

Lobster Houses as a Sustainable Fishing Alternative

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Scholarly Abstract

The Caribbean Spiny Lobster (*Panulirus argus*) is overexploited throughout its range, primarily due to failures in fishery management. In addition to contributing to overexploitation, the primary lobster fishing methods used in the Caribbean are harmful to the environment and the health of the fishers. However, one method, lobster houses, shows particular promise for alleviating these negative effects, but only under certain environmental and socioeconomic conditions and using the recommended management practices. Lobster houses have been used for over half a century by fishing communities in Ascension Bay, Mexico; and Batámano Bay, Cuba; which are two of the most successful spiny lobster fisheries in the Caribbean. Success in these two communities has led to the implementation of lobster house projects throughout the region with varying levels of success. The objective of this study is to determine which factors contribute to the sustainability of the *P. argus* fishery through the examination of three lobster house case studies (Ascension Bay, Mexico; Batámano Bay, Cuba; and Miches, Dominican Republic) and the scientific literature that evaluates the sustainability of this fishery. Lobster houses can play a vital role in promoting sustainability throughout the Caribbean by simplifying management, reducing incidental environmental damage, reduce harvest rates of illegal segments of the lobster population, reducing health risks to fishers, and standardizing practices.

Abstract

The Caribbean Spiny Lobster (*Panulirus argus*) is overfished, primarily due to failures in fishery management. The most popular lobster fishing methods used are contributing to overfishing and are harmful to lobsters, the environment, and the health of the fishers. However, one method, lobster houses, shows particular promise for reducing these negative effects, but only if certain conditions are met. Lobster houses have been used for over fifty years by fishing communities in Ascension Bay, Mexico; and Batámano Bay, Cuba; which are two of the more successful *P. argus* fisheries in the Caribbean. Success in these two communities has led to the creation of lobster house projects throughout the region with varying levels of success. The objective of this study is to determine which factors contribute to the sustainability of the *P. argus* fishery by examining three lobster house case studies (Ascension Bay, Mexico; Batámano Bay, Cuba; and Miches, Dominican Republic) and the scientific literature that evaluates the sustainability of this fishery. Lobster houses can play a vital role in promoting sustainability throughout the Caribbean by simplifying management, reducing incidental

environmental damage, reducing the rate of illegal lobster harvesting, reducing health risks to fishers, and standardizing practices.

Keywords: overfishing; lobster houses; *Panulirus argus*; fishery management, sustainable fishing

1. Introduction

Overfishing is a major problem throughout the world's oceans. The FAO estimates that 85% of the assessed marine fish stocks are either at capacity or overexploited, which is the highest recorded percentage since data were first collected in the mid-1970s (FAO, 2010). One of these species that has experienced a decrease in catch primarily due to overfishing is the Caribbean Spiny Lobster, *Panulirus argus* (Muñoz-Nuñez, 2009).

