval dispersal and geographic distribution of spiny lobster across international boundaries, maintaining sustainable lobster fisheries requires both local and international management, as well as joint management including monitoring, control and surveillance by all countries with lobster fisheries.
- Spiny lobster fishery regulations have been developed by WECAFC, CRFM and OSPESCA but there is no regional legislation.
- The most widely used management measures by the countries are minimum size limits and closed seasons for lobster fishing. To date, 28 countries in the region have implemented closed seasons.
- A Regional Caribbean Spiny Lobster Fishery Management Plan has been adopted by OSPESCA and is expected to be adopted by WECAFC, the Central American Integration System (SICA) and the Caribbean Community (CARICOM) in 2019.
- There is an urgent need to improve and harmonize data collection and stock assessments at the level of the individual spiny lobster stocks and regionally, and to address important knowledge gaps about the spiny lobster.

1. Introduction

Geographic distribution and ecology

The Caribbean spiny lobster, *Panulirus argus* (hereafter referred to as spiny lobster or lobster), is distributed in the subtropical western Atlantic from Bermuda and the east coast of the USA from North Carolina, to Rio de Janeiro, Brazil, including the entire Gulf of Mexico and the Caribbean Sea,¹ from shallow waters to depths up to 100 m (Figure 1).

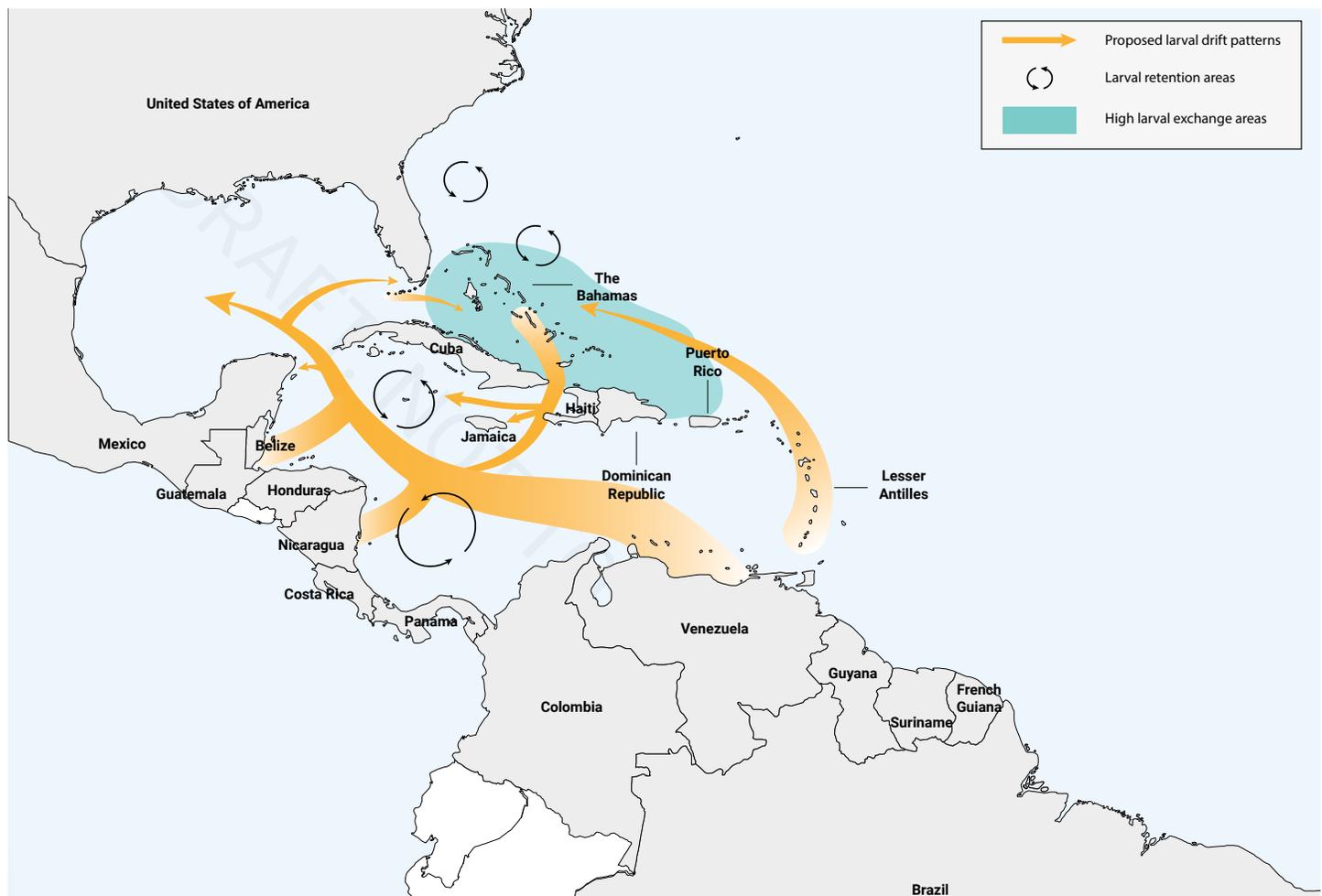
Figure 1. Spiny lobster distribution, major fishing areas and schematic representation of the limits of the spiny lobster stocks: northern, central, and southwest Caribbean stocks, and southern stock (Brazil). See text and Box 1 for details.



Two characteristics of the spiny lobster are highly pertinent to an ecosystem approach to fisheries and the collaborative management of this valuable resource:

1. It occupies various marine habitats, with seagrass beds, mangroves, coral reefs and rocky substrates the preferred habitats for juveniles and adults. Areas with the highest spiny lobster fishery production in the Caribbean are those with extensive shallow coastal zones with habitats that are suitable for juvenile lobsters. The highest stock abundance is observed in the western Caribbean and Brazil.²
2. It has a complex life cycle,³ with a 6–12 month planktonic larval period. Of particular importance is the dispersal of spiny lobster larvae by ocean currents throughout the Caribbean Sea and the Western Central Atlantic Ocean (Figure 2).⁴ Larvae are also retained in ocean gyres predominantly in the Gulf of Honduras, off Costa Rica and Panama, south of Cuba, and north of The Bahamas (Figure 2). Subsequently, the larvae migrate to coastal habitats, where they occupy shallow nursery areas for a further 6 to 8 months.

Figure 2. Proposed Caribbean spiny lobster larval dispersal patterns and larval retention areas in the Caribbean. See text for details.



Larval drift determines the source of recruitment to the fishery, and it is thought that maintaining the **lobster population** at a particular site may depend on larvae arriving from distant localities (Figure 2). The drift of larvae across political boundaries creates a strong link among the countries that share this transboundary resource.



Despite the 'import' of larvae, self-recruitment (i.e. juveniles returning to their natal population) may be dominant in some areas.

Strong larval connectivity has been identified between the Dominican Republic, Belize, Nicaragua, the Florida Keys and West Florida.⁵ Overall, these results are consistent with the major larval exporter countries (Venezuela, Nicaragua, Belize and the Dominican Republic) previously suggested.⁶ Another study suggested that sites in The Bahamas export larvae to the Gulf of Mexico, Turk & Caicos, Cuba, the Dominican Republic, Haiti, Puerto Rico, Jamaica, the Cayman Islands and Mexico.

In contrast, The Bahamas receives recruits from all areas of the Caribbean, with high levels from Turks & Caicos, the Dominican Republic, Haiti, Puerto Rico, the Lesser Antilles, parts of Cuba and Florida.

The Caribbean spiny lobster sustains one of the most valuable fisheries in the Western Central Atlantic Fishery Commission (WECAFC) region,¹ with an average annual landed catch of around 30,000 tons valued at up to US\$ 1 billion dollars (based on total landings and market prices, M. Perez, pers. comm.).

i In this report, 'region' refers to the WECAFC area of competence, unless stated otherwise.

2. Spiny lobster fisheries: Status and trends

2.1 Stock definition

Although it is difficult to define the different lobster stock units due to their long larval phase across wide areas of open ocean before settling in a suitable habitat,⁷ doing so is necessary if this internationally important fishery is to be managed effectively. The first stock classification carried out by the WECAFC of the Food and Agriculture Organization of the United Nations (FAO) identified four substocks within the Caribbean Sea and the Western Central Atlantic. A new stock structure, with three stocks in the Caribbean, was recently proposed (Figure 1 and Box 1).⁸ Another stock is proposed in Brazil, which has important genetic differences from the Caribbean population.⁹

Box 1 Joint Spiny Lobster Working Group adopts new stock structure



At its second meeting (in 2018), the Joint OSPESCA/WECAFC/CRFM/CFMC* Working Group on Caribbean Spiny Lobster considered this new spatial definition of spiny lobster stocks (Figure 1), which is largely consistent with the WECAFC, CRFM and OSPESCA geographical areas of influence. The Working Group therefore agreed to accept this new proposal in place of the former stock definition proposed by the FAO WECAFC Working Group in 2001 and also suggested that future regional management measures should be based on this new stock definition. Although there are separate stocks, there is a high level of connectivity among them due to larval drift. Therefore, collaboration and coordination will be required among the countries and fisheries bodies to manage the spiny lobster fishery.

* Central American Fisheries and Aquaculture Organization/Western Central Atlantic Fishery Commission/Caribbean Regional Fishery Mechanism/Caribbean Fishery Management Council

Meanwhile, the United States has identified a stock in the South Atlantic/Gulf of Mexico, and three stocks in the Caribbean Sea: Puerto Rico, St. Thomas/St. John, and St. Croix States.¹⁰ The existence of different possible stocks within the WECAFC area highlights the need for further investigations to definitively delimit each stock and to understand the interaction between them in terms of larval export and recruitment to the fishery.

2.2 Exploitation status

Stock assessments are generally limited by the availability of consistent time series of data including on catch, effort and recreational catch, as well as information on biological parameters. Collecting data on catch and effort is difficult, particularly because lobster fishing is carried out mainly by small-scale fishers with open access to the resource and limited reporting of catch and effort. Nevertheless, several countries routinely collect fisheries data and periodically conduct stock assessments.ⁱⁱ

At the subregional level, Central American Fisheries and Aquaculture Organization (OSPESCA) member countries have initiated efforts to harmonize data-collection formats and apply a simple fishery evaluation model.