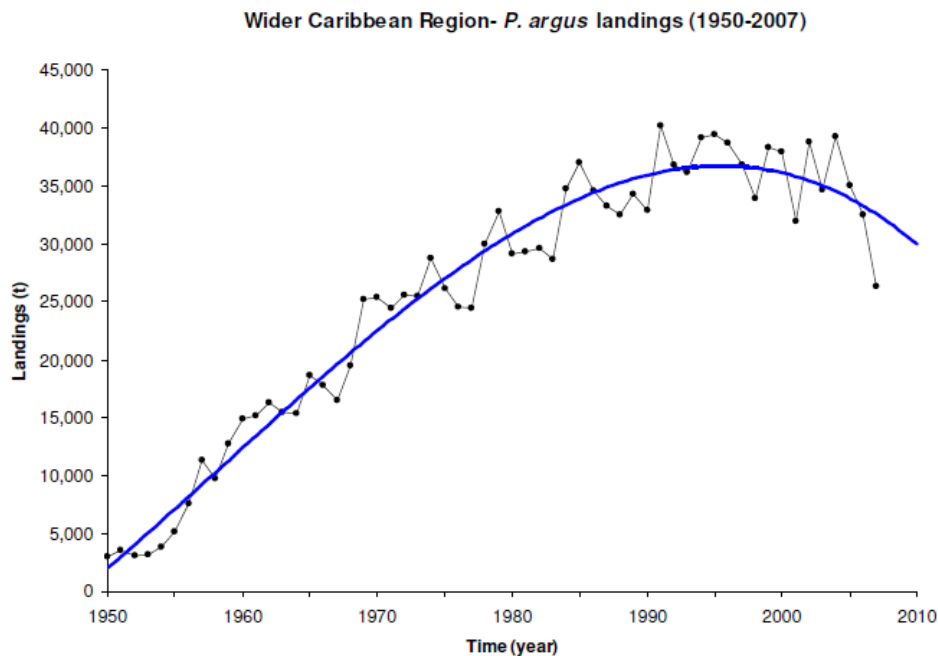


Figure 1. Historic landings of Caribbean Spiny Lobster (*P. argus*) for the entire Caribbean region including Brazil (from Muñoz-Nuñez, 2009).

The *P. argus* fishery faces significant challenges to sustainable management because it consists of small-scale fisheries that fail to consider several critical considerations: the lack of regional standardization, a dearth of regulations that take into account the complex life cycle of *P. argus*, a fishery's dependence on environmental factors, and the irregularity in the enforcement of regulations (Ehrhardt, 2005). Additionally, small-scale fisheries use multiple lobster fishing methods, which can affect multiple life stages (Ehrhardt, 2005) and complicate management (Salas et al., 2008).

Compressors are the most common fishing method used, even though they are illegal throughout most of the Caribbean (Herrera-Moreno and Betancourt, 2003a). When fishing with compressors, fishers use either gaffs or harpoons to spear lobsters immediately upon sight, killing or injuring the lobsters before they can be checked for eggs or assessed as legally sized. In addition, compressors allow the fishers to stay underwater longer and fish deeper, both of which

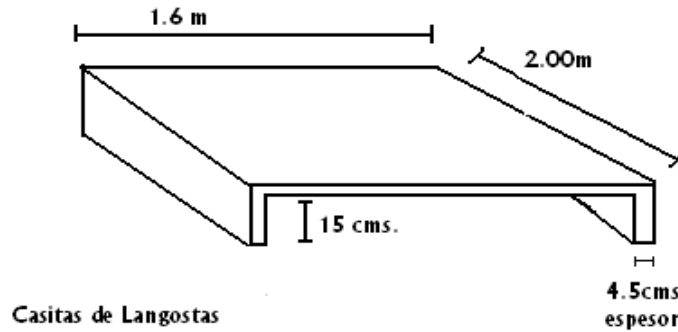


Figure 2. Lobster house design used by Reef Check, Dominican Republic, in Parque La Caleta (V. Galvan, personal communication, 10 June, 2010).

facilitate overexploitation and increase the amount of incidental damage done to the reef as the fishers search for lobsters hidden underneath corals and other living refuges. In addition to these negative environmental effects, the misuse of compressors has resulted in the development of health problems for many fishers, such as respiratory problems, limb paralysis, and death due to decompression complications (WWF, 2006).

Lobster houses have been suggested as a fishing method that could enhance the sustainability of fishing practices. These are shelters for lobsters usually made from ferrocement that are placed in shallow waters on the ocean floor (Fig. 2). This fishing method has gained popularity in the past fifty years due to its success in Cuba (Cruz and Phillips, 2000) and the Yucatan Peninsula (Sosa-Cordero et al., 2008), two of the most successful lobster fisheries in the Caribbean. In Cuba they are called “pesqueros,” in Mexico “casitas cubanas,” “sobmras,” or simply “casitas” (Cruz and Phillips, 2000). Due to their success in the Caribbean, lobster houses have spread in the past decade throughout the world (Herrnkind and Cobb, 2008)

Although lobster houses hold promise for reducing environmental damage, increasing harvest of legally-sized adults, and reducing health problems for fishers, no studies have substantially supported the idea that the lobster houses will increase production of lobsters as opposed to merely concentrating the same production into fewer fisheries (Herrnkind and Cobb, 2008). However, one study suggests that the attraction or production of *P. argus* in one region in the Bahamas depends on whether there is adequate post-larval supply, settlement substrate, and food resources (Eggleston and Lipcius, 1999). Consequently, lobster houses may only be sustainable when multiple conditions are met.

This study reviews the literature on lobster houses and considers three case studies in order to assess how the use of lobster houses may promote the sustainability of *P. argus* fisheries throughout the Caribbean by limiting damage to the environment, reducing harvest rates of juveniles and of lobsters with eggs, eliminating certain health problems to the fishers, and standardizing regional practices.