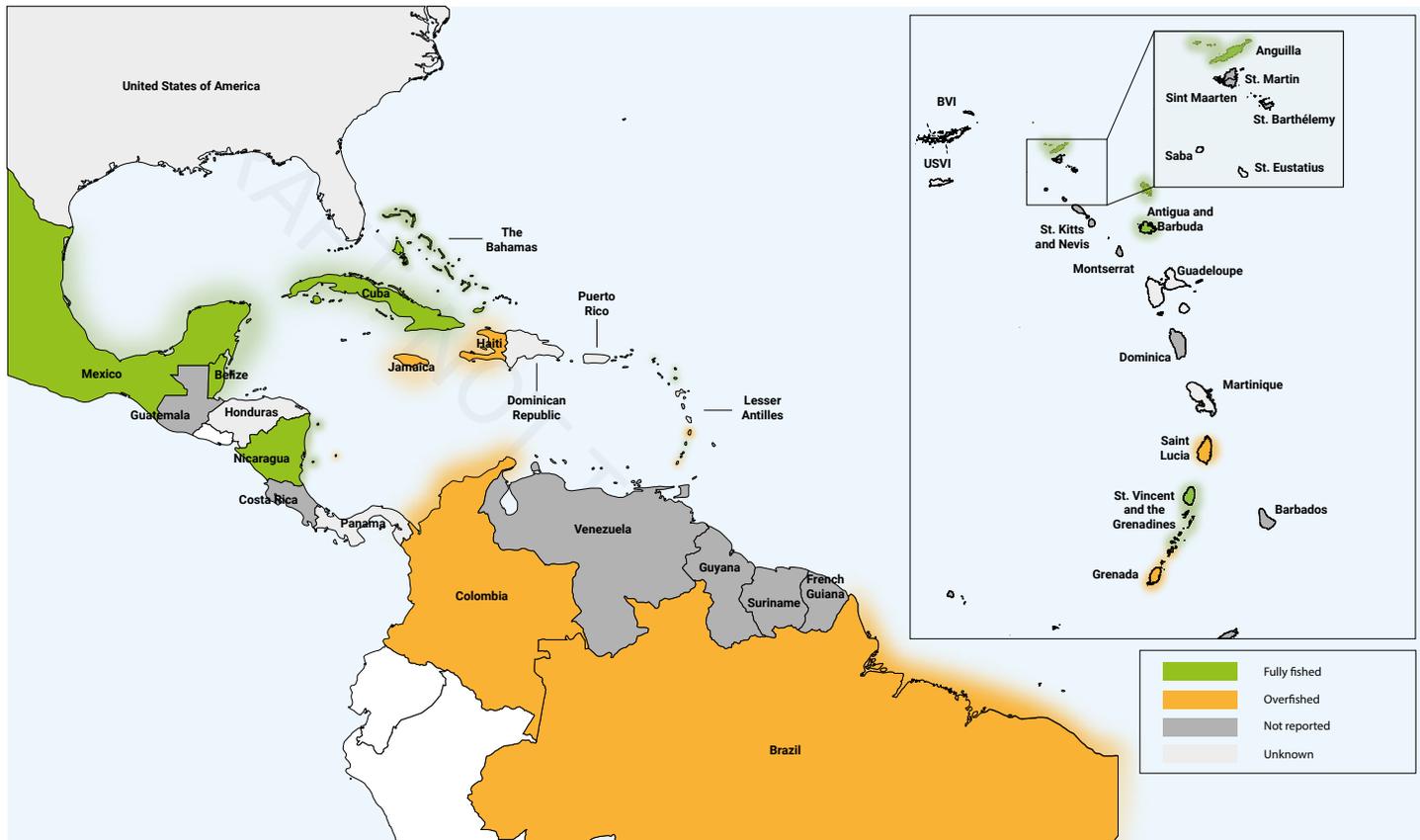
However, there are no harmonized methodologies and regional indicators or reference points that can generate comparable results on the exploitation status of the lobster fishery at the regional level.

Attempts to assess the exploitation status of spiny lobster in the WECAFC region show similar results. According to the 2018 FAO State of World Fisheries and Aquaculture Report, Caribbean spiny lobster stocks appear to be “maximally sustainably fished” throughout most of their range.¹¹ Another assessment indicates that all three Caribbean stocks (northern, central and southwestern) are fully exploited.¹² Consequently, an increase in fishing effort should not be permitted.

Assessments presented at the first and second meetings of the Joint OSPESCA/WECAFC/CRFM/CFMC Working Group on Caribbean Spiny Lobster (2014 and 2018) indicate that the stocks appear to have improved compared with 2006, and that the status in individual countries is either fully fished/stable, overfished, or unknown (Figures 3). A separate assessment for Brazil indicates that the stock has been heavily overexploited since the 1980s and may be close to collapse.¹³

ii For a list of countries, see Report of the first meeting of the OSPESCA/WECAFC/CRFM/CFMC Working Group on Caribbean Spiny Lobster, Panama City, Panama, 21–23 October 2014.

Figure 3. Spiny lobster exploitation status by country/territory based on the best available information (Reports of the first and second meetings of the Joint OSPESCA/WECAFC/CRFM/CFMC Working Group on Caribbean Spiny Lobster)



High demand coupled with reduced supply of spiny lobster has increased lobster prices and promoted overcapitalization (excess fishing effort) in the fishery. This may account for the overfished status in some areas.

The confidence levels of these assessments have not been stated and are affected by uncertainty about the degree of interaction among stocks through larval drift, particularly regarding the level of recruitment from different sources, which should be accounted for in assessments. It is clear that there is an urgent need to improve and harmonize data collection and spiny lobster stock assessments at the level of the individual stocks and regionally.

On the International Union for Conservation of Nature (IUCN) Red List of Threatened Species (2011), the Caribbean spiny lobster has been assessed as "Data deficient" and the current population trend is decreasing. If further information on catch per unit effort becomes available, it is likely that this species will be uplisted to a threatened category. Additionally, this species is listed in Annex III of the Specially Protected Areas and Wildlife (SPAW) Protocol that includes species whose exploitation is allowed provided it is regulated to ensure and maintain the population at an optimum level.

2.3 Spiny lobster fishery landings

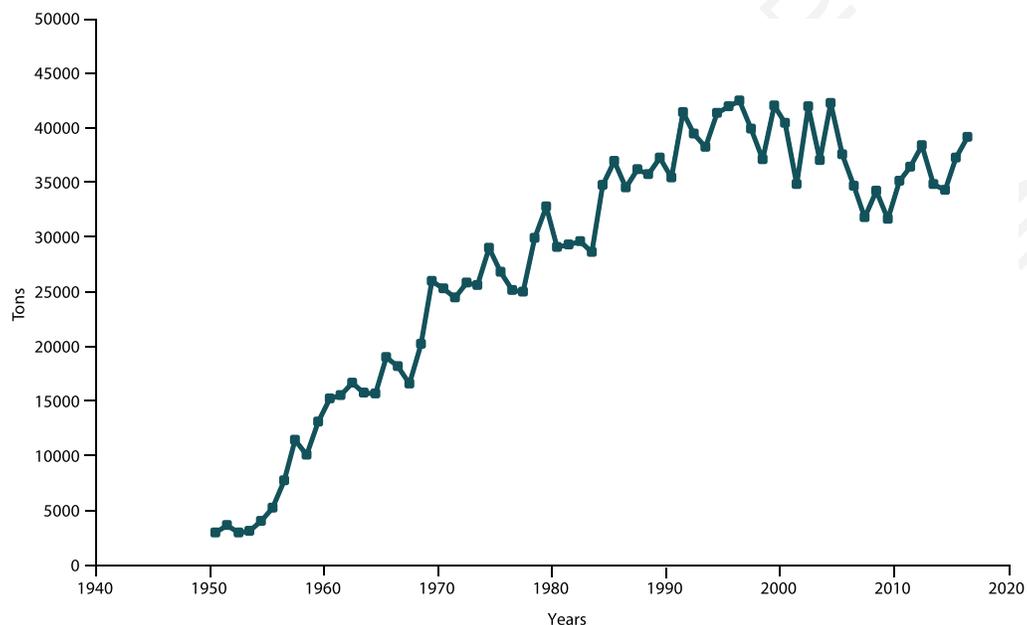
Box 2

Following a steady increase from 1950, landings in the WECAFC area decreased from 42,288 tons in 2004 to 31,720 tons in 2009 (Figure 4). This decrease was mostly due to intense exploitation and to environmental and ecological changes in the spiny lobster habitat.²⁸ Other contributing factors were illegal, unreported and unregulated (IUU) fishing (particularly by small-scale lobster fishers), insufficient regional coordination to manage this shared resource, and limited research at the national and regional levels to inform decision-making.

The status of the spiny lobster resource has also been inferred from trends in catch landings. From 2009 to 2016, total landings increased, reaching 39,244 tons in 2016. This recovery might have led the OSPESCA/WECAFC/CRFM/CFMC Working Group on Caribbean Spiny Lobster to conclude in 2014 that the state of the stocks appeared to have improved compared with 2006.

However, increasing catches on their own do not necessarily reflect improved stock status, and further investigation is required to determine the factors accounting for the catch trends observed.

Figure 4. Total landings (nominal weight in tons) of Caribbean spiny lobster from 1950 to 2016 (based on landings reported to FAO by countries, including Brazil)



2.4 Impact

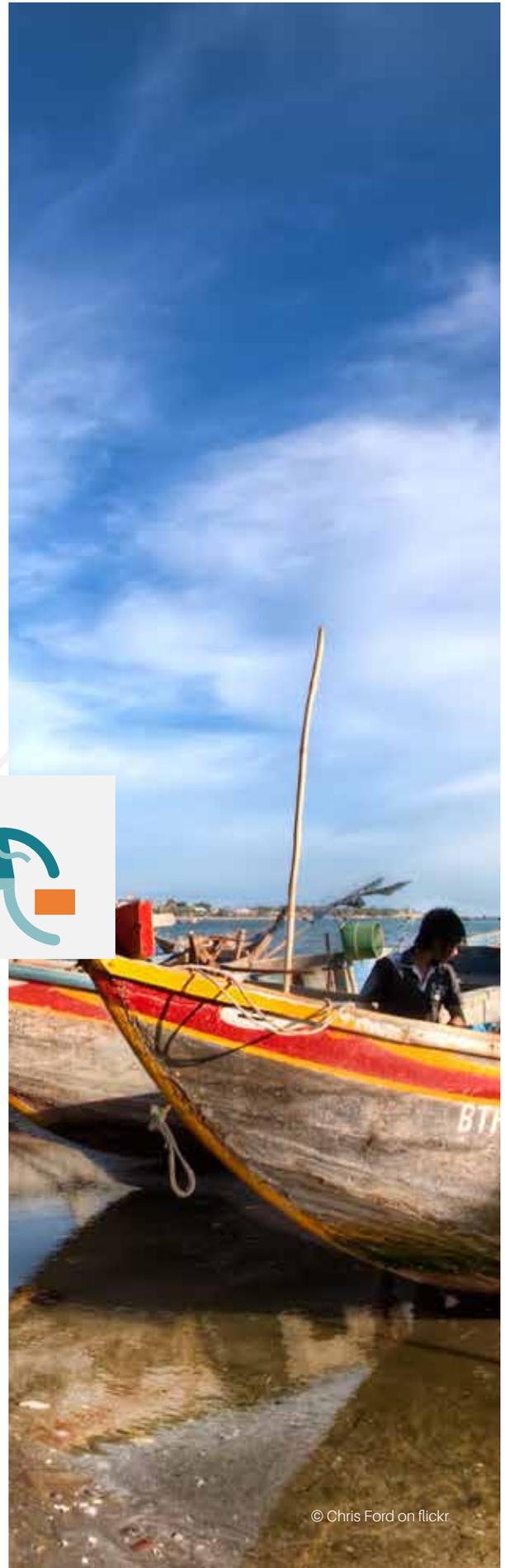
Impact is considered in terms of the achievement of specific societal goals and targets. While individual countries and subregional political bodies may have their own goals and targets, for this regional report the relevant Sustainable Development Goals (SDGs), particularly SDG 14, and Aichi Targets are considered in the context of the spiny lobster fisheries:

1. SDG 14, Target 14.4 (By 2020, effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield as determined by their biological characteristics);
 - Indicator 14.4.1: Proportion of fish stocks within biologically sustainable levels
2. Aichi Target 6: By 2020 all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits.

Determining whether or not the fishery is biologically sustainable will require further analyses based on reliable data and information.

In areas where overfishing is taking place, the fishery is clearly **not biologically sustainable under current conditions**, which means that these targets are not being achieved.

Furthermore, under a business-as-usual scenario, the fishery could potentially collapse, with the Brazilian fishery reportedly close to doing so. Because of the socioeconomic importance of the spiny lobster and its shared nature, improving its status should be a priority for international fisheries.