2. Methods

2.1 Critical Literature Review

We conducted a critical review of the literature including policy revision studies to promote the sustainability of the *P. argus* fishery, socioeconomic analyses of lobster house fisheries, and environmental assessments of the effects of lobster houses. Three lobster house

case studies were the focus: Ascension Bay, México; Batábano Bay, Cuba; and Miches, Dominican Republic. When appropriate, internet searches were conducted to corroborate and expand upon the reports, using both English and Spanish phrases including lobster houses, sustainability, “casitas,” and the locations of the case studies.

2.2 Fieldwork

We designed and implemented a lobster house pilot project for Los Mameyes, a fishing community in Miches, Dominican Republic from 2010 to 2011. Katie Conrad visited three other lobster house projects throughout the Dominican Republic and interviewed managers and fishers regarding the design, placement, management, regulations, enforcement, fishing methods, and success of their lobster houses. This data provided insight on how to conduct the Miches lobster house pilot project.

3. Results and Discussion

This study determined which characteristics of the three local lobster house fisheries contributed to their sustainability, as reported by the fishers, managers, and case study authors. A summary of the information obtained during our efforts is given below (Table 1). Each of four general categories will be discussed in turn: environmental conditions, design characteristics, management, and other socioeconomic factors. Within each category, we discuss the rationale behind our evaluation as to how well each aspect was addressed within each case study.

	Case Study Characteristics that May Contribute to Lobster House Fishery		
	Sustainability Ascension Bay, México	Batábano Bay, Cuba	Miches, Dominican Republic
Sources	Sosa-Cordero et al., 2008	Muñoz-Nuñez, 2009	Current Study
Lobster Houses Present	➤ 50 years	➤ 50 years	➤ 1 year
Exploitation status	Stable	Declining	Declining
Environmental Conditions			
Larval supply	√	√	√
Habitat requirements	√	√	√
Design Characteristics			
Material	√	√	○
Design	√	√	○
Placement	√	√	○
Management			
Organization	√	√	○
Territoriality	√	√	X
Regulations	√	○	○
Ban all other fishing methods	√	X	X
Ban catch of berried females	√	√	√

Closed season	√	√	√
Limited access	√	√	X
Minimum size limit	√	√	√
No fishing zones	√	√	O
Co-management	√	√	X
Enforcement	√	O	X
Socioeconomic Factors			
Openness to change	√	√	O
Availability of alternative livelihoods	√	X	X
Access to sustainable markets	√	√	X

Table 1. A list of the case studies examined in this study and their characteristics that contribute to the sustainability of the fishery. Fishery status indicates whether the *P. argus* catch is increasing, declining, or stable (no increase or decrease). Lobster houses present describes how long lobster houses have been used in the community. A √ indicates that the fishery has this characteristic, an O indicates that it is partially present, and X indicates that the characteristic is absent.

3.1 Environmental Conditions

The lobster house fisheries in Ascension Bay and Batábano Bay could not be successful if they did not each meet key environmental conditions: a constant supply of lobster larvae and the required habitats for all of the lobster's life stages. *Panulirus argus* landings primarily consist of new recruits and therefore correspond with fluctuations in recruitment (Cruz et al., 1995). Both larvae and settlement substrate (such as seaweed beds or mangroves) need to be present in order to recruit juveniles and support a viable lobster house fishery (Eggleston and Lipcius, 1999).

Lobster recruitment varies from year to year due to many biological and meteorological factors. The three lobster house case studies featured in this study have the advantage of being located in an area with high larval retention: Ascension Bay (Sosa-Cordero et al., 2008), Batábano Bay (Ehrhardt, 2005), and Miches (Herrera-Moreno and Betancourt, 2003a). We have found no evidence that any of these lobster house projects have failed due to a chronic lack of larvae. However, extreme weather events have disrupted the settlement of larvae, destroyed habitat, and decreased adult populations, resulting in a decrease in catch for years afterwards. This phenomenon has been observed in Ascension Bay (Sosa-Cordero et al., 2008), Batábano Bay (Muñoz-Nuñez, 2009), and in the Western Yucatan (Salas et al., 2008). Although these lobster house fisheries have had adequate larval recruitment in the past, climate change may influence the supply and distribution of larvae as major storms become more frequent and currents shift.

The Ascension Bay, Batábano Bay, and Miches sites all seem to have the lobster habitats required for development (Solares-Leal and Álvarez-Gil, 2003; Muñoz-Nuñez, 2009; Herrera-Moreno and Betancourt, 2003a). These include a nearby mangrove or macroalgae bed to provide settlement substrate for larvae; a shallow, sheltered bay filled with seagrass; patches of coral reef, between which lobster houses could be placed on sand or hard bottom substrates; and an extensive outer coral reef to provide habitat for spawning adults.

3.2 Material, Design, and Placement

The material used to construct lobster houses can affect how often the houses need to get replaced, their environmental impact, and their maneuverability during installation and lobster extraction. The materials and placement guidelines described in Table 2 are practiced in both the Cuban and Mexican fisheries and have been found to contribute to fishing success throughout the Caribbean (Miller, 1982; Quinn and Kojis, 1995; Salas et al., 2008; Eggleston et al., 1990). One of the greatest benefits of using lobster houses as opposed to free-diving is that the lobster houses reduce the inevitable damage to the reef by fishers and their boats. Refocusing the efforts of lobster fishers away from the fragile reefs and seagrass beds to hard substrate that is not natural habitat for many marine organisms minimizes incidental environmental damage.

Successful Lobster House Characteristics		
	Purpose	Source
Ferrocement	Heavy enough not to cause environmental damage in minor storms and can last for multiple fishing seasons	Miller 1982
Size: 1x1 m with a height of around 15 cm	Large enough to accommodate many lobsters and prevent most predators from entering	Eggleston et al. 1990
Depth 5-20 m	Accessible by free diving	Quinn and Kojis 1995
Hard substrate	The house does not sink into the sand or mud	Miller 1982
Flat substrate	Provide stability	Salas et al. 2008
Close to seagrass and macroalgal beds	Food access and minimizes incidental environmental damage	Salas et al. 2008
Distance between houses 30-50 m	Maximize the use of houses for moving between food patches	Salas et al. 2008
Sides of the house should be facing the dominant current	Protect the lobsters from currents and prevents the crawl space from filling with sand and debris	Salas et al. 2008
50 m away from natural refuges	Maximize the availability of shelter throughout the ocean floor and minimizes incidental environmental damage	Salas et al. 2008

Table 2. Beneficial lobster house placement characteristics derived from interviewing experienced lobster house fishers from Cuba and Mexico.

Dominican fishers using lobster houses in Miches have been reluctant to follow the above guidelines because lobster houses are such a new fishing method and because it takes more time to find sites that meet all of these requirements. Ferrocement lobster houses have only been introduced to the Dominican lobster fishery in Miches this past summer. Other fishers in the community have had previous experience with lobster houses made from more impermanent materials, such as tires and aluminum roofing. Lobster houses made from these

alternative materials will cause more environmental reef damage than ferrocement houses because they are lightweight and easily destroyed during storm surges. Typically they disintegrate after only one season (Miller, 1982).

3.3 Management

Ascension Bay and Batábano Bay both share certain aspects of their management systems that contribute to the overall sustainability of the lobster house fishery: organization, territoriality, adoption of certain regulations, and regulation enforcement at the local and national level. The adoption of these management practices by other lobster house fisheries will likely contribute to their sustainability. In contrast, although the Dominican Republic has a relatively comprehensive set of regulatory laws, the country lacks adequate enforcement of these regulations. In addition, lobster houses were only introduced to the country a few years ago, so the adoption of the necessary management and enforcement practices are only beginning to be developed.

Organization at the local, national, and regional levels is important to ensure that the rights of fishers are protected and that they have access to the resources they need, facilitating the delegation of management responsibilities, and protecting the environment and fishing resources. Good organization is the foundation on which the other managerial aspects of the fishery must be based in order to allow for the highest production and quality possible at the lowest cost (WWF, 2006). Fishers in Ascension Bay (Sosa-Cordero et al., 2008) and Batábano Bay (Puga Millán, 2005) are organized at the local level by membership in a fishing cooperative and association, respectively. By participating in these organizations, individual fishermen receive benefits such as credit for buying fishing gear, access to storage facilities, certain fishing sites, and more markets with better prices. Furthermore, participation helps fishers to develop their commercialization strategies and serves to provide more incentive to respect regulations—as well as the ability to create and enforce their own regulations (WWF, 2006).