3. Associated social and economic aspects

3.1 Benefits from the spiny lobster

Box 3 Human communities in the WECAFC region derive a range of social and economic benefits from the spiny lobster:

Provisioning ecosystem service:

Nearly 40,000 tons of spiny lobster were landed in the WECAFC area in 2016 (FAO fisheries statistics). The spiny lobster fishery is a source of:

- **Income:** The annual value of the total spiny lobster fishery landings in the Caribbean and Western Central Atlantic ranges from US\$ 400 million to US\$ 1 billion. In 2011, exports were valued at around US\$ 378 million (FAO). Income from the spiny lobster fisheries in turn supports socioeconomic development in the countries where it is exploited.
- **Food security:** Although most of the lobster catch is exported, lobster and other reef species have always been part of the diet of indigenous communities such as the Miskito communities in Nicaragua.
- **Employment:** Spiny lobster fisheries are an important source of employment and are key to the livelihoods of some coastal communities that do not have any other form of subsistence.

Cultural ecosystem service:

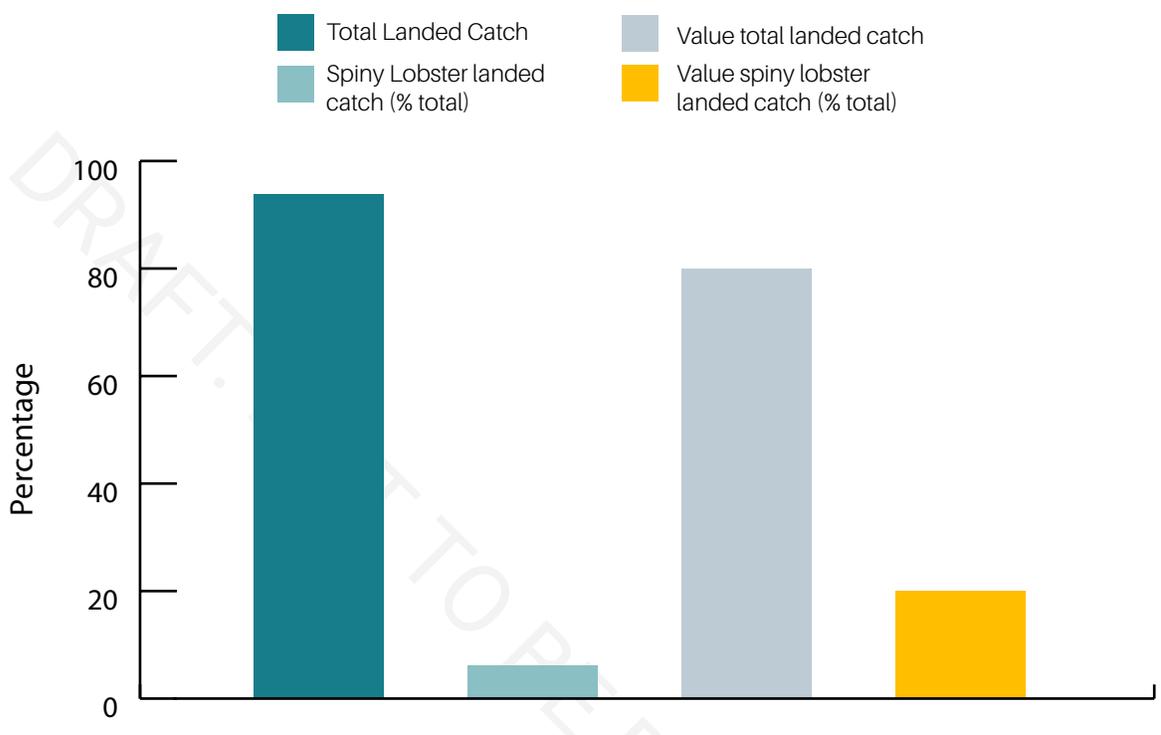
- **Recreation:** There are more than 100,000 recreational spiny lobster fishers in the region. The spiny lobster is also an attraction in reef dive tourism.
- **Luxury food:** Spiny lobster is valued as a luxury food item and a highly prized delicacy, both for export and locally within the tourism sector.
- **Culture and tradition:** The spiny lobster has cultural and traditional importance in the region, including being regarded as a cultural icon.

3.2 Spiny lobster production and value

The Caribbean spiny lobster sustains one of the most economically important fisheries in the WECAFC region, as illustrated by its landings and value compared to total other fishery landings and value in the Caribbean Large Marine Ecosystem (LME) in 2014 (Figure 5). While the landed catch of lobster comprised only about 6 per cent of the total fishery landings in this LME, its value amounted to 20 per cent of the value of the total landings.¹⁴ Globally, the Caribbean spiny lobster accounted for about 14 per cent of world lobster landings in 2013.¹⁵

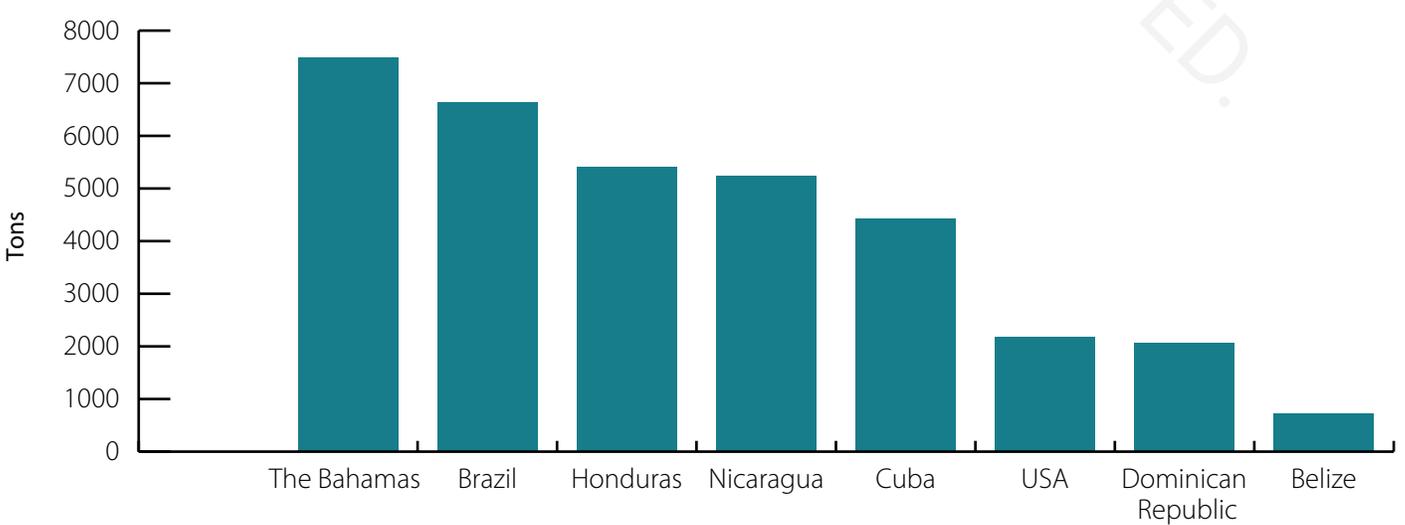


Figure 5. Spiny lobster landings and value compared to total other fishery landings and value in the Caribbean Large Marine Ecosystem in 2014 (Sea Around Us)



The main spiny lobster-producing countries (based on their average annual landings) are shown in Figure 6. While The Bahamas followed by Brazil, Honduras, Nicaragua and Cuba are the top five producers, the spiny lobster is exploited to varying degrees throughout its geographic range.

Figure 6. Main Caribbean spiny lobster-producing countries based on the average annual landings from 2012 to 2016 (FAO catch statistics)



Spiny lobster fisheries are generally artisanal or small-scale, with the exception of Honduras, Nicaragua and Cuba, where they are mainly industrial. The average annual total production of spiny lobster from all Caribbean and Western Central Atlantic countries reporting their fishery statistics to FAO for the period 2012–2016 was approximately 35,000 tons whole weight.¹⁶

On average, each commercial fisher catches about 500 kg of spiny lobster per year. From 2012 to 2016, the annual value of the landings in the Caribbean and the Western Central Atlantic ranged between US\$ 400 million and US\$ 1 billion.

The contribution of the spiny lobster fishery to national gross domestic product (GDP) is unknown. In most countries, the information available refers to the contribution of the entire fishing sector to GDP, which is generally not more than 5 per cent. Nevertheless, in many Caribbean nations the spiny lobster is of major economic importance to commercial, recreational and artisanal fishers who are dependent on its proper management.

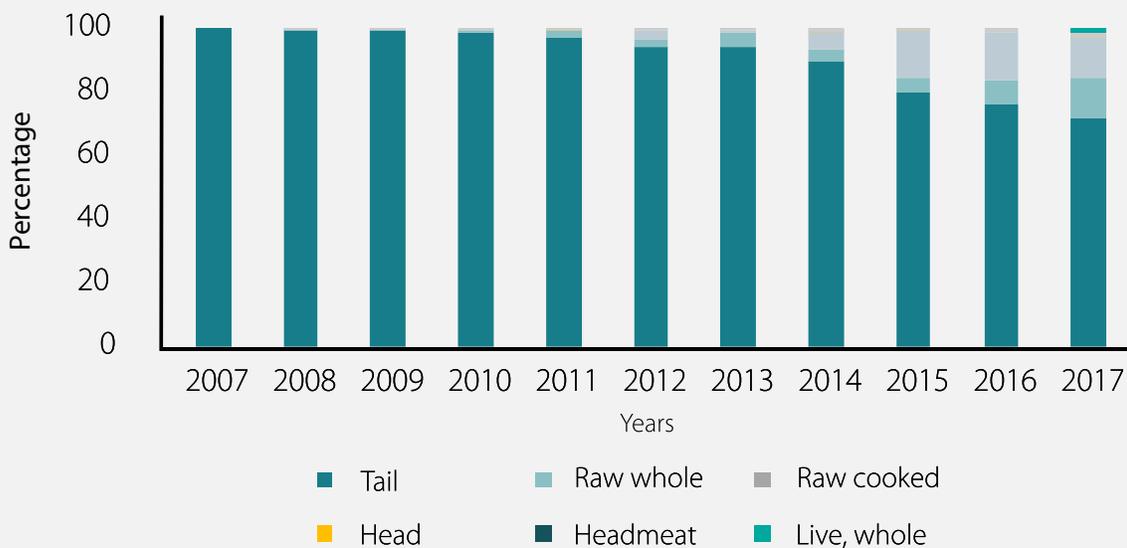
Box 4

In most countries, more than 90 per cent of the spiny lobster catch is exported, although in some countries there is a significant local market in the tourism sector. Traditionally, the main destination market has been the United States, which receives 90 per cent of spiny lobster exports from Central and South America. Recently, however, export markets have opened up in the European Union and Asia. There are opportunities to diversify and add value to the spiny lobster export product by, for example, exporting live or frozen whole lobsters instead of only the tails (see Box 5). International coordination and collaboration could assist the lobster-producing countries with identifying and exploiting potential opportunities with respect to markets for spiny lobster and its commercialization.

Box 5 Adding value to lobster: The example of Nicaragua

Recently, some countries have started exporting live, whole frozen, and whole pre-cooked spiny lobsters. The latter are destined mainly for the European market, with France being the main market for lobster in Europe, and the main distribution centre to other European countries, particularly Spain, Italy, Germany and Belgium. Nicaragua is becoming one of the main exporters of lobster to France, and it is diversifying the lobster export products to include live or processed whole lobster.

Percent of lobster export value by product type



3.3 Employment



Spiny lobster fisheries provide a significant level of employment in the region.²⁹ In some areas, lobster fisheries – particularly artisanal ones – are the **key economic livelihood of coastal communities**, who may have no other means of subsistence.³⁰

In 2010, more than 60,000 commercial fishers and some 100,000 recreational fishers were estimated for the entire Caribbean and Western Central Atlantic region, along with 200,000 people engaged in other activities related to fishing. In 2016, Brazil had 12,000 lobster fishers. Information on employment by gender is usually provided for all fisheries combined and is not available for the spiny lobster fisheries, which is a gap that should be addressed. In some countries, lobster fishers may also target other species such as queen conch and sea cucumbers, and may engage in other activities such as tourism and agriculture. For example, in 2016, 68 per cent of fishers in The Bahamas reported that fishing was their main occupation, while the remainder also engaged in other activities.¹⁷ Having alternative sources of income is particularly important during the spiny lobster closed season, where this exists.