Organization also facilitates the delegation of management responsibilities. A popular fishing organization is the co-management system as practiced in the Mexican lobster house fishery in Ascension Bay, which assigns management responsibilities not just to the government's fisheries department, but also to fishing communities. These arrangements may have additional internal regulations at the community level to ensure sustainability (Sosa-Cordero et al., 2008). These additional regulations are agreed upon by every cooperative member and can promote stewardship by increasing enforcement opportunities for resource users to control outcomes and enhancing cooperation between user groups and the government for enforcement (Cochrane, 1998). When internal regulations are made, the national government must formally recognize them if cases are to be brought to court for arbitration (Sosa-Cordero et al., 2008). The Cuban *P. argus* fishery is organized for top-down enforcement from the Ministry of Fisheries to the local fishing association but also delegates certain management responsibilities to fishing communities (Joyce, 1997). In Miches, fishers are unable to organize due to a lack of resources, though the national fishery council has created comprehensive regulations and implemented the collection of basic fishery data. However, the desire to organize exists, and internal regulations may be adopted if the benefits are apparent.

Organization at the regional level is necessary for *P. argus* as a common pool resource. Viewing *P. argus* as such would require the presence of regional infrastructure to collect more information, such as the regional population dynamics, in order to support national and regional policies (Ehrhardt, 2005). Regional coordination has proved a challenge in the Caribbean

because it is one of the most socially and politically complex regions in the world, consisting of 26 countries and 19 territories that range from small to large, rich to poor, developed to undeveloped. The region also has five official languages and diverse indigenous cultures (Fanning et al., 2009). There are currently seven regional and international organizations working on fishery problems in the Caribbean, though these have incomplete coverage and lack effective inter-organizational communication (Mahon, 2008). In May 1, 2009, CLME (Caribbean Large Marine Ecosystem) Project was launched with the goals of achieving maximum sustainable yield of fisheries in the region by 2015 and introducing an ecosystem-based approach to fisheries management. The first step of implementation was to incorporate the Caribbean's regional organizations into a centralized framework and to designate management responsibilities (Fanning et al., 2009). If CLME can facilitate the process of standardizing data collection, hopefully standardization of regulations throughout the Caribbean will result.

The adoption of territoriality is essential to the success of a lobster house fishery. Batábano Bay (Muñoz-Nuñez et al., 2009) and Ascension Bay (Sosa-Cordero et al., 2008) lobster house fisheries, are both based on a territorial management system in which each individual fisher is given his own territory on which to place lobster houses. In the past, lobster house fisheries that have not used territoriality either failed completely or have remained small-scale because fishers do not want to invest their time and money into fishing and maintaining houses when access to their property cannot be guaranteed. Communities in the Northern Yucatan adopted lobster houses at the same time as Ascension Bay but the community did not adopt the campo system (Seijo, 1993). Fishers soon abandoned the houses and reverted back to using other fishing methods, eventually leading to the collapse of the fishery (Solares-Leal and Álvarez-Gil, 2003). Currently 10 of the lobster houses in Miches are open access, but there is concern among fishers that other fishers in the community and from elsewhere will take lobsters from houses that are not theirs, from those 40 that are owned and operated individually. Until territoriality is implemented and respected in Miches, it is unlikely that lobster houses will be successful.

To have a sustainable *P. argus* fishery, regulations that account for the population dynamics and complicated life cycle of the lobsters are needed. Although many countries in the Caribbean already have adopted some regulations to protect *P. argus* populations, they often provide incomplete protection from overexploitation. The most valuable management regulations for *P. argus* fisheries in this study are summarized in Table 3. The Mexican Punta Allen fishery has adopted and implemented all of these regulations and is regarded as a sustainable *P. argus* fishery (Sosa-Cordero et al., 2008). However, one of the possible contributors to overexploitation in Cuba's Batábano Bay is the disregard for a single regulation – using multiple lobster fishing methods – which in turn puts pressure on each of the life stages (Muñoz-Nuñez, 2009). In the Dominican Miches fishery, other lobster fishing methods are used as well and there are no regulations on materials used or their placement. To ensure the sustainability of these lobster house fisheries, all of these regulations should be adopted and enforced.