3.4 Human well-being and social justice in spiny lobster fisheries

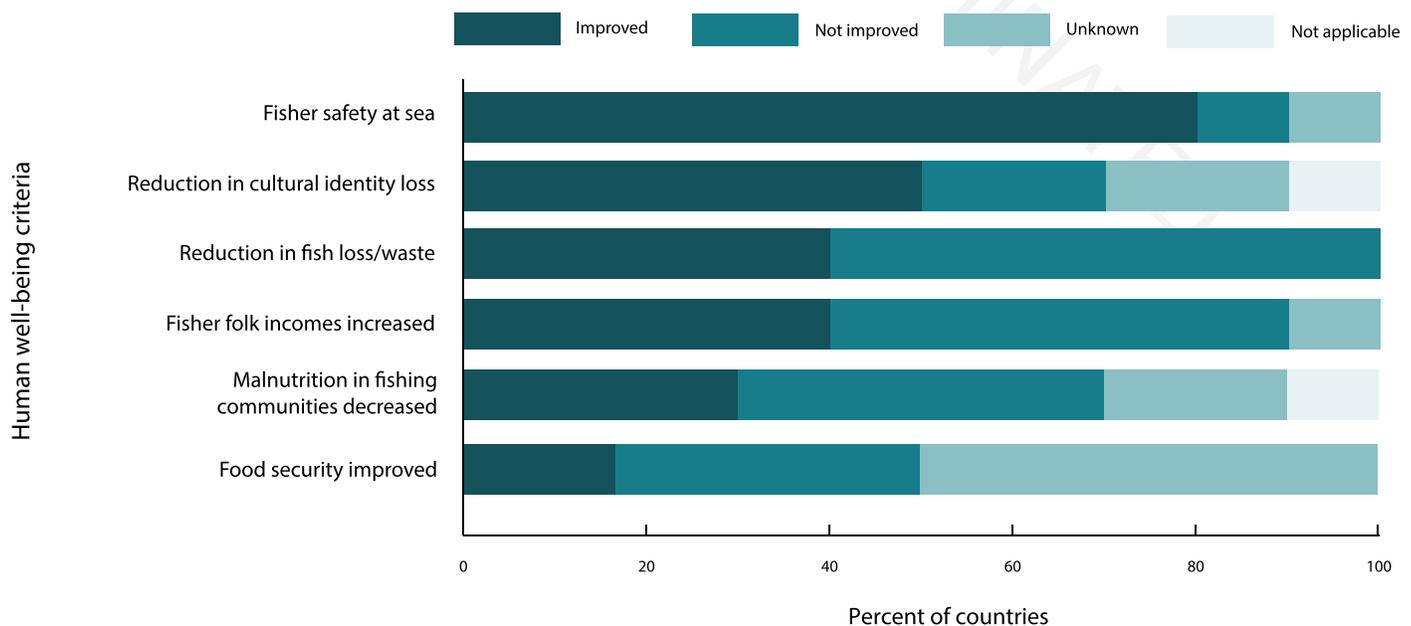
The status of spiny lobster fisheries has a direct bearing on the well-being of the communities that exploit this resource as their major source of income and livelihoods.

Six human well-being indicators of the Governance Effectiveness Assessment Framework (GEAF)¹⁸ were assessed in the context of the spiny lobster for the baseline period 2011–2015 in the countriesⁱⁱⁱ involved in the ECOLANGOSTA+ subproject^{iv} (Figure 7).

In general, the results show that:

- Eighty per cent of the countries reported an improvement in safety at sea at the end of the baseline period.
- Twenty per cent of the countries reported that food security had improved, while 40 per cent reported no improvement and for 40 per cent its status was “unknown” during the period. Spiny lobster is considered a luxury product for the export market or for domestic consumption in the tourism sector, and its high price may put it out of the average citizen’s reach. Therefore, in general the spiny lobster is not likely to make a significant contribution to food security.
- About half of the countries did not notice improvements in fishers’ incomes, while 40 per cent reported an increase.

Figure 7. Level of human well-being in the ECOLANGOSTA+ countries that exploit the spiny lobster

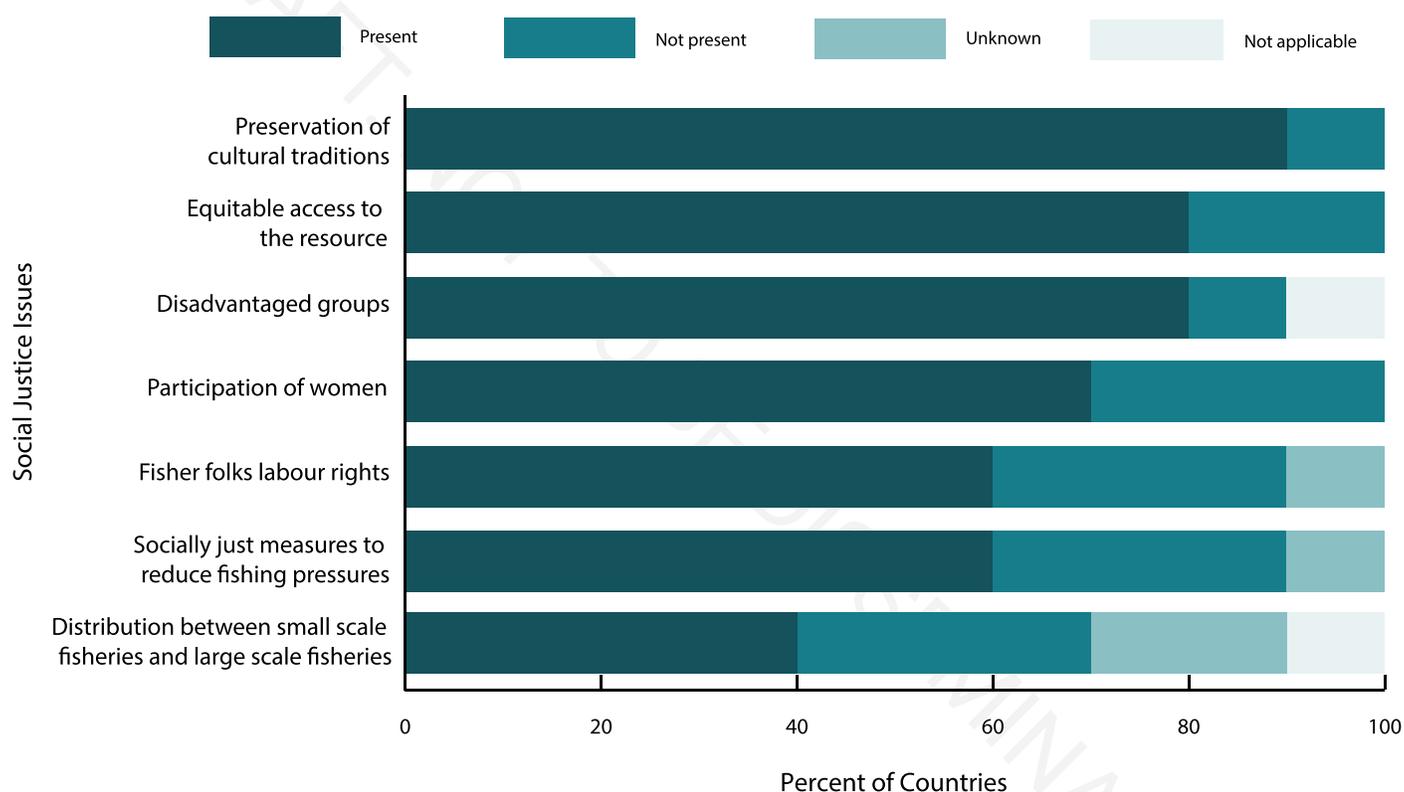


iii The Bahamas, Belize, Colombia, Costa Rica, Dominican Republic, Guatemala, Honduras, Jamaica, Nicaragua, Panama
 iv Ecosystem Based Fisheries Management for the Caribbean Spiny Lobster subproject (ECOLANGOSTA+)

Seven social justice issues (Figure 8) in the GEA¹⁹ were assessed for the baseline period 2011–2015 with respect to the spiny lobster. The four social justice issues addressed by the highest percentage of countries were: participation of women, preservation of cultural traditions, disadvantaged groups, and equitable access to resources.

On the other hand, up to 30 per cent of the countries did not address participation of women, distribution between small and large scale fisheries, fishers' labour rights and socially just measures to reduce fishing pressure.

Figure 8. Percentage of countries in the ECOLANGOSTA+ subproject that address social justice issues



The above assessments were constrained to the countries involved in the ECOLANGOSTA+ subproject, and should be extended to the other countries that exploit spiny lobster.

3.5 Impact

Improvements in human well-being and social justice are implicit in many societal goals and targets, particularly the SDGs. These assessments show that there is room for improvement with respect to all the human well-being and social justice issues assessed, some more so than others. In addition, overfishing of the spiny lobster is likely to have significant adverse economic consequences for the communities and countries that exploit this resource.

This is relevant to SDG Target 14.7 (By 2030, increase the economic benefits to Small Island Developing States and least developed countries from the sustainable use of marine resources, including through sustainable management of fisheries, aquaculture and tourism) and Indicator 14.7.1 (Sustainable fisheries as a percentage of GDP in Small Island Developing States, least developed countries and all countries). The contribution of spiny lobster fisheries to GDP is unknown, but declining landings (due to overfishing and other probable causes) will reduce the economic benefits that spiny lobster resources provide to countries.

4. Drivers and pressures

4.1 Drivers

Drivers are the economic, social, cultural and political factors that motivate human activities and satisfy basic human needs such as food and employment. They increase or mitigate pressures on spiny lobster populations, with the key drivers for the spiny lobster fishery as follows:

- **Economic value:** High prices along the value chain and high market demand for export and by the local tourism sector and people with high purchasing power represent the main drivers. High demand and reduced supply significantly increased the prices paid for lobster and have promoted further overcapitalization (excessive fishing effort) in the fishery,²⁰ which has contributed to overfishing in some countries.
- **Employment:** Lobster fishing is one of the most viable work options. In remote fishing communities where economic development is low, fishing of spiny lobster and other associated resources such as the pink snail and sea cucumber is a very attractive source of income.
- **Consumer awareness:** Consumer awareness is a positive driver, mainly in the export destination markets and in the tourism sector. Awareness has been growing about the conditions under which spiny lobster is harvested, especially through industrial fishing that uses scuba gear, and that lobsters caught illegally should not be sold or consumed.
- **Destructive fishing:** Catching of immature and berried lobsters by fishers using scuba, and 'ghost fishing' by lost or abandoned lobster fishing gear can be destructive. In the GEAF survey²¹ on minimizing the use of destructive fishing gear, specifically scuba, 80 per cent of the ECOLANGOSTA+ subproject countries in the southwestern stock mentioned that scuba diving is not practised in lobster fishing, while the remaining 20 per cent recognized that it has decreased. Scuba diving is not practised in the central and northern Caribbean stocks. One important concern is the cryptic mortality (unreported/unobserved lobster deaths) caused by lost or abandoned fishing gear (traps or pots), particularly during the closed fishing season. The obvious result of not investing in retrieving fishing gear, such mortality may be substantial and its effect on stock productivity could be significant. More studies are needed to assess the ecological impact of lost and abandoned fishing gear on critical spiny lobster habitat and lobster fishery production.
- **Habitat degradation:** Spiny lobster production and survival are highly dependent on the quality of its preferred marine habitats, particularly shallow-water nursery habitats. Coastal development and pollution, particularly from landbased sources and activities, have degraded mangroves, seagrass beds and coral reefs in the region.²² The extent to which habitat degradation has affected spiny lobster populations in the region is unknown and requires further investigation.

4.2 Pressures

Pressures, which can be natural or anthropogenic, are factors that result in unsustainable fishing of the spiny lobster or induce negative changes in its health or its populations. The open-access nature of the lobster fishery can exacerbate its unsustainable exploitation. Among the key pressures that may affect the spiny lobster are:

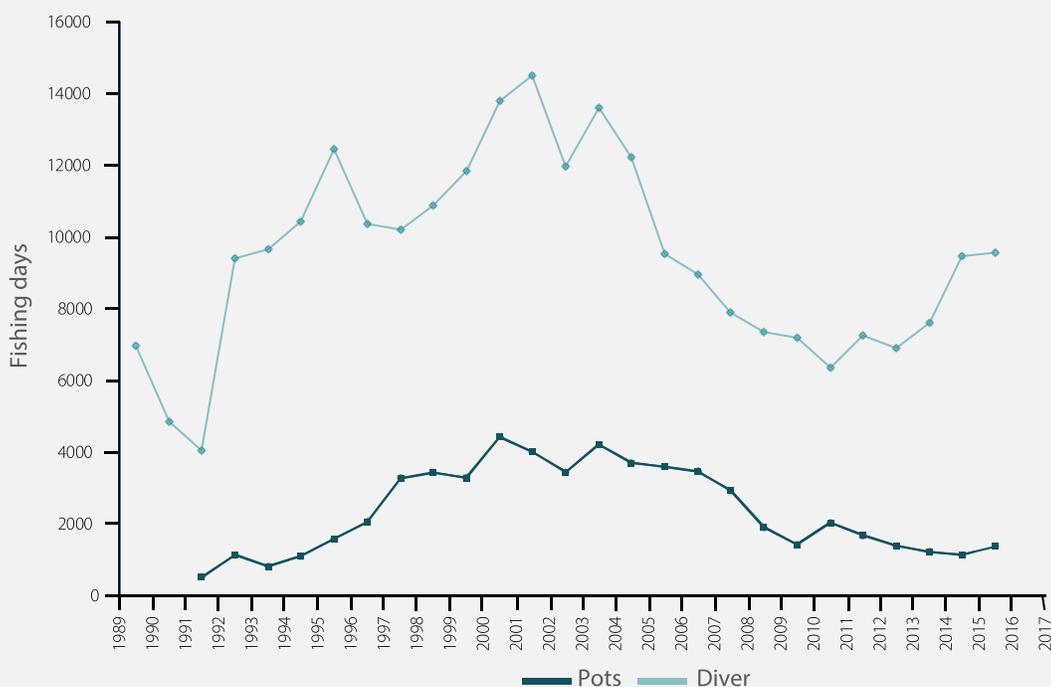
- **Fishing effort:** Excessive fishing effort (e.g., number of boats, lobster traps and fishing days that exceed the level required for optimum sustainable catch) has contributed to overfishing in some countries. The results of a GEAF survey on whether the spiny lobster fishing effort is at an agreed level in the region suggest that for the southwest stock and central stock (related to the CRFM and OSPESCA areas of influence), the levels of fishing effort are unknown, while for the northern stock (USA, Cuba, The Bahamas) the catch/effort ratio is at the agreed level (set by the fishery management plans that are in place).
- **Illegal, unreported and unregulated fishing:** IUU is one of the major factors contributing to unsustainable fishing of spiny lobster. However, IUU fishing has not been systematically and reliably quantified in the region. In a GEAF survey on IUU fishing in the spiny lobster fishery, 100 per cent of the countries involved in the ECOLANGOSTA+ subproject stated that the levels of IUU fishing are unknown.
- **Predation:** The extent of spiny lobster mortality caused by invasive species such as the lionfish, which preys on juvenile spiny lobster, is unknown.
- **Climate change:** Spiny lobster populations are affected by rising sea temperatures and coral bleaching, as well as increasing frequency and intensity of hurricanes. Coral bleaching can have a major impact on spiny lobster habitats and populations. Moreover, the long planktonic larval phase of the spiny lobster increases its vulnerability to warming surface waters. A study²³ to assess the impacts of climate change on lobsters found that projected losses in diversity and appropriate habitats for lobster species (including *Panulirus*) occur mainly in tropical areas (between 18° S and 20° N) and are higher on the coasts of the Wider Caribbean/Brazil.
- **Disease:** Disease is one of the main sources of spiny lobster mortality (especially in young specimens).^{24,25} The pathogenic virus *Panulirus argus* Virus 1 (PaV1) has been reported in the Caribbean since 2000. Figure 9 shows the incidence of the PaV1 in adult spiny lobsters in the Caribbean Sea in 2010-2011. Incidence ranged between 1-17 per cent of the samples, with highest incidence in the Florida Keys (11 per cent) and Puerto Rico (17 per cent). The impact of this virus on the spiny lobster population is unknown, but if it continues to spread, it could have significant consequences for the fishery.



Box 6 Reduction in use of scuba in lobster fishing

The countries with the highest use of scuba in spiny lobster fishing are Honduras and Nicaragua. In the case of Nicaragua, industrial fishing using scuba decreased from 4,000 fishing days in the 2000s to less than 2,000 fishing days in recent years. In Nicaraguan artisanal fishing, scuba currently accounts for less than 20 per cent of the fleet.

The Government of Nicaragua reported that in 2015–2017, there were seven diving-related deaths, compared with one in 2018. In 2008, there were 26 industrial vessels that were dedicated to diving, while in 2019 there are only eight vessels. The number of divers has also reduced, from around 1,300 to 600. This has been influenced by the fact that fishing for spiny lobster using pots is preferred because of greater demand on the international market for whole lobsters rather than for the tails.



Nominal effort trend in fishing days of industrial lobster boats that use pots and scuba in Nicaragua



© By Manuel Pérez (OSPESCA)

Box 7

In The Bahamas, there are between 700,000 and 800,000 artificial spiny lobster refuges (condominiums or casitas) in operation that are never retrieved from the fishing grounds and are replaced at a rate of about 20 per cent per year. These are deployed in shallow habitats, where they attract many juvenile lobsters. The environmental impact of "casita-like" devices has not been assessed in The Bahamas but their effect on nursery habitat and on the survival and growth of juvenile lobsters is of serious concern in the spiny lobster and other fisheries.

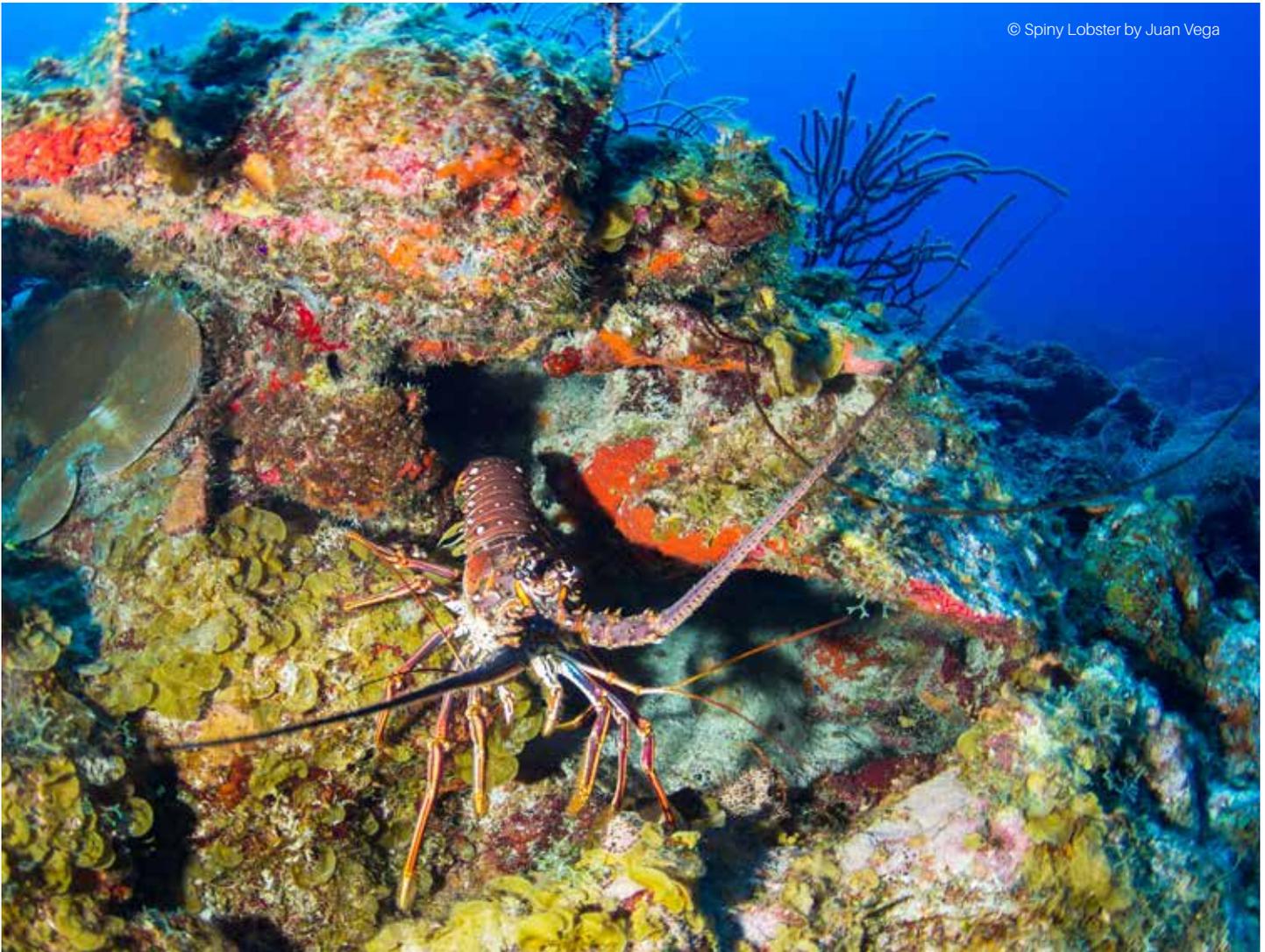
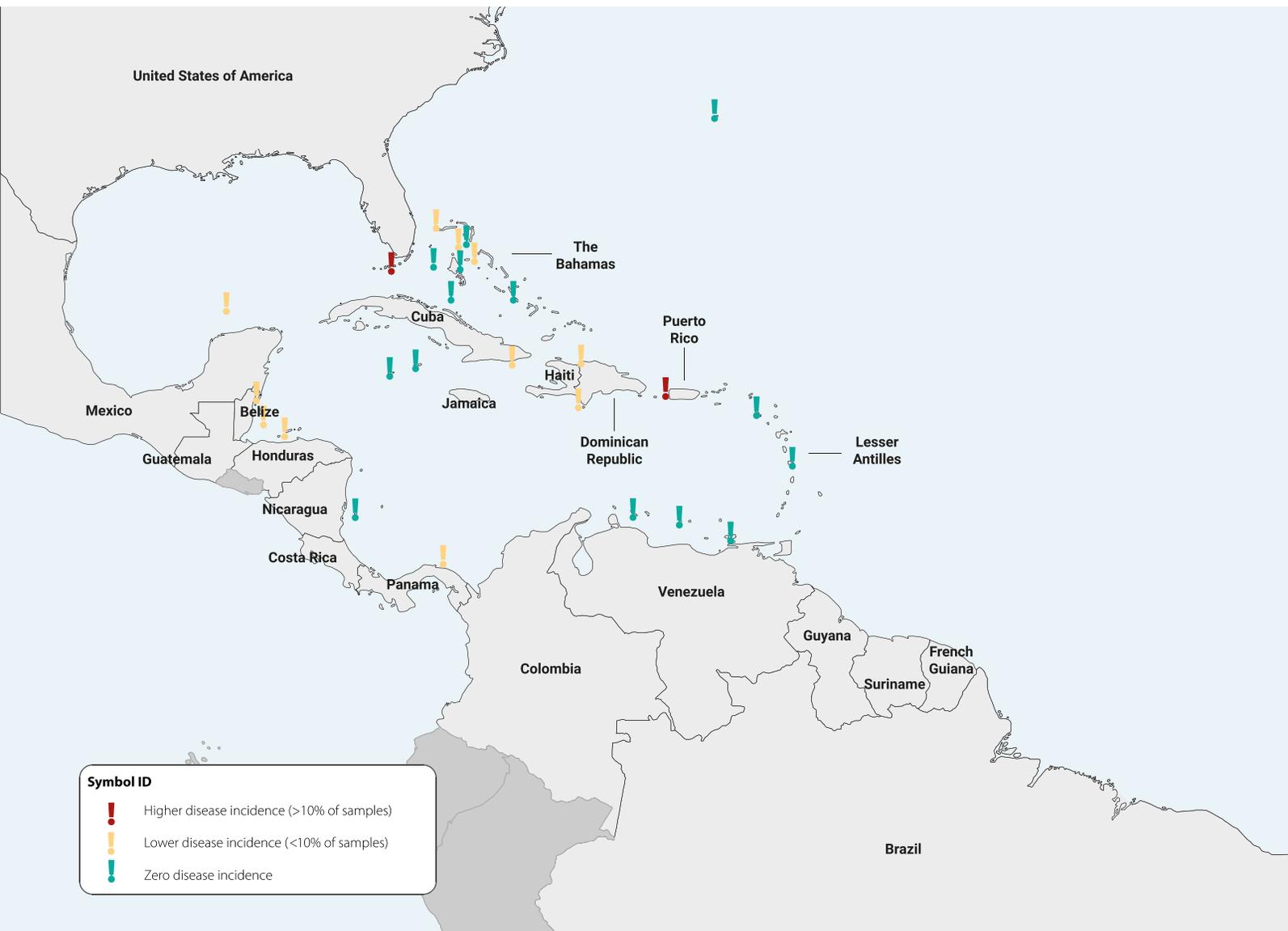