Recommended National Regulations	Function	Source
Minimum size limit (81 CL)	Allows 75% of lobsters to reach reproductive age	Muñoz-Nuñez 2009
Ban illegal-sized lobster trade	Encourages enforcement of the size limit internationally	Ehrhardt 2005

Berried lobster fishing ban	Protects breeding females	Ehrhardt 2005
Closed season March to May	Protects breeding lobsters	Ehrhardt 2005
No-fishing zones in major nursery habitats	Preserve feeding grounds, protect juveniles, and enhance overall reproduction	Muñoz-Nuñez 2009
No-fishing zones in coral reefs	Preserve feeding grounds, protect larger lobsters that have a higher reproductive potential, and reduce damage to coral reefs that may provide additional food	Sosa-Cordero et al. 2008
Ban compressors	Reduce negative health effects, reduce overfishing because the fishers are able to stay underwater for longer and fish at greater depths	Herrera-Moreno and Betancourt 2003b
Ban gaffs and harpoons	Kill or injure lobsters before they can be assessed as legally sized or checked for eggs	Herrera-Moreno and Betancourt 2003b
Ban all other lobster fishing methods	Avoid fishing pressure on multiple life stages and reduce cannibalism induced by the use of lobster traps	Muñoz-Nuñez 2009
Limit access	Facilitate data collection and reduce overfishing	Muñoz-Nuñez 2009
Construction material regulations	Prevent incidental damage to the environment by poorly made houses during extreme weather events, as well as prevent environmental contamination	Salas et al. 2008
Placement regulations	Prevent damage to coral reefs, seagrass beds, and other vegetation	Salas et al. 2008
Standardized regional data collection procedures	Facilitates data collection and allows for the regional analysis of management strategies	Ehrhardt 2005

Table 3. Recommended regulations for *P. argus* fisheries at the local or national level.

In addition to the lack of standardized and biologically-appropriate regulations within and between countries, regulations are rarely enforced due to the regional lack of governmental resources and environmental education (Herrera-Moreno and Betancourt, 2003b). The lack of enforcement is the greatest contributor to lobster overfishing in the Caribbean (Ehrhardt, 2005). Although this characteristic is the most prevalent in Miches, it is also germane to Batámano Bay (Muñoz-Nuñez, 2009). The problems with enforcement in Miches are shared with the other two fisheries and involve corruption of government officials, lack of sufficient government resources, and the absence of economic incentives for compliance (Muñoz-Nuñez, 2009).

3.5 Socioeconomic Factors

Lobster houses are the lobster fishing method with the highest number of lobsters caught per unit effort, resulting in higher profits per lobster, and are among the most time

efficient method used. Lobster houses are low cost to construct and maintain compared to other fishing methods (Miller, 1982). Lobster houses can also increase efficiency by accumulating lobsters during fishing bans, so that the majority of catch is caught in the first two months after the lobster fishing season opens (Solares-Leal and Álvarez-Gil, 2003). Therefore, fishers can refocus their fishing efforts on other species or alternative livelihoods after this two month period.

There are many advantages to using lobster houses over alternative lobster fishing methods, but the fishery must adopt appropriate management strategies. Due to the difficulties involved in creating and enforcing these strategies, this may be the major barrier to fisheries adopting lobster houses. Lobster fisheries in the Dominican Republic are an example of communities that lack the openness to change their management strategies. Dominican lobster house projects face opposition by fishers skeptical of lobster houses because they are not a fishing method that has been traditionally practiced in the country and because the management strategies associated with it are unfamiliar. Fishers in the Dominican Republic are poor and do not have the resources to invest in lobster houses, which have a prohibitively high initial investment cost and may not attract enough harvestable lobsters to pay for themselves for almost a year, which makes it difficult for them to invest in lobster house construction. Dominican fishers tend to be subsistence-based and as such are focused on acquiring enough lobster to cover daily living expenses. Waiting a year to start receiving the benefits of building a lobster house is not feasible. Many of the fisheries are unorganized and fishers travel great distances to other areas to fish, creating concern that other fishers will construct houses in their fishing areas or steal from their casitas. In addition, regulation enforcement is non-existent and would require increased investment by the government and/or increased community involvement in order to enforce the additional regulations required for successful lobster house fisheries.

Another downside to exclusively using lobster houses as a fishing method is that it limits when and where fishing can take place. Initially, anywhere from two months to a year may be needed for enough lobsters to be attracted to the lobster houses. The decline in lobster catch during winter migration and the high interannual variation in catch rates (Ehrhardt, 2005), suggests the need for viable alternative livelihoods. This is not a problem in Ascension Bay, where many of the fishers are members of Mexican tourism cooperatives. In Cuba, however, an increasing number of fishermen have been struggling due to extension of fishery regulations and a decline in catch due to overfishing and a lack of alternative livelihoods. Many Cuban fishers resort to selling lobsters to the black market, further increasing overfishing (Piñeiro et al., 2007).