Figure 9. Incidence of *Panulirus argus* Virus 1 in adult spiny lobsters in the Caribbean. Samples were collected between 2010 and 2011. (Data source: <http://pav1.org/>)



4.3 Impact of spiny lobster fisheries on marine habitats and biodiversity

An ecosystem approach to fisheries requires that the fishery's impact on other components of the ecosystem is considered in decision-making. Spiny lobster fisheries have the potential to affect habitats and biodiversity through various means, including:

- Damage from fishing gear (including lost and abandoned gear, and impact of condominiums or casitas on seagrass beds) and from fishing operations, such as from boat anchors and oil spills.

- By-catch, which includes a number of different groups such as molluscs, reef fish, crabs and, as reported on certain islands, catfish sharks. Such incidental catch can be on average 5 per cent of the total catch in weight in a single fishing trip.

Further investigations are needed to assess the impact of the lobster fisheries on marine habitats and biodiversity.

5. Responses

Responses include measures and actions taken by decision makers, fishing communities and others to ensure that spiny lobster fisheries are sustainable. They also include the institutional, policy and legal frameworks and processes that are relevant to spiny lobster fisheries management.

Responses are divided into 'governance' and 'management' (including stress-reduction measures). Governance covers architecture/arrangements and processes.²⁶

Box 8

Due to the wide larval dispersal and geographic distribution of lobster across international boundaries, maintaining sustainable lobster fisheries will require an appropriate mix of both local and international management, as well as joint management that includes monitoring, control and surveillance by all countries with lobster fisheries.

In 2018, an assessment of the existing governance architecture and governance arrangements (2011–2015 baseline) was conducted for the three intergovernmental fisheries organizations or mechanisms – WECAFC, CRFM and OSPESCA – that manage the spiny lobster fishery and whose respective area of mandate corresponds to the distribution of the lobster stocks (see Figure 1 and Box 1). The assessment sought to determine whether these organizations were adequate to implement the ecosystem approach to spiny lobster fisheries. Specifically, the geographic and thematic coverage of the arrangements, their mandates and the application of the policy cycle were evaluated. To be effective, each 'governance arrangement' must have:²⁷

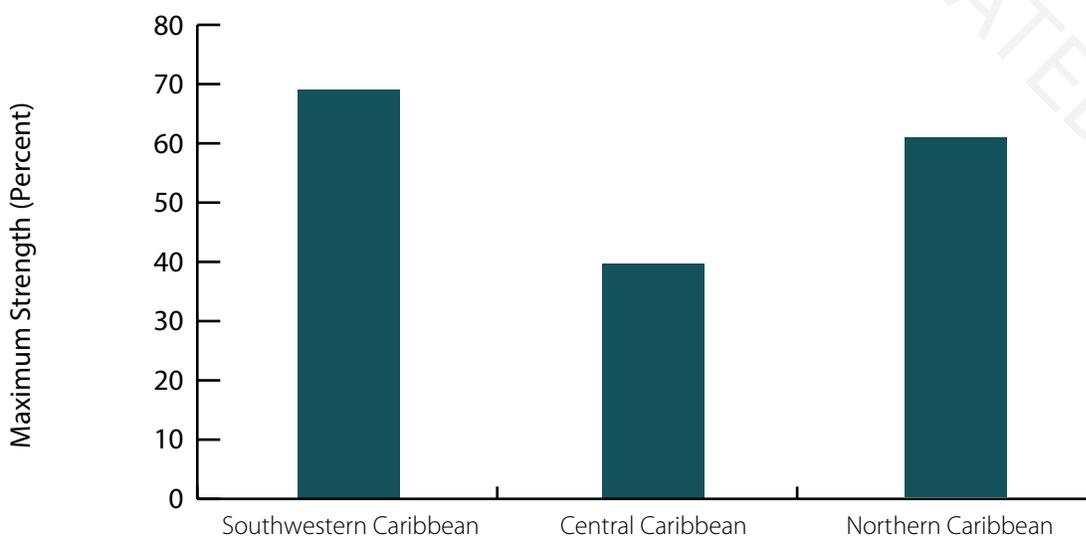
- A complete policy process that can take up data and information, generate advice, make decisions, implement decisions and review all aspects of the process;

- Capacity for (1) Policy advice and decision-making, (2) Management planning and decision-making, and (3) Day-to-day action.

5.1 Governance architecture

- **Existence of arrangements that address the governance of lobster fisheries at the regional/subregional level:** Results (Figure 10) indicate that subregional coordination is strongest in the OSPESCA area (southwest stock) where there are, for example, binding subregional agreements, which do not exist in the other fisheries organizations' area of competence.

Figure 10. Strength of the regional/subregional governance arrangements for the three Caribbean spiny lobster stocks. Baseline 2011–2015.



- **Degree of application of the policy cycle stages by the fisheries mechanisms:** The best-applied stages of the policy cycle are policy advice and management advice (Figure 11). OSPESCA has a higher degree of application of most of the seven stages of the policy cycle, while WECAFC does not engage in policy decision-making, management decision-making or management implementation. WECAFC is undergoing a transformative process to possibly become a regional fisheries management organization (RFMO), but it is not yet known whether its mandate will extend to spiny lobster.

Figure 11. Degree of application of the stages of the policy cycle in each of the regional/subregional fisheries mechanisms that manage the spiny lobster fishery. Baseline 2011–2015

	Fully complete	Almost complete	Less complete	Not complete
Stages of the policy cycle	OSPESCA	CRFM	WECAFC	
Policy Advice (I)	Fully complete	Fully complete	Almost complete	
Management Advice (III)	Fully complete	Almost complete	Almost complete	
Management Review (VI)	Almost complete	Almost complete	Less complete	
Management Data and Information (VII)	Almost complete	Almost complete	Less complete	
Policy Decision-Making (II)	Almost complete	Less complete	Not complete	
Management Decision-Making (IV)	Almost complete	Less complete	Not complete	
Management Implementation (V)	Almost complete	Less complete	Not complete	

The weakest stages of application, and to which attention should be paid, are those of management data and information, policy decision-making, management decision-making, and management implementation. This has implications for spiny lobster fishery management options: for instance, should there be similar coverage of the policy cycle stages across the three fisheries mechanisms or a single RFMO with a mandate for all the stages (for spiny lobster and other fisheries resources of commercial importance in the Caribbean and Western Central Atlantic region)?

Within WECAFC, there is a Regional Spiny Lobster Working Group made up of representatives of the WECAFC member countries that are also members of OSPESCA, the CRFM or the CFMC. This group has the advantage of including all the countries that have lobster fisheries, thus facilitating the coordination and implementation of actions at the regional level.

5.2 Governance processes

A range of initiatives undertaken in the WECAFC region to improve management of the spiny lobster fisheries is given in annex 1. Among these are:

- **Fisheries regulations:** OSPESCA, the CRFM and FAO WECAFC have developed spiny lobster fisheries regulations, which OSPESCA was the first to adopt and implement in 2009, followed by the CRFM in 2015, and FAO WECAFC in 2016. The regulations cover aspects such as minimum sizes and weights, types of fishing gear, protection of berried lobsters, prohibition of scuba, and fishing closures during different months of the year. In 2018, the FAO WECAFC/OSPESCA/CRFM/CFMC Spiny Lobster Working Group recommended that the regulations be harmonized in the future according to the distribution of the substocks. Major weaknesses include the practical application of the regulations and their enforcement as well as monitoring, control and surveillance of the spiny lobster fisheries.

- **Subregional processes:** Although there are policies, strategies and management plans within OSPESCA, CRFM and WECAFC areas, there is no regional legislation. In OSPESCA, subregional regulations regarding spiny lobster fishing (regulation OSP-02-09) were only introduced in 2009, and include a subregional closed season.^v In 2015, the Caribbean Community (CARICOM), through the CRFM, promoted the adoption of the St. George's Declaration, which contains a series of regulatory measures for spiny lobster that seek to harmonize management of the Caribbean spiny lobster fishery in this subregion. WECAFC has approved a set of recommendations that are also based on OSPESCA regulations.
- **The Regional Caribbean Spiny Lobster Fishery Management Plan (MARPLESCA Plan):** This plan, which was developed under the subproject "Ecosystem Based Fisheries Management for the Caribbean Spiny Lobster (ECOLANGOSTA+)", was officially adopted in December 2018 by the OSPESCA Ministerial Council. The plan is expected to be presented for adoption at the seventeenth WECAFC session in July 2019 and at a joint meeting of ministers of fisheries and agriculture from the Central American Integration System (SICA) and CARICOM countries in October 2019. The overall objective of the plan is to establish a systematic process for managing spiny lobster fisheries within a framework that promotes sustainable use, ecological balance and social and economic benefits for the participants in the value chain. (Details of the Plan are available in the WECAFC document WECAFC/SAG/IX/2018/6).

It has been suggested that the Interim Coordination Mechanism for Sustainable Fisheries formed by WECAFC, CRFM and OSPESCA is the most viable mechanism for coordinating the implementation of the plan and should be strengthened to become a permanent mechanism. The WECAFC/CRFM/OSPESCA/CFMC Regional Spiny Lobster Working Group can provide technical support (related to the Management advice and Data & information stages of the policy cycle).

The MARPLESCA Plan specifically aims to:

- Strengthen the effective application of OSPESCA regulation OSP-02-09 and the CARICOM St. George's Declaration, as well as WECAFC recommendations.
 - Manage the spiny lobster fisheries across the region in a coordinated and participatory manner, within the framework of the SICA/OSPESCA, CARICOM/CRFM and WECAFC governance model.
 - Promote adequate organization for the institutionalized participation of the key actors in the management of the fishery.
 - Promote the conditions for the adoption and implementation of the plan throughout the geographical range of the spiny lobster, within the framework of the CLME+^{vi} Strategic Action Programme.
- **CLME+ Strategic Action Programme, Spiny Lobster Substrategy:** The UNDP/GEF project "Catalyzing Implementation of the Strategic Action Programme for the Sustainable Management of Shared Living Marine Resources in the Caribbean and North Brazil Shelf Large Marine Ecosystems" (CLME+ Project, www.clmeproject.org) is supporting the implementation of the politically-endorsed^{vii} 10-year (2015–2025) CLME+ Strategic Action Programme (SAP) for the sustainable management of shared living marine resources in the Caribbean and North Brazil Shelf Large Marine Ecosystems (CLME+ region). One of the SAP substrategies specifically addresses moving towards an ecosystem approach to the Caribbean spiny lobster fisheries, with actions aimed at: (i) enhancing transboundary and cross-sectoral coordination arrangements; (ii) expanding, as possible, the geographic scope of the arrangements implemented by OSPESCA; (iii) facilitating full policy cycle implementation; and (iv) implementing a decision-support system. It builds upon the achievements of the CLME+-funded MARPLESCA pilot project coordinated by OSPESCA (e.g., simultaneous closed season, the subregional fisheries management plan, and the joint CRFM-OSPESCA action plan). The adoption of the SAP has contributed significantly towards developing initiatives and implementing actions for an ecosystem approach to spiny lobster fisheries.
 - **Seafood traceability system:** The ECOLANGOSTA+ subproject is promoting the design and adoption of a traceability standard system for fishery products, with an emphasis on improving the traceability of Caribbean spiny lobster products through the value chain and supporting the combat against IUU fishing.
 - **Certification:** The Bahamas obtained certification of its spiny lobster fishery from the Marine Stewardship Council (MSC) in 2018. Since 2011, Brazil, Nicaragua and Honduras have been trying to obtain certification by developing Fishery Improvement Projects (FIPs) under MSC standards. A lobster fishery in the Mexican Caribbean was certified between 2012 and 2017.
 - **Harmonized stock assessments and data collection:** The ECOLANGOSTA+ subproject is promoting the adoption of the regional management plan for Caribbean spiny lobster, which incorporates a harmonized approach to data collection and fishery assessment, the establishment of a traceability system for fishery products, and the strengthening of governance.
 - **Financing for lobster fisheries management:** Self-financing for spiny lobster fisheries management within the WECAFC, OSPESCA and CRFM countries to carry out their respective mandates is usually limited and unsustainable. Financing for fisheries management should be considered in terms of the monetary value of the spiny lobster resource in comparison with the cost of sustainably managing its fisheries. Estimating this ratio remains a pending issue in most countries.

v In December 2018, the Council of Ministers of OSPESCA approved a resolution mandating that the SICA countries make a complete revision of OSP-02-09 to ensure that the regulations are adapted to the current fishery conditions.

vi The Caribbean Large Marine Ecosystem and the North Brazil Shelf Large Marine Ecosystem

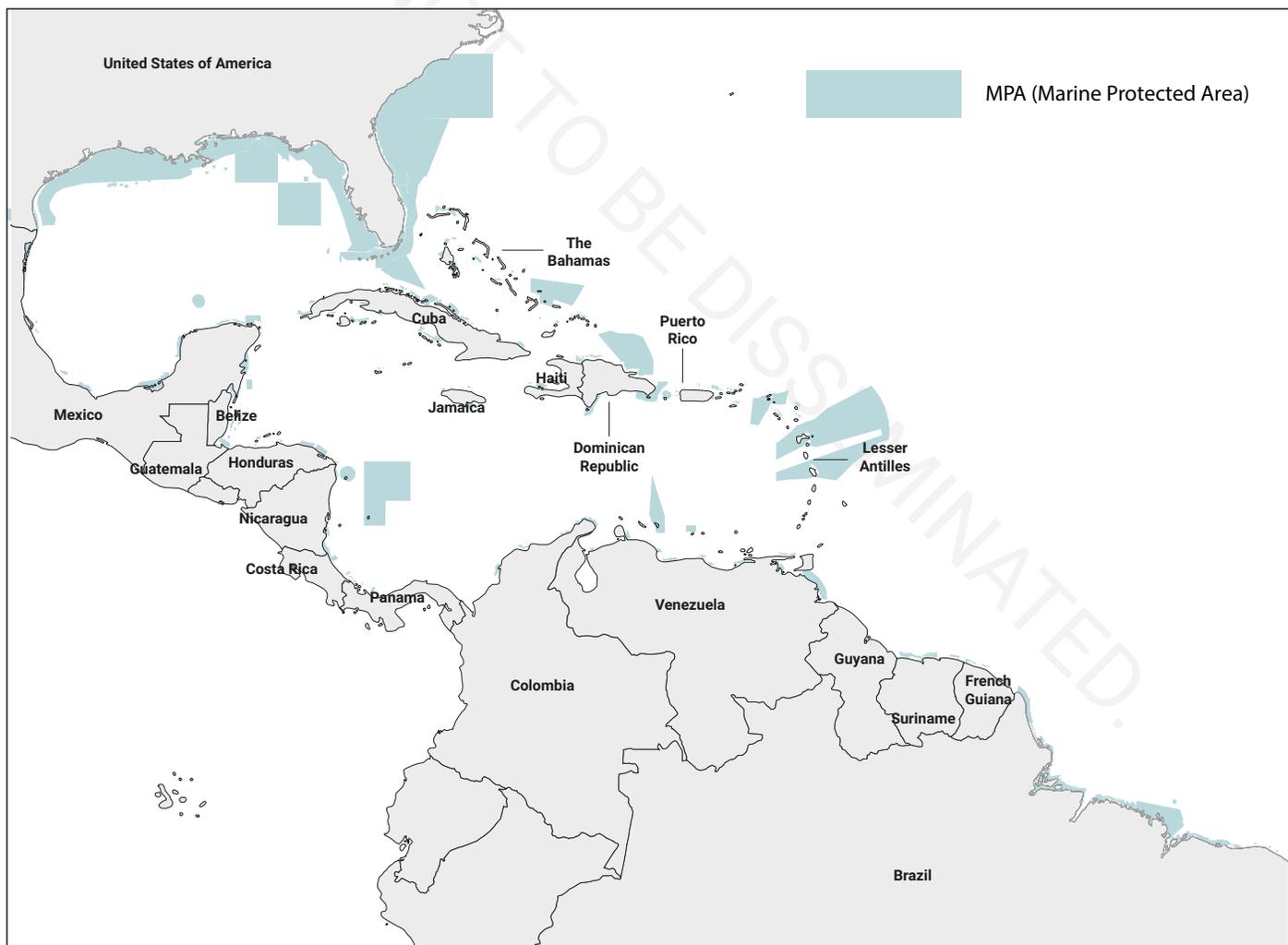
vii To date, the SAP has been endorsed by 26 countries.

- Marine protected areas (MPAs):** MPAs are an important tool in lobster stock replenishment and fishing-related livelihoods. Globally, MPAs have been shown to increase fish size, population density, biomass, and species richness. These increases are also seen outside the MPA boundaries through the spillover effect. Most countries within the spiny lobster distribution range have MPAs that function as stock replenishment areas that may benefit Caribbean spiny lobster populations. Examples of MPAs in the Caribbean Sea that are in the vicinity of major spiny lobster fishing grounds (Figure 1) and larval retention and exchange areas (Figure 2) are illustrated in Figure 12. The potential impact of these MPAs on spiny lobster populations should be investigated. The location of lobster fishing grounds and larval retention/exchange areas as well as nursery habitats must be considered in the placement of future MPAs for lobster stock replenishment.



The location of lobster fishing grounds and larval retention/exchange areas as well as nursery habitats must be considered in the placement of future MPAs for **lobster stock replenishment**.

Figure 12. Marine protected areas (Light Green) in the Caribbean Sea³¹ in the vicinity of spiny lobster fishing grounds and larval retention and exchange areas.



The foregoing illustrates that a comprehensive range of responses and stress-reduction measures are planned or being implemented for spiny lobster fisheries management in the WECAFC region. While this is very positive, a high level of collaboration, coordination and harmonization across national, subregional and regional levels is required to ensure that the objectives are met. Furthermore, the larval connectivity among the spiny lobster stocks that are exploited by different countries makes a collaborative and harmonized approach to spiny lobster fisheries management particularly important.

5.4 Recommendations for action

1. In the policy cycle for spiny lobster fisheries management, the collection and analysis of fishery-dependent and independent data (particularly of catches, fishing effort, maturity and size) should be improved. Currently, most countries lack robust national statistical systems and make only limited use of operational objectives and indicators in their planning. This implies that the status of the spiny lobster fishery and progress towards particular goals based on predetermined indicators cannot be reliably assessed and monitored.
2. Related to the above, the type of data (units, variable collection formats) and fishery evaluation models must be harmonized so that the data and results are comparable within a regional perspective. In addition, environmental and socioeconomic data associated with the fishery should be collected.
3. To address IUU fishing of spiny lobster, more inter-institutional coordination is needed at the national, subregional and regional levels to define joint protocols for action and the exchange of data and information. Artisanal fishing vessels should be equipped with appropriate instruments that allow vessels' movements to be monitored and the existing fleet to be quantified. Traceability should be an important component in fisheries management and in combating IUU fishing.
4. A sustainable financing plan should be designed and implemented by fisheries authorities in charge of managing lobster fishing. Without sustainable and adequate financing, effective management of spiny lobster fisheries (and fisheries in general) will be constrained.
5. Access to new markets and the generation of added value should continue to be promoted. The associated data, together with traceability data, will allow the socioeconomic evolution of the spiny lobster fishery to be evaluated over time.
6. Intersectoral integration in spiny lobster fisheries management should continue to be promoted, since there are activities outside the fisheries sector that have an impact on fisheries (e.g., coastal development, tourism and exploitation of other marine natural resources) and management approaches that require inter-institutional coordination (e.g., among institutions with different yet relevant areas of mandate and authority).
7. MPAs should be considered by those countries where they do not yet exist or should be expanded as necessary where they do exist, to improve spiny lobster populations. MPAs' contribution to the sustainability of lobster fishing should be quantified. Better use of spatial planning and geographic information systems will help in establishing or expanding MPAs and responsible fishing areas.
8. Studies with a regional/subregional focus on the PaV1 virus, particularly its levels of incidence, its impacts on the lobster fishery and its socioeconomic implications, should be strengthened.
9. There is an urgent need to estimate fishing effort, particularly the number of traps/pots and divers in artisanal and industrial fisheries and associated catch/landings at the regional/subregional level. Quantifying the operational pots and those that are lost will help improve the evaluation of the impact of fishing on the lobster fisheries (fishing mortality) and on critical habitats.
10. The spiny lobster's contribution to food security and protein consumption in the countries, as well as its contribution to GDP, should be quantified.
11. OSPESCA countries have defined a minimum size of capture (carapace length) and a minimum weight for export and marketing purposes. The European market in particular requires traceability of the product that it imports. An assessment of the impact of these requirements on lobster fisheries in the region is required.