In Miches, there is a lack of sustainable alternative livelihoods and fishing is the main industry in the coastal community. The development of marine tourism opportunities could provide jobs for fishers that exploit their knowledge of the ocean, such as sport fishing and whale tours (Sosa-Cordero et al., 2008). Diving and snorkeling are popular tourist activities in the Caribbean and are very profitable, but they will require the fishers to learn new skills. One study found that tourists to the Dominican Republic are willing to pay as much as \$60 for a two-dive trip and that fishers can make as much or even more money as guides (Wielgus et al., 2010). In Ascension Bay, some Mexican fishers have switched careers to become guides, reducing fishing pressure (Solares-Leal and Álvarez-Gil, 2003). In Miches there are currently few opportunities for fishers to enter the tourist industry. If laws are not enforced and/or no alternative livelihoods are available, fishers may continue to use illegal lobster fishing methods, which will result in lobster overfishing. The Cuban fishery is becoming overfished, now that

other methods in addition to lobster houses are used and regulations are not enforced (Muñoz-Nuñez, 2009).

A market for the higher cost of sustainably produced lobster is necessary, ideally located close to the lobster fishing community. This local financial incentive could motivate fishers to invest in the high initial cost of building lobster houses in exchange for a greater return on their product in the long-run. The use of lobster houses also allows fishers to catch live lobsters, potentially allowing them to export them abroad, where the price offered for each catch is highest. Such a market is currently exploited by the Ascension Bay fishery in Mexico (Solares-Leal and Álvarez-Gil, 2003), and one is growing in Cuba (Puga Millán, 2005).

Unfortunately, assessing domestic and international live lobster markets is impractical in the Dominican Republic. Almost all of the catch in the DR is killed upon capture and is quickly consumed domestically (Wielgus et al., 2010), therefore minimal infrastructure exists for exportation. Live export does not often occur. There is high domestic demand for lobster due to the well-developed tourism industry, although no distinction is made for sustainably harvested lobsters. Nonetheless, the market for sustainably-caught lobster in the Dominican Republic is likely to grow as environmental concerns and consumer demand for local, sustainably-caught fish rise. Another way to access the sustainable lobster market is through certification by the Marine Stewardship Council. The lobster fisheries in Ascension Bay are currently undergoing the final stages of the certification process (L. Borillon, personal communication, January 31, 2011). Certification would require fisheries to meet basic requirements, such as maintaining fishing activity at a sustainable level and adhering to all local, national, and international laws (Marine Stewardship Council, 2010). The Miches fishery currently lacks all of the basic requirements for certification, so certification would take a number of years to acquire.

4. Conclusions

Achieving sustainability in *P. argus* fisheries is a difficult task. The complex life cycle of the lobster coupled with the confusion of harvesting by small-scale fisheries in a politically and culturally diverse region greatly complicates sustainability efforts. A lack of adequate fishing regulations and enforcement of such regulations does not help either. However, management of this fishery is becoming easier due to the increasing global demand for sustainably-caught fish, the rising local and global awareness of the negative environmental and social effects of current lobster fishing practices, the increasing collaboration between countries with regard to fishing policy formation, and the growing number of certified small-scale lobster fisheries.

We have suggested that lobster houses may contribute to a sustainable lobster fishery if certain environmental characteristics, management practices, and socioeconomic factors are present. The Mexican lobster house fishery in Ascension Bay is a perfect model of a sustainable fishery, because there have been no significant harvest declines nor negative environmental effects over its entire 50-year existence. Cuba's Batámano Bay lobster house fishery is rapidly declining and lacks regulation enforcement. However, it could become more sustainable as a fishery if the regulations outlined in this paper are incorporated under regular enforcement and if there are the appropriate socioeconomic incentives for sustainable extraction. The Miches fishery is only in the beginning stages of the transition to sustainability, given that it lacks sufficient organization at the local and national level, appropriate regulations, regular enforcement, and the socioeconomic incentives to support a sustainable lobster house fishery. As such, Miches will require a number of years before the fishery can develop these prerequisites for lobster houses to contribute to a successful and sustainable lobster house fishery.

Although they may take a significant amount of time to implement in some fisheries, lobster houses can play a vital role in promoting sustainability throughout the Caribbean by simplifying management, reducing incidental reef damage, reducing health risks to fishers, and standardizing fishing practices.

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