References

- 1 FAO. 1991. FAO Species Catalogue. Vol. 13. Marine lobsters of the world. An annotated and illustrated catalogue of species of interest to fisheries known to date. Holthuis, L.B., FAO Fisheries Synopsis. No. 125, Vol. 13. Rome, FAO. 292p.
- 2 Ehrhardt, N., R. Puga and M. Butler IV. 2011. Implications of the Ecosystem Approach to Fisheries Management in Large Ecosystems. The case of the Caribbean Spiny Lobster. In: Towards Marine Ecosystem-based Management in the Wider Caribbean. Fanning, L., R. Mahon and P. McConney (eds). Pp 157–175.
- 3 Cruz, R. 2002. Manual de métodos de muestreo para la evaluación de las poblaciones de langosta espinosa. FAO Documento Técnico de Pesca. No. 399. Roma, FAO. 2002. 43p.
- 4 Ehrhardt, N., R. Puga and M. Butler IV. 2011. Implications of the Ecosystem Approach to Fisheries Management in Large Ecosystems. The case of the Caribbean Spiny Lobster. In: Towards Marine Ecosystem-based Management in the Wider Caribbean. Fanning, L., R. Mahon and P. McConney (eds). Pp 157–175.
- 5 Segura-García, I., L. Garavelli, M. Tringali, T. Matthews, L. M. Chérubin, J. Hunt and S. J. Box. 2019. Reconstruction of larval origins based on genetic relatedness and biophysical modeling. Scientific Reports (2019) 9:7100 | <https://doi.org/10.1038/s41598-019-43435-9>
- 6 Kough, A. S., C.B. Paris & M.J. Butler. Larval Connectivity and the International Management of Fisheries. PLoS One 8 (2013).
- 7 Ehrhardt, N., R. Puga and M. Butler IV. 2011. Implications of the Ecosystem Approach to Fisheries Management in Large Ecosystems. The case of the Caribbean Spiny Lobster. In: Towards Marine Ecosystem-based Management in the Wider Caribbean. Fanning, L., R. Mahon and P. McConney (eds). Pp 157–175.
- 8 Truelove, N.K., A.S. Kough, D.C. Behringer, C.B. Paris, S.J. Box, R.F. Preziosi, and M.J. Butler IV. 2016. Biophysical connectivity explains population genetic structure in a highly dispersive marine species. Coral Reefs, 36 (1). pp. 233-244. ISSN 0722-4028
- 9 Andrade, H. A. 2015. Stock assessment of the red spiny lobster (*Panulirus argus*) caught in the tropical southwestern Atlantic. Lat. Am. J. Aquat. Res., 43(1): 201–214.
- 10 NOAA Fisheries. 2018. Caribbean Spiny Lobster. [online] Available at: <https://www.fisheries.noaa.gov/species/caribbean-spiny-lobster> [Accessed 27 Dec 2018].
- 11 FAO. 2018. The State of World Fisheries and Aquaculture 2018 – Meeting the sustainable development goals. Rome.
- 12 CERMES. 2018. Application of the Governance Effectiveness Assessment Framework (GEAF) to the CLME+ EcoLangosta Lobster Pilot. Draft Report. Prepared by CERMES, UWI. 18 November 2018.
- 13 Andrade, H. A. 2015. Stock assessment of the red spiny lobster (*Panulirus argus*) caught in the tropical southwestern Atlantic. Lat. Am. J. Aquat. Res., 43(1): 201–214.
- 14 Ehrhardt, N., R. Puga and M. Butler IV. 2011. Implications of the Ecosystem Approach to Fisheries Management in Large Ecosystems. The Case of the Caribbean Spiny Lobster. In: Towards Marine Ecosystem-based Management in the Wider Caribbean. Fanning, L., R. Mahon and P. McConney (eds). Pp 157–175.
- 15 Pauly D. and Zeller D. (Editors). 2015. Sea Around Us Concepts, Design and Data. Available at: searoundus.org.
- 16 FAO. 2017. The world lobster market. Graciela Pereira and Helga Josupeit, FAO consultants. Globefish Research Programme Volume 123. Rome, Italy.
- 17 FAO. 2017. The world lobster market. Graciela Pereira and Helga Josupeit, FAO consultants. Globefish Research Programme Volume 123. Rome, Italy.
- 18 FAO. 2015. Report of the first meeting of the OSPESCA/WECAFC/CRFM/CFMC Working Group on Caribbean Spiny Lobster, Panama City, Panama, 21–23 October 2014. FAO Fisheries and Aquaculture
- 19 FAO. 2017. The world lobster market. Graciela Pereira and Helga Josupeit, FAO consultants. Globefish Research Programme Volume 123. Rome, Italy.
- 20 Callwood, K. 2016. "Condos, Connectivity, and Catch: Analyzing the State of the Bahamian Spiny Lobster Fishery." (2016). Open Access Dissertations. 1761. https://scholarlyrepository.miami.edu/oa_dissertations/1761

- 21 CERMES. 2018. Application of the Governance Effectiveness Assessment Framework (GEAF) to the CLME+ EcoLangosta Lobster Pilot. Draft Report. Centre for Resource Management and Environmental Studies (CERMES) University of the West Indies, Cave Hill Campus.
- 22 CERMES. 2018. Application of the Governance Effectiveness Assessment Framework (GEAF) to the CLME+ EcoLangosta Lobster Pilot. Draft Report. Centre for Resource Management and Environmental Studies (CERMES) University of the West Indies, Cave Hill Campus.
- 23 Behringer D.C., M.J. Butler, J.D. Shields. 2008. Ecological and physiological effects of PaV1 infection on the Caribbean spiny lobster (*Panulirus argus* Latreille). *J Exp Mar Biol Ecol* 359. Pp 26–33.
- 24 Mahon, R., A. Cooke, L. Fanning and P. McConney. 2013. Governance arrangements for marine ecosystems of the Wider Caribbean Region. Centre for Resource Management and Environmental Studies, University of the West Indies, Cave Hill Campus, Barbados. CERMES Technical Report No 60. 99p.
- 25 Mahon, R., A. Cooke, L. Fanning and P. McConney. 2013. Governance arrangements for marine ecosystems of the Wider Caribbean Region. Centre for Resource Management and Environmental Studies, University of the West Indies, Cave Hill Campus, Barbados. CERMES Technical Report No 60. 99p.
- 26 Ehrhardt, N., R. Puga and M. Butler IV. 2011. Implications of the Ecosystem Approach to Fisheries Management in Large Ecosystems. The case of the Caribbean Spiny Lobster. In: *Towards Marine Ecosystem-based Management in the Wider Caribbean*. Fanning, L., R. Mahon and P. McConney (eds). Pp 157–175.
- 27 CERMES. 2018. Application of the Governance Effectiveness Assessment Framework (GEAF) to the CLME+ EcoLangosta Lobster Pilot. Draft Report. Centre for Resource Management and Environmental Studies (CERMES) University of the West Indies, Cave Hill Campus.
- 28 UN Environment Caribbean Environment Programme. 2019. State of the Convention Area Report on Marine Pollution in the Wider Caribbean Region (2019). Caribbean Environment Programme (CEP) Technical Report. UN Environment CEP/Secretariat for the Cartagena Convention, Kingston, Jamaica.
- 29 Boavida-Portugal, J., R. Rosa, R. Calado, M. Pinto, I. Boavida-Portugal, M. Araújo, F. Guilhaumon. 2018. Climate change impacts on the distribution of coastal lobsters. *Marine Biology* (2018): 165 (12) p 186. <https://doi.org/10.1007/s00227-018-3441-9>
- 30 Butler M.J., D.C. Behringer, J.D. Shields. 2008. Transmission of *Panulirus argus* virus 1 (PaV1) and its effect on the survival of juvenile Caribbean Spiny lobster. *Dis Aquat Org* 79 (3). Pp 173–182.
- 31 UNEP-WCMC and IUCN. 2018. Protected Planet: The World Database on Protected Areas (WDPA), July 2018 version, Cambridge, UK: UNEP-WCMC and IUCN.

Annex 1.

Progress in regional initiatives taken before and after 2015 to improve management of the Caribbean spiny lobster fisheries

Initiative	Before 2015	After 2015
Regional Regulation	There was only the regional Regulation OSP-02-09 of the SICA/OSPESCA. The United States used this regulation to define the import size of spiny lobster in Florida.	CARICOM/CRFM issues the St. George's Declaration and WECAFC approves a recommendation on management measures. Both are in line with the OSPESCA Regulation.
Closed season	There was only the regional ban established by OSPESCA. Harmonized ban on the same dates for all Central American countries except Belize. Information indicated that only 54 per cent of the Caribbean lobster countries had a closed season.	Some countries outside of OSPESCA adopt the same closed season established in Central America (e.g., Mexico and Colombia). Eighty per cent of the lobster-producing countries have an established ban.
Regional Management Plan	There was only one proposal at the level of the OSPESCA countries, which was never adopted and applied.	A regional management plan is prepared with scope for countries outside of OSPESCA (i.e. including CRFM and FAO WECAFC). The plan was adopted by OSPESCA in December 2018 and some activities have been implemented. A regional adoption is expected by the WECAFC and CRFM-OSPESCA Fisheries Ministers in 2019.
Regional coordination of fisheries organizations	There was only one MoU between CRFM and OSPESCA.	An MoU is signed to create an Interim Coordination Mechanism for Responsible Fisheries between CRFM, OSPESCA and FAO WECAFC.
Diversification of markets and products	Only lobster tails were exported, mainly to the US market.	Diversification begins in some countries towards whole and live lobster and exporting to markets other than the United States.
Traceability	Only at the national level in some countries.	Promotion of traceability in the countries of the ECOLANGOSTA+ subproject with a regional approach based on existing national experiences. Synergies with other organizations created.
Scuba diving in industrial fishing	Prohibition of scuba diving in OSP Regulation 02-09 of the countries of OSPESCA, directed mainly towards Honduras and Nicaragua. In Nicaragua between 2010 and 2015, on average, 21 per cent of the industrial fleet was divers.	Scuba diving persists, but the industrial fleet has been reduced and converted to pots. In Nicaragua, the average percentage of diving vessels has decreased to 12 per cent. The landing of live lobster is contributing to decreased use of scuba diving.
Fisheries certification	A certified Mexican fishery and The Bahamas, Nicaragua and Honduras were in the process of implementing a Fisheries Improvement Project (FIP).	In 2017, the Mexican fishery was no longer certified but The Bahamas was certified in 2018. Brazil, Nicaragua and Honduras are continuing the FIP process to achieve certification.

Initiative	Before 2015	After 2015
Resource evaluation and data collection	Proposal of an evaluation model for Central American countries and of formats for data collection in the proposed management plan for the OSPESCA countries. Data collection was deficient.	Proposal is extended to the countries of the ECOLANGOSTA+ subproject and is included in the expanded Regional Management Plan. Countries of the ECOLANGOSTA+ subproject have been trained and have received support to collect data and apply the model. Data collection is still deficient because there is a lack of human resources and financing. Work is carried out at the ECOLANGOSTA+ level to harmonize the evaluation of the Central American lobster stock.
IUU fishing	It had not been quantified, although it was known to exist. In 2014, the WECAFC Regional Working Group on IUU Fishing was created. In the OSPESCA countries, Regional Regulations for a Vessel-Registry, Satellite-Monitoring and Combat System for IUU Fishing were adopted.	Problems persist with quantifying IUU fishing in the region. WECAFC has a regional plan to combat IUU fishing. It is expected that the application of the traceability system will help reduce this problem. OSPESCA is updating the Ship Registry.
Ghost fishing	It had not been quantified but clearly existed, given the gear (e.g., pots or traps) lost or abandoned at sea.	The non-quantification of existing and lost gear at the national and regional levels persists.

DISSEMINATED.

